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16. Abstract

Project 0-6663 Phase 2 involved evaluation of the TxDOT automated visual distress 3D laser system van and three automated systems developed by automated visual distress data collection vendors. The research team selected 20 test sections in the Austin and Waco Districts comprising asphalt concrete pavement, surface treatments, portland cement concrete, and continuously reinforced concrete pavements. Each of the 550-ft-long test sections were subsectioned at 50-ft intervals and were evaluated manually by an experienced Long Term Pavement Performance (LTPP) manual distress rating team and a TxDOT Pavement Management Information System (PMIS) manual distress rating team. In each case the manual raters followed the LTPP or PMIS Rating Manual protocols to identify and measure distress on each test section. In addition, cross slope was measured with the FACE® Dipstick; texture was measured with the circular track meter; and digital crack map images were obtained by manually marking each crack using different colors related to three width categories and then photographing selected 50-ft subsections using a high-end digital camera. These manual measurements provided a baseline for comparison with the TxDOT and vendor automated system data output. The four participants collected automated distress, cross slope, texture, and crack map images during late July and August, finishing on August 30, 2013. Based on previous discussions with TxDOT and the vendors during a webinar held on January 30, 2013, data was reported by TxDOT and the vendors for three time intervals: 1) immediately after data collection with no manual post processing; 2) within 2 business days with minimal post processing; and 3) within 4 weeks with full, manual post processing. The last set of completed data was received in early October, 2013. These data sets were used by the research team to conduct both analytical and visual comparative analysis of output from the four automated systems presented in this report.

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Field Evaluation of Automated Distress Measuring Equipment

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Products

Chapter 4 of this report also constitutes the deliverable P2, *Recommendations for Selection of Automated Distress Measuring Equipment*.

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Chapter 1. Introduction

1.1 Motivation for Project

The Texas Department of Transportation (TxDOT) has developed a state-of-the-art 3D system for the automated measurement of pavement surface rutting and distresses at highway speeds. This system will allow the assessment of road performance at both the network and project levels and potentially eliminate the need for manual visual assessments to rate pavement distress at the network level for Pavement Management Information System (PMIS) applications. Furthermore, the improved accuracy of these systems will eliminate many subjective elements associated with visual rating and can lead to more consistent and reliable data.

It is anticipated that the improved accuracy of these systems will impact the TxDOT PMIS distress and condition scores. PMIS is used to monitor statewide pavement condition and to evaluate the effectiveness of pavement maintenance and rehabilitation treatments. PMIS is also used to report progress in achieving the statewide pavement condition goal (90% of lane miles in "good" or better condition) and the condition score goals established annually for each district. A change in accuracy and precision of pavement condition data will affect the PMIS outputs, possibly resulting in misleading information about the performance of the pavement network. For instance, the larger number of distresses captured by transitioning to a more precise measurement system will cause an apparent increase in the deterioration of the pavement network. Consequently, current algorithms and utility functions used in PMIS may require revision to reflect the improved accuracy of these new systems.

To ensure the rational adoption of the new systems, TxDOT has initiated this project to provide an independent assessment of the accuracy and repeatability of the new automated distress data measurements provided by the TxDOT systems as well as the vendor systems used by other DOTs that are considered the state of the practice. The TxDOT system was compared to other similar systems from a variety of vendors to identify the best system for automated distress. This project has three Phases. Phase 1 evaluated the rut and transverse profile measurements; Phase 2 evaluated automated surface distress, texture, and cross slope data measurements. A third phase, which TxDOT added during the project, is currently underway. Phase 3 was incorporated into the scope of the project during Phase 2 with the objective of extending the automated systems' evaluation with a focus on network-level processes and applications. The Phase 3 study will be addressed in a future report. This report describes the experiments, analyses, and results of Phase 2 along with the analyses and findings from the assessment of the impact of upgrading the automated measurement system on the TxDOT PMIS scores.

1.1.1 Summary of Phase 1

Phase 1 involved the development of a factorial experiment of over 26 pavement test sections to evaluate the rut and transverse profile measurement capabilities of automated systems at highway speeds. These test sections were located in the Austin District and included dense graded and permeable friction course hot-mix asphalt concrete, and surface treatments representing the population of pavement textures apparent on the Texas road network. The reference data included transverse profiles measurements collected every 25 ft on each 550-ft-long test section in addition to manual rut measurements collected every 5 ft in both wheel paths using a 6-ft straight edge and rut wedge based on ASTM standards. In addition to TxDOT's efforts, four service providers collected automated measurements on the same intervals as the reference data: Applus (with a laser crack measurement system [LCMS] from INO), Dynatest (with a laser rut measurement system [LRMS] from INO), Pathways (in-house developed 3D system), and Roadware (with INO LRMS).

The accuracy and repeatability of each automated system were assessed by performing two independent assessments. One assessment was of the rut measurement hardware systems, based on the ability of each system to produce accurate transverse profiles in relation to reference measurements. The second assessment accounted for both hardware and software (i.e., filters and data processing algorithms) and was based on the calculated rut depth measured on the pavement surface.

The Phase 1 results were presented to TxDOT Urban District engineers during a meeting held at CTR with the Pavements Section of the Construction Division. Since that time, TxDOT has been restructured and PMIS and the automated data collection personnel and equipment have been transferred to the Pavement Performance Branch of the Maintenance Division.

1.1.2 Summary of Phase 2

In Phase 2 a literature review was conducted to determine the state of the practice for automated distress measurements by different vendors and highway agencies in the US and abroad. In addition, similar studies, such as Pierce et al. (2012), were considered and discussed with the TxDOT PMC during the experimental design. During this phase, a second field study was performed involving 20 test sections located in the Austin and Waco Districts. The Phase 2 experiment was developed to provide a two-pronged comparison: 1) automated distress, texture, and cross slope measurements collected in the field at highway speeds by TxDOT were compared with measurements from vendor-automated systems; and 2) both TxDOT and vendor results were compared with manual measurements collected by experienced PMIS and Long-Term Pavement Performance (LTPP) manual distress raters. In addition, the crack maps reported by each vendor were compared to digital crack maps produced statically by visual detection and measurement of crack length and severity by the research team.

In addition to TxDOT, the three vendor system participated in the study: Dynatest (with an INO LCMS), Fugro (with an INO LCMS), and WayLink-OSU (with an in-house-developed 3D system). The recommendations for the selection of distress measurement system are provided in Chapter 4 of this report.

In addition, the impacts of the improved accuracy of rutting measurements on PMIS scores were analyzed using a Monte Carlo technique to simulate the PMIS condition databases of the entire TxDOT highway network for the current five-sensor discrete measurement system and the analyzed continuous rut measurement system. The findings of this analysis are reported in Chapter 5 of the report.

1.2 Automated Data Collection Technologies

Prior to the beginning of project 0-6663, TxDOT performed a survey of highway agencies to determine the current state of the practice regarding rut measurements of flexible pavements in the US. This survey revealed that a variety of automated systems are used to measure rutting and identified various state DOT and national standards that define pavement rutting, including manual, static, and automated measurement protocols (TxDOT 2010).

An extensive literature review was also conducted during this study with a focus on data collection technologies and the providers currently performing PMIS data collection in the United States and/or abroad whose technologies are commercially available or can be readily contracted. This review revealed that a number of technologies are still under development and may be available as soon as next year. In addition, some technologies available in Europe (in particular in the United Kingdom, Sweden, and Denmark) are comparable or potentially superior to those available in the US. However, the practical cost and time limitations of the study limited participation to technologies that were commercially available at the time the field surveys were conducted and met the operational requirements established by the researchers and TxDOT. These requirements were discussed with the vendors during two webinars (Phase 1 rutting and Phase 2 visual distress) to ensure that no unavailable technologies were considered for evaluation, and that all participants met the basic equipment specification requirements.

A preliminary review of equipment and vendors made apparent that several vendors used the same hardware (e.g., INO systems such as LRMS or LCMS) but may use different software algorithms to process the measurements. In other cases, vendors may have developed both the hardware and software systems, which are totally proprietary. Consequently, visual distress data are measured and processed differently and the results are reported using different formats depending on the libraries developed to meet DOT and other customer requirements. Each vendor contacted for participation in the Phase 2 study incorporated the LTPP distress protocols in their protocols. Due to funding and time limitations for the Phase 2 study, it was considered impractical to require the vendors to develop a new visual distress processing algorithm that could report results in the TxDOT PMIS protocol. Likewise, it was not feasible for TxDOT to develop the algorithms and rules sets necessary to report data in the LTPP protocol. Thus, both LTPP and PMIS manual visual distress measurements were collected by experienced raters during collection of the reference data on each section.

During automated testing on each section, the researchers asked the equipment operators questions in order to understand the logic incorporated in the vendor's software as well as the capabilities and limitations of the hardware systems. This information was later used to develop the reporting time frames for data since it was determined that none of the systems provided true, fully automated analysis of results that could be delivered at the end of a data collection run. As a result the researchers required each participant to provide data immediately after a run, within 2 days with minimal processing, and at the end of 4 weeks with full manual processing. Full manual processing was expected to provide the most accurate measurements possible.

Chapter 2. Phase 2 Experiment

The Phase 2 experiment was designed with the objective of evaluating high-speed measurements of automated distress measurement systems (ADMS) for Texas conditions. Twenty test sections were selected in order to capture a representative sample of typical pavement characteristics encountered on Texas highways for the main experimental variables of the study; these test sections also represented roadway geometric conditions that could present challenges for the automated systems. The data collection was carried out in three main stages. The first stage consisted of the manual measurement of surface distresses, texture, and cross slope data by experienced manual raters. The second stage consisted of the high-speed data collection of each type of data by the different automated systems. Once the automated measurements were completed, the research team conducted the data collection of reference digital crack maps by photographing the cracks visually detected and measured in the field. This section presents the different experimental variables considered for the experimental design, describes the selected test sections, and documents the data collection process.

2.1 Experimental Design

The first part of the experimental design consisted of identifying the critical variables affecting automated measurement systems. Most of the important variables affecting automated measurement systems are well known; the list was expanded after interaction with TxDOT PMC and the service providers. Additionally, as occurred during the experiment in Phase 1, the initial list of selected variables was modified while we progressed on the manual data collection and new problems and ideas arose. Following are some of the most important variables accounted for during the selection of test sections:

1. Pavement type:
    a. Flexible (hot-mix asphalt [HMA], surface treatments [ST], others)
    b. Rigid (jointed concrete pavement [JCP], continuously reinforced concrete pavement [CRCP])
2. Pavement condition:
    a. Type of distress (from LTPP and PMIS protocols)
    b. Severity of distress (low, medium, high)
3. Characteristics of the road:
    a. Surface texture (fine, coarse)
    b. Lane width (narrow, wide)

Secondary variables considered in the experimental design and used for selection of test sections included the following:

4. Pavement condition (additional):
    a. Combination of distresses
    b. Presence of sealed cracks

5. Characteristics of the road (additional):
    a. Presence of horizontal curve
    b. Presence of vertical curve
    c. Presence of shoulder
    d. Variation in pavement cross slope
6. Facility type (IH, US, SH, FM/RM)
7. Other anomalies considered were lighting and environmental conditions, flushing, lane-shoulder separation, transitions from light to dark pavement surface coloration, extensive patching, and variable edge conditions including vegetation and edge drop offs.

As for Phase 1, the survey sections were 550 ft in length (around 0.1 miles). The total number of survey sections was set to 20 upon agreement with TxDOT and covered as many variables and combination of variables as possible. The experiment included flexible pavements, which comprise approximately 94% of the pavements in Texas. Flexible pavements were sub-divided into two main types: HMA and ST. In addition, a permeable friction course (PFC) surface was included in the study with the objective of capturing whether the automated systems might produce a larger number of false positives on surfaces with negative macro-texture, as suggested by the literature. Rigid or portland cement concrete pavements were sub-divided into JCP and CRCP. Thus, the measurements produced by the ADMS were evaluated on the most representative types of pavements encountered in Texas. Due to the labor-intensive and time-consuming processes involved in the reference crack map data collection, the number of collected crack maps was limited to three 50-ft subsections per test section at 10 of the 20 test sections of the study, thus collecting a total of 30 reference crack maps for the analyses. Table 2.1 shows the number of test sections for each surface type in the experiment and type of data collected.

Table 2.1: Distribution of Test Sections According to Surface Type

Type of Pavement		**Number of Test Sections**	
		Distresses, Texture and Slope	Digital Crack Maps
Flexible	HMA	7	4
	STs	7	3
	PFC	1	1
Rigid	JCP	2	1
	CRCP	3	1
	Total	*20*	*10*

One of the challenges faced in Phase 2 that was not a consideration in Phase 1 was that not all relevant pavement types exist in the Austin District. For example, there are no JCP sections in the Austin District on the state-maintained network; further, CRCP pavements only exist on very high traffic volume pavements and lack the range in distress types and severity that were required to meet the Phase 2 objectives. Therefore, in addition to the sections identified in the Austin District, the research team had to establish test sections in the Waco District, which increased the complexity and time involved in coordinating traffic control, mobilizing data collection teams, and conducting data collection. Figures 2.1 and 2.2 show the locations of the 13 test sections selected in the Austin District and the 7 test sections in the Waco District respectively. Please note that some of test section were located side-by-side or contiguous and therefore their pins overlap, appearing as one section in the maps.

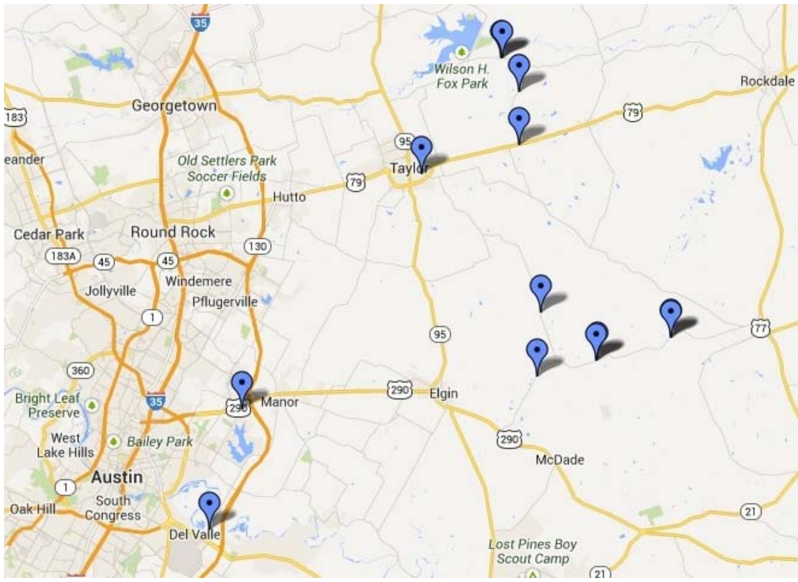


Figure 2.1: Location of Test Sections in the Austin District

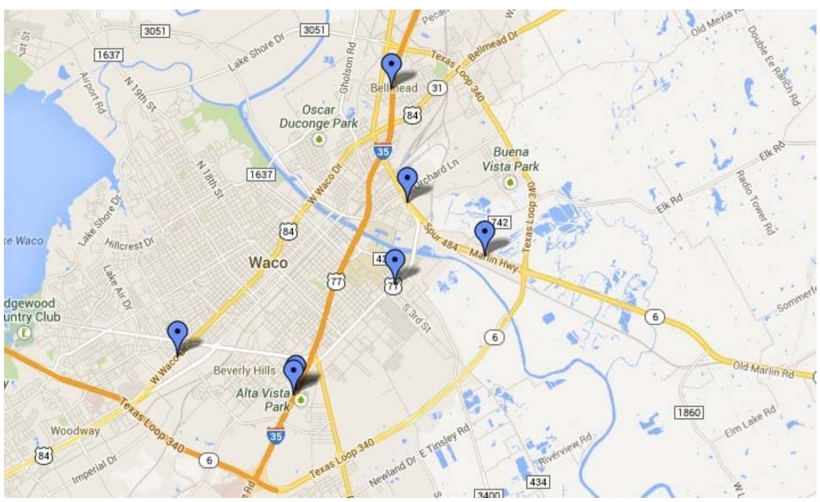


Figure 2.2: Location of Test Sections in the Waco District

2.2 Description of Test Sections

Table 2.2 presents the main characteristics of every test section of the experiment. The "Manual DC Order" and "Automated DC Order" columns contain the order in which each section's data was collected during the manual and the automated data collection respectively ("DC" abbreviates "data collection"). To avoid any confusion, each test section will be referred to in this report using the names presented in the third column, unless stated otherwise. The fourth and fifth columns indicate the direction and District in which each section was collected. The lane tested in all sections was the outer lane except for section US84, where the inner lane was surveyed. The sixth column indicates the surface type of each test section while the remaining columns indicate the posted speed limit and the type of paint marking for the inner and outer stripes. The information presented in the last three columns was used to guide the automated and manual data collection as explained in the next section of the report.

Table 2.2: Main Characteristics of Test Sections

Manual DC Order	Automated DC Order	Name	Direction	Location	Surface Type	Speed Limit (mph)	Inner Stripe	Outer Stripe
1	8	**FM619-1**	NB	Austin	ACP* - ST	65	Solid	None
2	3	**FM696-1**	EB[1]	Austin	ACP - ST	65	Solid	Solid
3	6	**FM696-2**	WB[1]	Austin	ACP - ST	65	Solid	Solid
4	4	**FM696-3**	EB[1]	Austin	ACP - HMA	65	Solid	Solid
5	5	**FM696-4**	WB[1]	Austin	ACP - HMA	65	Solid	Solid
6	7	**FM696-5**	WB	Austin	ACP - HMA	65	Solid	Solid
7	9	**FM112-1**	EB	Austin	ACP - ST	35	Solid	None
8	10	**FM1331-1**	WB[1]	Austin	ACP - ST	65	Dashed	Solid
9	11	**FM1331-2**	EB[1]	Austin	ACP - ST	65	Dashed	Solid
10	12	**FM1063-1**	SB	Austin	ACP - ST	65	Solid	None
11	13	**US79-1**	WB	Austin	ACP - PFC	70	Dashed	Solid
12	1	**FM973-1**	NB	Austin	ACP - HMA	60	Solid	Solid
13	2	**FM3177-1**	SB	Austin	ACP - HMA	60	Dashed	Solid
14	17	**La_Salle-1**	SB	Waco	ACP - HMA	40	Dashed	Solid
15	15	**Spur484-1**	EB	Waco	ACP - HMA	60	Dashed	Solid
16	16	**US77-1**	EB	Waco	JCP	40	Dashed	Joint
17	20	**US84-1**	NB	Waco	JCP	50	Dashed	Curb
18	18	**IH35-1**	SB[3]	Waco	CRCP[2]	50	Dashed	Curb
19	19	**IH35-2**	SB[3]	Waco	CRCP	50	Dashed	Curb
20	14	**IH35-3**	SB	Waco	CRCP	40	Dashed	Curb

(*ACP – asphalt concrete pavement) [1]Side-by-side section [2]CRCP with asphalt patch/overlay [3]Contiguous sections

The following subsections contain pictures of each test section along with an aerial view extracted from Google Maps in order to provide information about surrounding landmarks such as intersecting roads, horizontal curves, buildings, and other features.

2.2.1 FM619-1

- Located in Austin District on FM 619 (coordinates: -97.260216,30.427958)

Figure 2.3: Picture and Aerial View of FM619-1

2.2.2 FM696-1

- Located in Austin District on FM 696 (coordinates: -97.197021,30.381105)

Figure 2.4: Picture and Aerial View of FM696-1

2.2.3 FM696-2

- Located in Austin District on FM 696 (coordinates: -97.195511,30.381889)

Figure 2.5: Picture and Aerial View of FM696-2

2.2.4 FM696-3

- Located in Austin District on FM 696 (coordinates: -97.112907,30.404057)

Figure 2.6: Picture and Aerial View of FM696-3

2.2.5 FM696-4

- Located in Austin District on FM 696 (coordinates: -97.111603,30.405031)

Figure 2.7: Picture and Aerial View of FM696-4

2.2.6 FM696-5

- Located in Austin District on FM 696 (coordinates: -97.264336,30.366222)

Figure 2.8: Picture and Aerial View of FM696-5

2.2.7 FM112-1

- Located in Austin District on FM 112 or E. Walnut Street (coordinates: -97.395889,30.564747)

Figure 2.9: Picture and Aerial View of FM112-1

2.2.8 FM1331-1

- Located in Austin District on FM 1331 (coordinates: -97.305000,30.677795)

Figure 2.10: Picture and Aerial View of FM1331-1

2.2.9 FM1331-2

- Located in Austin District on FM 1331 (coordinates: -97.306343,30.677818)

Figure 2.11: Picture and Aerial View of FM1331-2

2.2.10 FM1063-1

- Located in Austin District on FM 1063 (coordinates: -97.285370,30.645325)

Figure 2.12: Picture and Aerial View of FM1063-1

2.2.11 US79-1

- Located in Austin District on highway US 79 (coordinates: -97.285011,30.593393)

Figure 2.13: Picture and Aerial View of US79-1

2.2.12 FM973-1

- Located in Austin District on FM 973 (coordinates: -97.638672,30.214649)

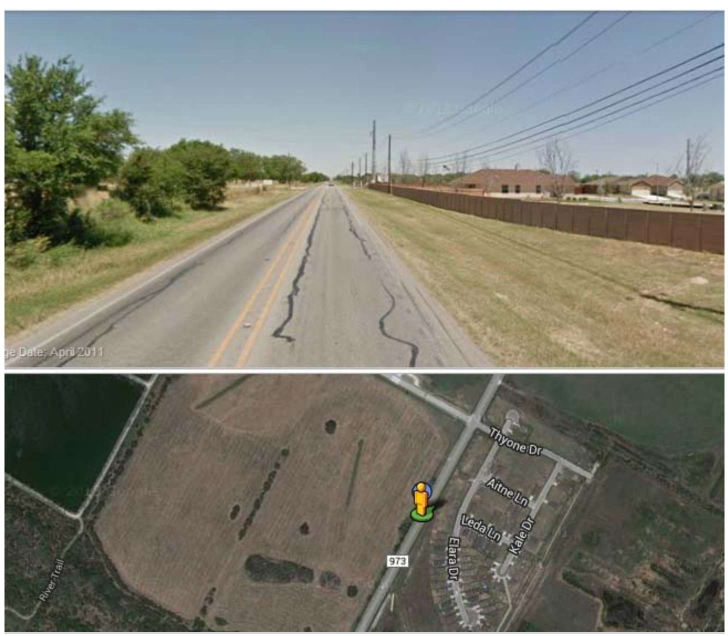


Figure 2.14: Picture and Aerial View of FM973-1

2.2.13 FM3177-1

- Located in Austin District on Decker Lane near US 290 (coordinates: -97.601555,30.333504)

Figure 2.15: Picture and Aerial View of FM3177-1

2.2.14 La_Salle-1

- Located in Waco District on Loop 491 or La Salle Avenue (coordinates: -97.108971 ,31.543566)

Figure 2.16: Picture and Aerial View of La_Salle-1

2.2.15 Spur484-1

- Located in Waco District on Marlin Highway or Spur 484 (coordinates: -97.081589,31.550722)

Figure 2.17: Picture and Aerial View of Spur484-1

2.2.16 US77-1

- Located in Waco District on S. Loop Drive alongside US 77 (coordinates: -97.104897 ,31.564384)

Figure 2.18: Picture and Aerial View of US77-1

2.2.17 US84-1

- Located in Waco District on US 84 or W. Waco Drive (coordinates: -97.174248,31.524954)

Figure 2.19: Picture and Aerial View of US84-1

2.2.18 IH35-1

- Located in Austin District on the SB frontage road alongside IH 35 (coordinates: -97.138550, 31.516293)

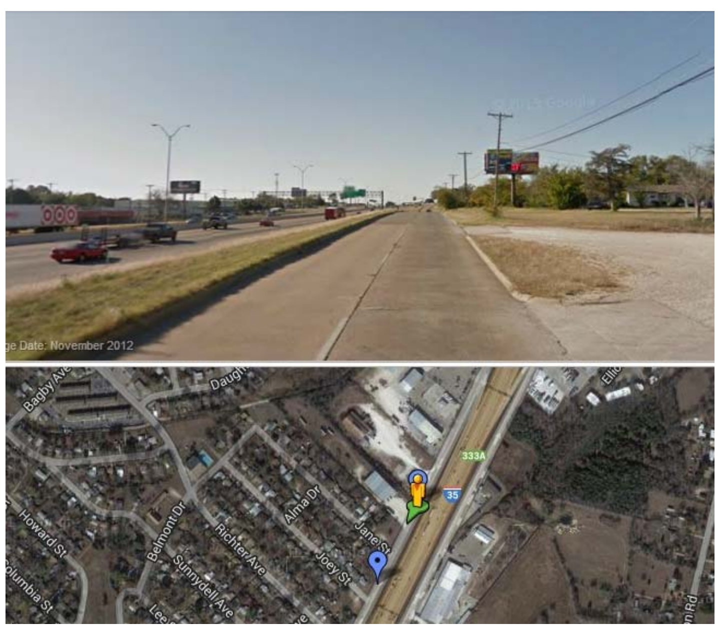


Figure 2.20: Picture and Aerial View of IH35-1

2.2.19 IH35-2

- Located in Waco District on the SB frontage road alongside IH 35 (coordinates: -97.139343, 31.514938)

Figure 2.21: Picture and Aerial View of IH35-2

2.2.20 IH35-3

- Located in Waco District on the SB frontage road alongside IH 35 (coordinates: -97.109703, 31.593853)

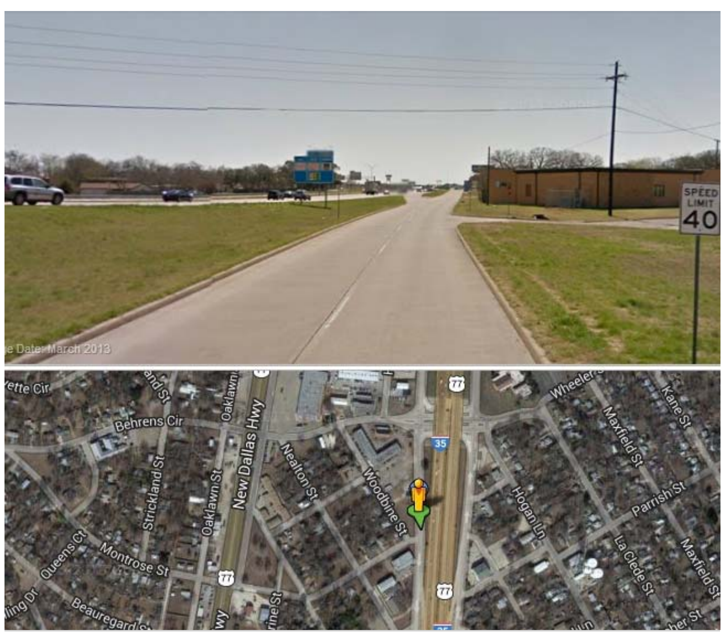


Figure 2.22: Picture and Aerial View of IH35-3

2.3 Data Collection

2.3.1 Manual Distress, Texture, and Cross Slope Data

The manual data collection was carried out during June and July of 2013. Traffic control was required to perform the measurements for all types of data simultaneously in the 550-ft-long pavement sections. All manual measurements were conducted by experienced raters that collected the following types of data:

- Surface Distresses
    - as defined by the LTPP protocol
    - as defined by the TxDOT PMIS *Rater's Manual*
- Surface Texture
- Cross Slope

Each test section was divided into 12 50-ft subsections for analysis as indicated in the diagram of Figure 2.23. The first step during manual data collection consisted of marking the test section with spray paint to indicate the starting and ending points of each subsection as well as additional relevant information. The marking of the sections aimed to inform the automated system operators of the locations at which the manual raters performed their measurements in order to ensure consistency for the data comparison. Each subsection was then marked with spray paint, with numbered crosses marking every 50 ft, dashes marking every 25 ft, and dots marking every 5 ft.

Figure 2.24 shows the yellow (or white) line painted transversally at the starting and ending points of the test sections. The figure also shows the measuring wheel used to locate the starting and ending points of the subsections. Figures 2.25 and 2.26 show the marking applied to indicate the 5- and 50-ft increments respectively, measured from the beginning of the test section. The 5-ft increment markings were used as the reference for taking the individual pictures during the reference crack map data collection. In addition, a 2-ft-long white arrow was placed 1 ft before the beginning of each test section using temporary pavement stripe.

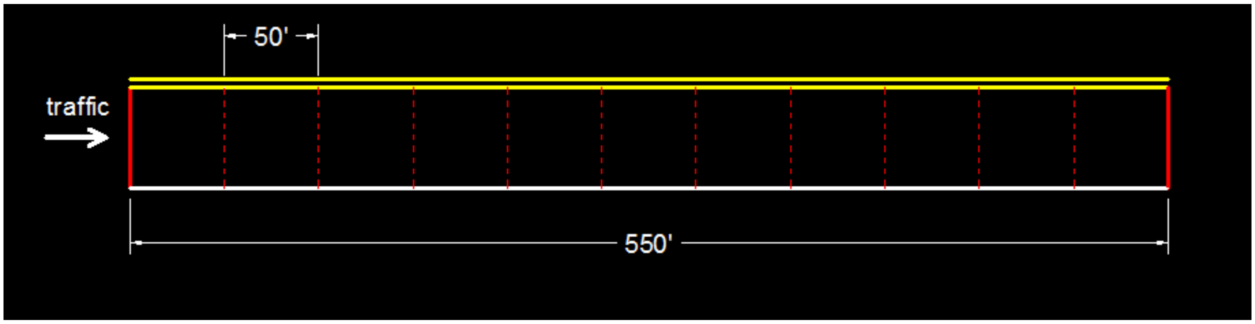


Figure 2.23: Layout and Dimensions of Subsections

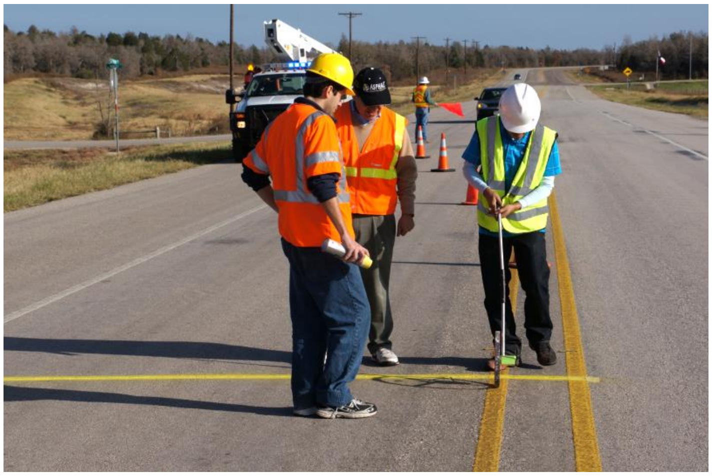


Figure 2.24: Marking Applied to Indicate the Starting and Ending Points of the Test Section

Figure 2.25: Painted Dots to Indicate 5-ft Increments from the Beginning of the Test Section

Figure 2.26: Special Marking to Indicate 50-ft Increments from the Beginning of the Test Section

Manual Distress Surveys

The visual measurement of pavement surface distresses was performed for every section by two different crews of raters. One crew measured the distresses as defined by the LTPP protocol (Miller 2003), and the other crew measured the distresses as defined in the TxDOT PMIS *Rater's Manual* (TxDOT 2009). Each crew consisted of two raters with extensive, practical experience in the respective protocols.

Figure 2.27 shows the manual LTPP raters performing the visual rating in one of the sections. The raters were asked to perform the collection of surface distresses and crack maps as they usually do for any other LTPP or PMIS section without any input of suggestion from the researchers, in order to ensure that the collected measurements are representative of a regular manual distress survey. As shown in Figure 2.27, the LTPP raters used a measuring wheel to determine the extent of each type of surface distress. The PMIS rater, however, did not use a measuring wheel. Both crews reported the measured pavement distresses as defined by the respective protocols summarized in every 50-ft subsection. In addition, the LTPP raters reported the crack maps manually drawn in the field maps for all sections.

Figure 2.27: Manual Raters Performing Visual Rating of LTPP Distresses

Surface Texture

The reference texture data was obtained by the CTR research team using the circular track meter (CTM) shown in Figure 2.28. The measurements were taken at the beginning of each 50-ft subsection for both wheel paths. The location of each wheel path was determined using a measuring tape at 35 in. from both sides of the centerline of the pavement lane (located half way between the inside edges of the pavement edge markings) as indicated on AASHTO PP-69-10. Texture data was recorded three times for each location.

Figure 2.28: Placement of CTM, Inside Wheel Path

Cross Slope

The cross slope measurements were taken at the beginning of each 50-ft subsection (same location of texture measurements) by the same crew of raters that performed the manual collection of pavement surface LTPP distresses. Figure 2.29 shows two LTPP expert raters collecting transverse profile measurements using a FACE ® Dipstick inclinometer with a 1-ft spacing of the two measurement feet. The raters reported the cross slope values every 1 ft for each of the measured transverse profiles. As indicated in the LTPP protocol, two runs were completed per transverse profile; "one run up the transverse line and a return along same line to complete a closed-loop survey" (Miller 2003). The raters followed the procedure indicated in the LTPP protocol except that the initial slope measurement was taken from the junction of the transverse measurement line and the inside edge of the paint stripe along the inside edge of the lane.

Figure 2.29: LTPP Raters Collecting Cross Slope Data

2.3.2 Automated Data Collection

After the manual distress assessments were conducted following TxDOT and LTPP procedures, the vendors (service providers) were given the detailed location of the sections and were contracted to schedule and conduct automated surveys. In addition to the TxDOT 3D camera and laser system, three proprietary systems were used in this experiment by the vendors:

- Dynatest Consulting Inc., with an INO LCMS;
- Fugro-Roadware, with an INO LCMS;
- WayLink Systems Co.–Oklahoma State University (OSU), with an in-house developed 3D system.

Other vendors were invited to participate in the Phase 2 data collection during meetings at the 2013 TRB Exhibition and during a webinar held with vendors held on January 30, 2013. Vendors were contacted to attend the webinar based on a list provided by the Road Profiler User Group. Although several vendors expressed interest in participating in the study, only three vendors completed service agreements with CTR and actually collected data. TxDOT was required to abide by all of the criteria and requirements listed in the service agreements, though an agreement was not required for TxDOT.

Each participant was asked to perform automated measurements at highway speeds of the following types of data:

- Distresses based on the LTPP protocol on each 50-ft subsection. TxDOT reported data based on the PMIS protocol.
- Texture: mean profile depth in mm every 50 ft. for at least the outer wheel path.
- Cross slope in mm/mm every 50 ft along the 550-ft test section. For each 50-ft subsection, the cross slope was reported in 1-ft intervals.
- Digital crack maps for each section according to the following crack severity levels: less than 3 mm (.12 in.) wide, between 3 and 6 mm (.24 in.) wide, and more than 6 mm wide.

In order to capture the difference in accuracy for different levels of manual intervention, every participant was asked to report each data type within the following three time frames:

- Fully automated processing with no manual post-processing (right after data collection run)
- Semi-automated processing with minimum manual post-processing (within 2 business days)
- Semi-automated processing with higher manual post-processing (4 weeks after data collection)

Every participating system collected data in the Austin and the Waco Districts on 2 different days, following the same circuit (order indicated in Table 2.2). A CTR navigator accompanied the vendor (or TxDOT) during data collection in order to guide the driver through the optimized route, discuss the project with accompanying vendor (or TxDOT) representatives and to ensure that each test section was measured only once per one data collection run, at the posted maximum speed (or up to 55 mph).

Figures 2.30 to 2.33 show pictures of the four automated distress measurement van that participated in the experiment. In addition, Appendices F and G contain reports that Fugro-Roadware and WayLink-OSU voluntarily submitted to the researchers after completing their data collection. These appendices contain further information about their system capabilities and the processing applied to the data requested for this study.

Figure 2.30: TxDOT's 3D System

Figure 2.31: Fugro's ARAN 48 with Pave3D System

Figure 2.32: Dynatest's Pavement Condition Survey System

Figure 2.33: WayLink-OSU's PaveVision3D Ultra

2.3.3 Reference Crack Maps

TxDOT and the three vendors completed the automated surveys during late July and August; the last vendor completed data collection on August 30, 2013. After completion of the automated surveys, the research team returned to the test sections to collect the reference digital crack maps. In this way, the effects of temperature and traffic on test section cracking was minimized to limit variability between the automated measurements collected by TxDOT and the vendors and static measurements collected by the researchers. The digital crack maps were collected for 3 of the 12 subsections per test section. The criteria used to select the three subsections at every test section was based on a field evaluation of each test section by multiple researchers who inspected each 50-ft. subsection to determine which presented the most interesting types (alligator, longitudinal, transverse, wheel path, non-wheel path, lane edge, etc.) and combinations of cracks for the comparison. Based on this, the researchers conferred and selected the three subsections.

The process for obtaining the digital crack maps consisted of three main steps:

1) marking the cracks visually detected in the field,

2) collecting digital images of the marked 50-ft-long section and,

3) processing the collected images for producing crack maps with the three severity levels.

The first step, consisting of marking the cracks, was carried out by three members of the research team that marked (with chalk) all cracks using a color coding system to differentiate distress severities based on crack width. Cracks were marked with three chalk colors depending on crack widths (red < 3mm, blue 3–6mm, and green >6 mm) using a ruler marked in millimeters to check crack widths when necessary. Figures 2.34 to 2.36 show the crack coloring process.

Figure 2.34: Marking Section with Colored Chalk on FM 1063

Figure 2.35: Cracks Marked with Chalk in Different Colors according to Crack Width, (Red < 3mm, Blue 3–6mm) on FM 1063

Figure 2.36: Crack Marked in Green (>6mm Width) on FM 1331-1

Note that although the TxDOT PMIS protocols do not record crack width (severity), crack severity levels are used in the LTPP protocol. The severity levels used in the LTPP protocol include low severity cracks if they are narrower than 6 mm, moderate if they are between 6 and 19 mm (.24 in. to .75 in.), and high if they are wider than 19 mm. The crack width categories selected by the researchers for the Phase 2 experiment differed from the LTPP protocol to allow the research team to evaluate the state of the art and capabilities of crack measurement systems, given that vendors reported that their equipment could accurately measure cracks of narrower width than specified in the LTPP protocol.

Due to the complicated coarse aggregate patterns, "phantom" cracks (lines formed by aggregate edges, cracked aggregate, flushed asphalt, etc.) had to be closely examined and left unmarked. An example of a phantom crack (outlined in white) is shown in Figure 2.37. Phantom cracks can also be created by loss of aggregates that roughly form a line and create the illusion of a crack (Figure 2.38).

Figure 2.37: Phantom Cracks Marked in White on FM 1063

Figure 2.38: Phantom Cracks Created by Loss of Aggregates on FM 1063

Once the cracks were marked for the entire section, the next step consisted of taking digital pictures of the pavement surface. The pictures were taken using a high-resolution (21.1 megapixel) digital camera mounted on the front of a vehicle through a bracket system designed so that the area captured by the picture would cover the entire width of the surveyed lane and more. The digital camera was operated remotely from a laptop located inside the vehicle connected with the camera via a USB cable. The laptop provided a view of the pavement surface through the camera lens and was used by the operator to direct data collection of the crack map photos. The camera lens was fixed at a specific focal length that provided a digital image of the entire lane width from the center line stripe to the pavement edge. The digital pictures were then transmitted and stored in the laptop memory. The vehicle was used to transport the camera from one location to the next (every 5 ft). Once the camera was positioned for the next picture, the vehicle was stopped and the engine turned off in order to minimize vibrations of the camera.

Figure 2.39: Digital Crack Map Data Collection Underway

Approximately 2 to 4 hours were required per section to mark cracks and collect the digital crack map photos depending on the amount cracking on the section and other factors. Data collection download rate from the camera to the laptop was also a limiting factor that increased the total time required to map the test section.

The dimensions covered by each picture were approximately 13 ft in the transversal direction by 10 ft in the direction of traffic. At least one picture was taken every 5 ft in the direction of traffic, collecting a total of 10 pictures per section. Therefore, there was an overlap of 2.5 ft on the upper and bottom parts of the pictures between consecutive locations. This overlap was introduced in order to ease the stitching of the 10 consecutive pictures of each section.

The 10 consecutive pictures taken at each test subsection were stitched using the panoramic image stitcher software Microsoft Image Composite Editor, providing a unique digital image per subsection. The software corrects the effect of the camera's lens distortion and finds the best rotation and position of the individual pictures to produce the stitched image.

Once a unique digital stitched image of the entire marked test subsection was produced, the third and last step of the process for obtaining the crack maps took place. This step consisted of processing the digital image of the section to determine the location of each visually detected crack for the different severity levels. For this, a custom image processing algorithm was developed by the researchers using MATLAB to detect the location of each red (cracks less than 3 mm wide), blue (cracks between 3 and 6 mm wide), and green (cracks more than 6 mm wide) line. In addition to the developed algorithm, the researchers supervised each detected line manually to ensure the highest possible quality for the reference crack maps.

Chapter 3. Phase 2 Data Analyses

This chapter is divided into three main parts. The first part describes the processing and comparative analyses performed on the measurement of pavement surface distresses. This section includes the comparison of reported digital crack maps and the comparison of the summary distress statistics using both the LTPP and the TxDOT PMIS protocols for rating surface distresses. The second and third part of the chapter reports the comparative analyses performed on the measurement of surface texture and cross slopes values respectively.

3.1 Analysis of Surface Distresses

The distress data collected for Phase 2 consists of two main types: digital crack maps and distress statistics. The first part of this section covers the processing and main observations from the qualitative comparison performed for the crack maps reported by each participant and time frame. The second and third parts report the analyses and observations from the comparison of distresses statistics for both PMIS and LTPP protocols. The comparison of distressed statistics as defined by the LTPP protocol was performed to evaluate the automated measurement systems presented by the participating vendors: Fugro, WayLink-OSU, and Dynatest. In contrast, the PMIS protocol comparison was designed to evaluate the TxDOT 3D automated system.

3.1.1 Digital Crack Maps

The crack maps reported by the participants were evaluated qualitatively by comparing them against digital crack maps manually collected by the researchers. The crack detection and crack width measurement for the manual crack maps were obtained statically by manual raters in the field; the crack maps reported by the automated systems were collected at highway speeds and processed using customary algorithms for the detection and classification of cracks. The crack maps were collected at three 50-ft subsections per section on 10 test sections; therefore a total of 30 50-ft crack maps were analyzed in the study. The 10 test sections selected for the collection of crack maps included HMA surfaces, surface-treated ACP, JCP, and CRCP. The criteria and processes used to collect both the manual and the automated crack maps were described in Chapter 2.

The following appendices report all the crack maps for every participant and time frame as well as the crack maps manually drawn by the LTPP raters:

- Appendix A.1 – Crack Maps Comparison: TxDOT Fully Automated Delivery
- Appendix A.2 – Crack Maps Comparison: WayLink-OSU Fully Automated Delivery
- Appendix A.3 – Crack Maps Comparison: Dynatest Fully Automated Delivery
- Appendix A.4 – Crack Maps Comparison: Dynatest Semi-Automated Delivery
- Appendix A.5 – Crack Maps Comparison: Fugro Fully Automated Delivery
- Appendix A.6 – Crack Maps Comparison: Fugro Semi-Automated Delivery
- Appendix A.7 – Crack Maps Comparison: LTPP Manual Distress Survey (MDS)

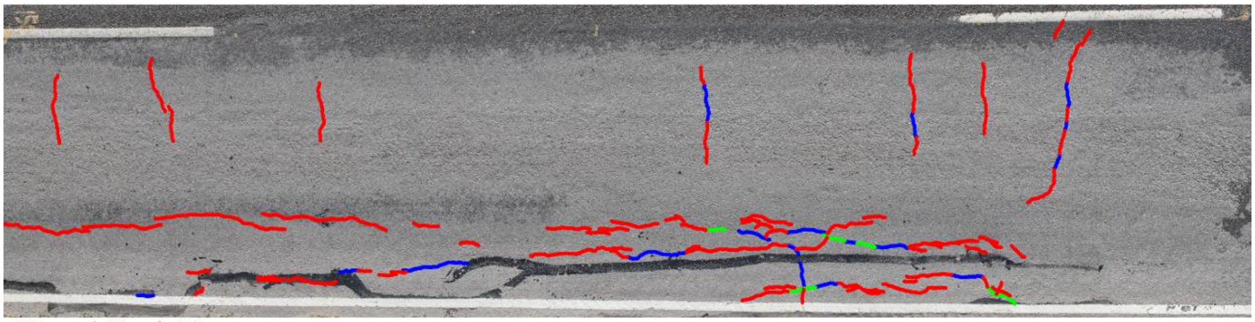
Each page of the Appendices A.1 to A.7 report the manual crack maps (on the top) along with the participant's crack map (on the bottom) for the corresponding section and station. The numbers used to label each test section correspond to the manual data collection (DC) order (see Table 2.2). As an example, Figures 3.1 to 3.3 show the manual and the participant's crack maps corresponding to section FM3177-1 (number 13 from manual DC order), station 150-200 (i.e., located between the markings for 150 ft and 200 ft from the beginning of the section), which is an ACP; Figures 3.4 to 3.6 show the crack maps for section US84-1 (number 17 from manual DC order), station 400-450, which is a JCP. The color convention for the manual crack maps were determined as follows: the red lines represent the crack less than 3 mm (.12 in.) wide, the blue lines represent cracks 3–6 mm (.24 in.) wide, and the green lines represent cracks greater than 6 mm wide. In addition, the crack maps manually drawn in the field by LTPP raters were also included to the comparison (at bottom of Figures 3.1 to 3.6). It should be noted that researchers were searching for, and marking, *only* cracks and crack severity—the automated systems and manual LTPP rater were searching for all types of distresses.

The qualitative analysis of the crack maps reported by the LTPP raters for all test sections (Appendix A.7) indicates that, overall, there is a good match with the cracks detected and measured by the research team. However, this comparison shows that even trained raters who are walking along a test section might miss distresses. For example, in section US84-1 (number 17 from manual DC order), the researchers found a much greater number of fine transverse cracks on the JCP pavement than did the raters (Figure 3.4). Factors that explain the differences between these two crack map datasets include the following:

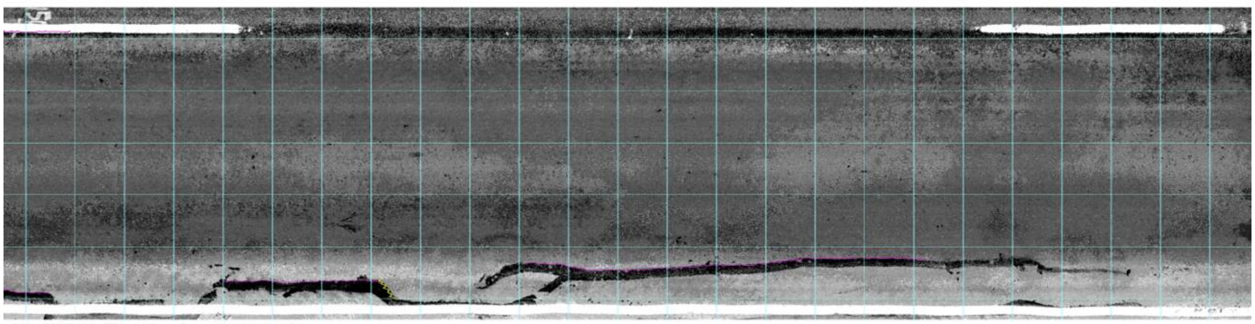
- Amount of people and time spent on each subsection searching for distresses, since three to five researchers spent 2 to 4 hours creating three 50-ft crack maps, while the two LTPP raters completed their survey for the entire 550-ft in 15 to 30 minutes.
- Lighting conditions, such as angle of the sun.
- Interpretation of actual cracks as phantom cracks and vice versa (i.e., rating errors; see Figure 2.37 and 2.38 for examples).
- The time lag between the LTPP manual rating and the researchers' crack map rating—during that time, more or less cracking could have occurred due to additional traffic, the shrinking/swelling of clay soils, dry land cracking, crack healing, temperature effects, and other factors.

Another significant factor that explains the differences observed between the researchers' and the LTPP raters' crack maps is differing criteria. The manual raters followed LTPP crack severity levels, which differ from those defined by the researchers. Also, LTPP ratings may combine cracks with other features depending on severity and extent. For example, patch severity levels are defined based on the severity of other distresses located within the boundaries of the patch. Thus, on section FM696-2 (number 6 from manual DC order), the researchers marked cracking, whereas the LTPP raters marked the patch and rated it as Low Severity based on cracking and other distresses within the patch. Thus, they did not mark the cracks as a second type of distress.

Section 13 /// Station 150-200

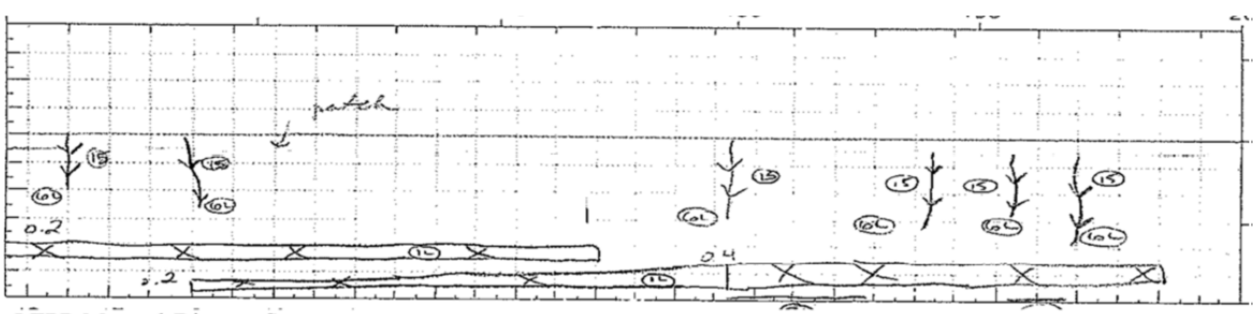


Manual Crack Map



TxDOT (Fully Automated)

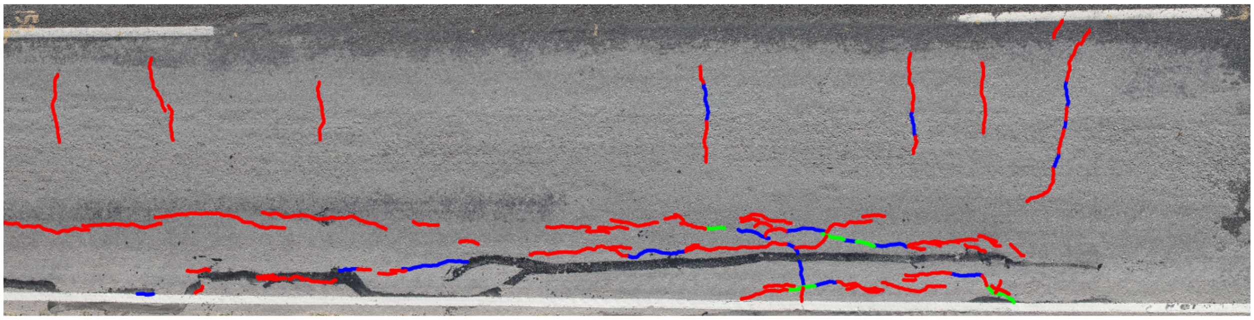
OSU (Fully Automated)



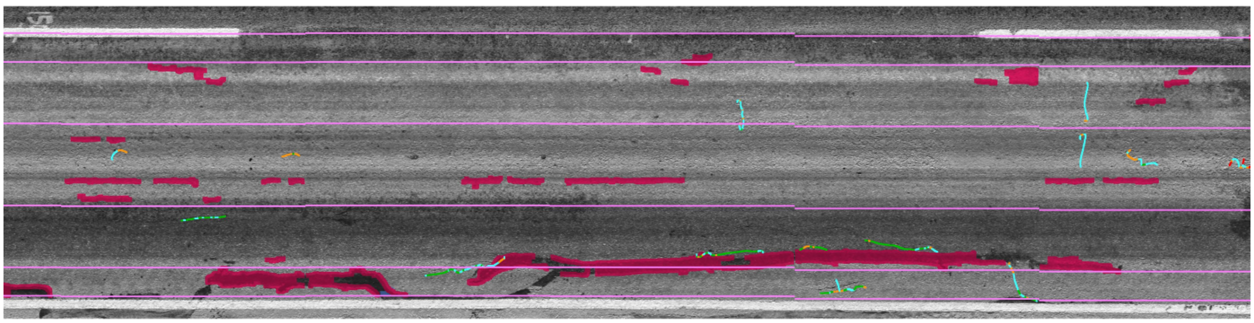
LTPP Manual Distress Survey

Figure 3.1: Manual, TxDOT, WayLink-OSU and LTPP MDS Crack Maps Corresponding to FM1377-1 (Number 13 from Manual DC Order), Station 150-200

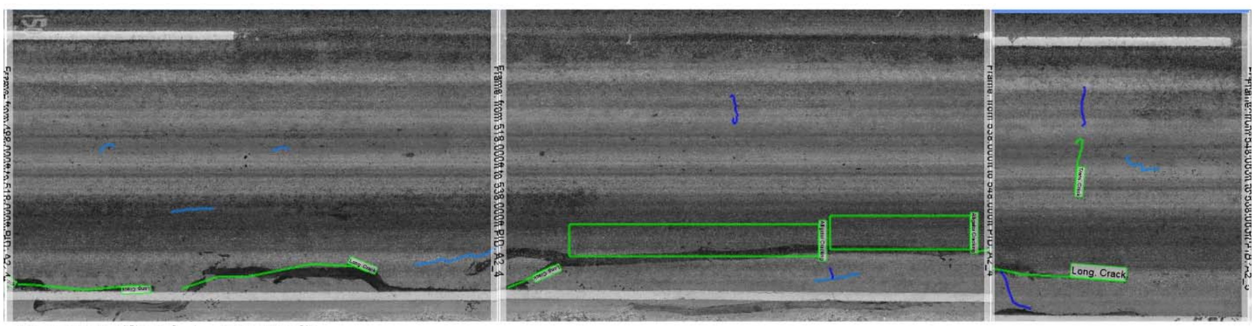
Section 13 /// Station 150-200



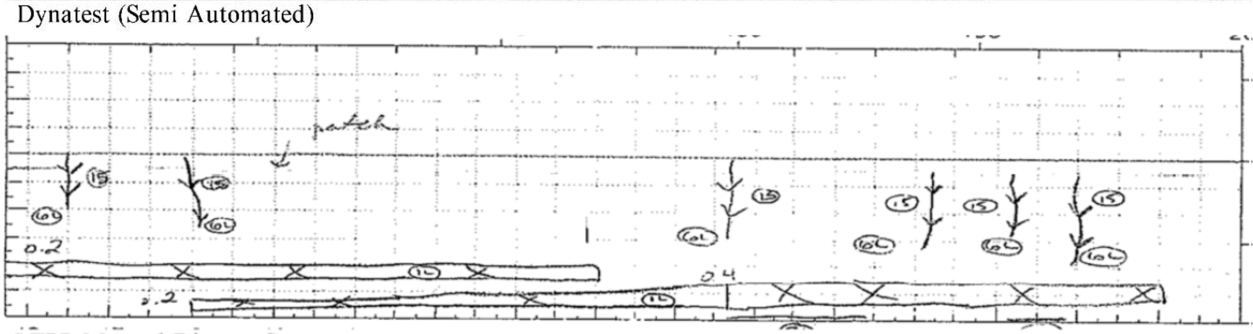
Manual Crack Map



Dynatest (Fully Automated)



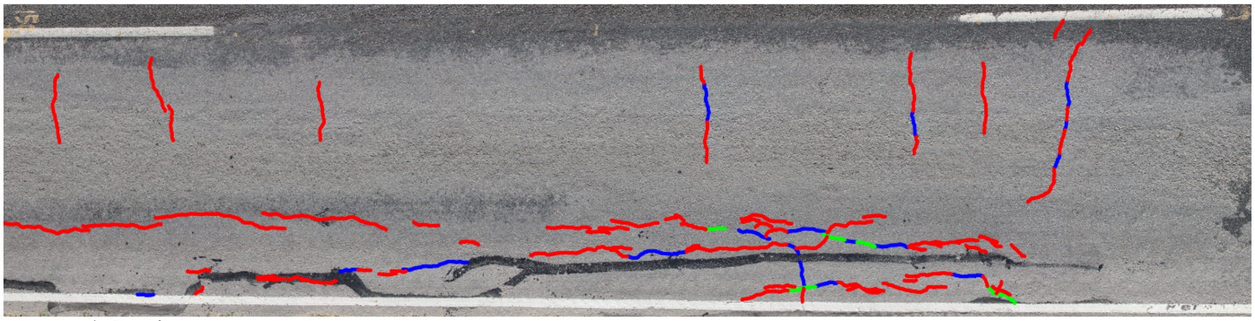
Dynatest (Semi Automated)



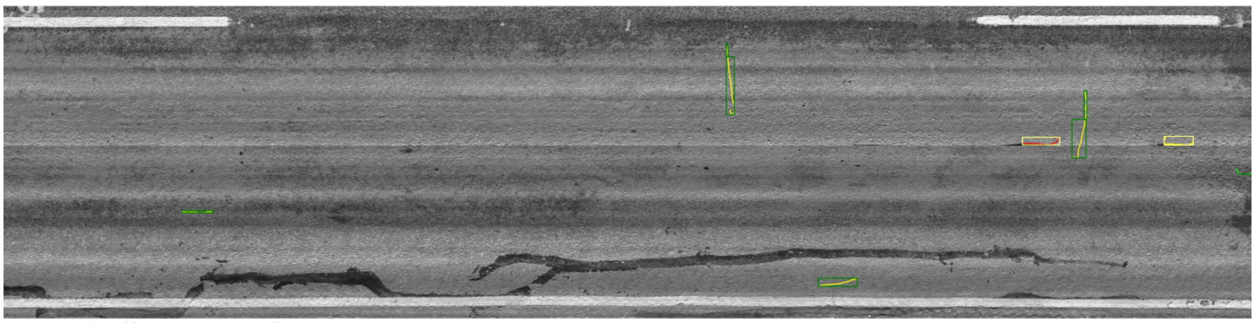
LTPP Manual Distress Survey

Figure 3.2: Manual and LTPP MDS Crack Map along with Dynatest Crack Maps Before and After Manual Intervention, Corresponding to FM1377-1 (Number 13 from Manual DC Order), Station 150-200

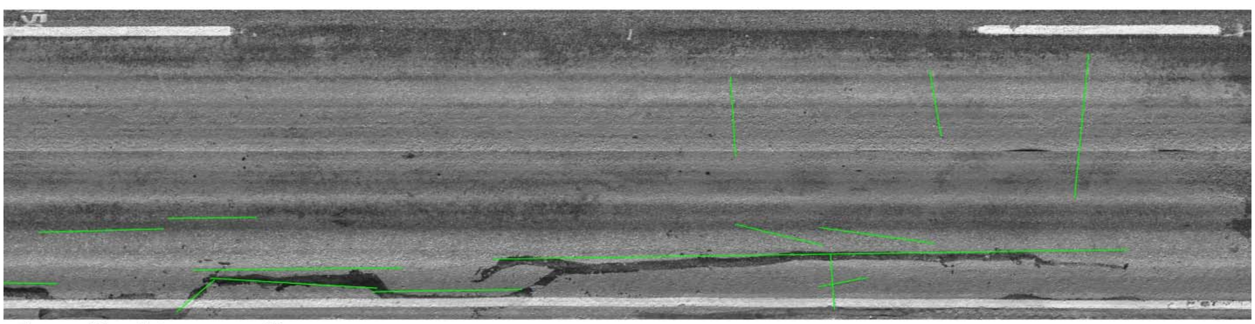
Section 13 /// Station 150-200



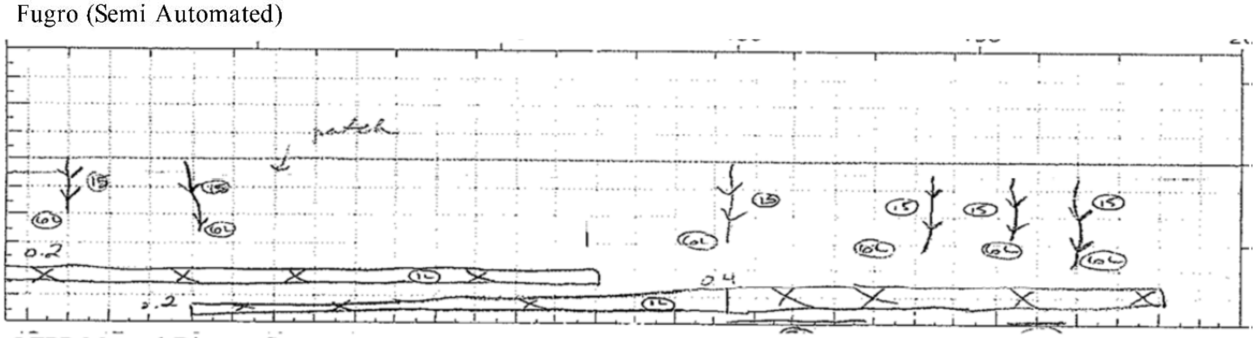
Manual Crack Map



Fugro (Fully Automated)



Fugro (Semi Automated)



LTPP Manual Distress Survey

Figure 3.3: Manual and LTPP MDS Crack Map along with Fugro Crack Maps Before and After Manual Intervention, Corresponding to FM1377-1 (Number 13 from Manual DC Order), Station 150-200

Section 17 /// Station 400-450

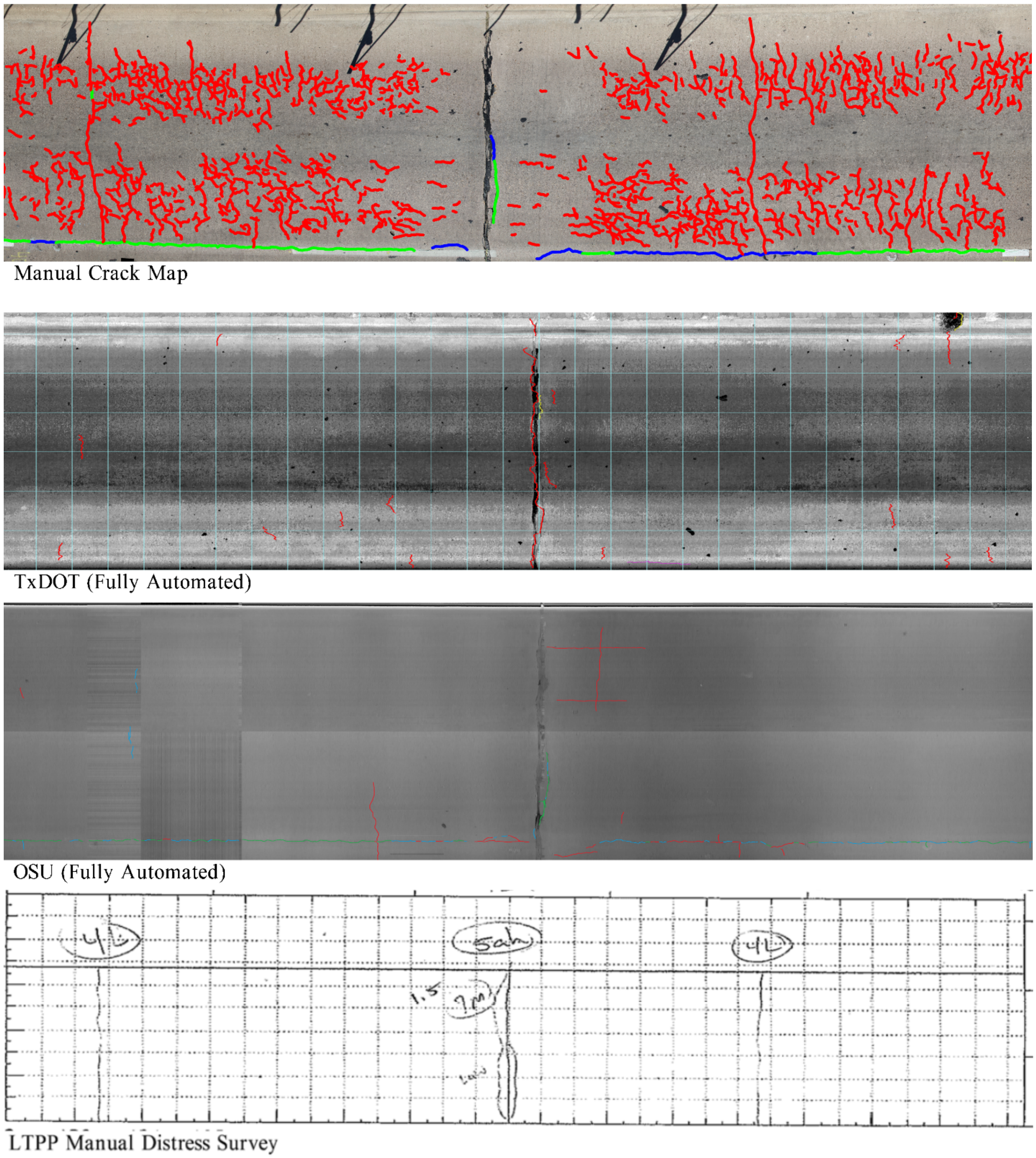
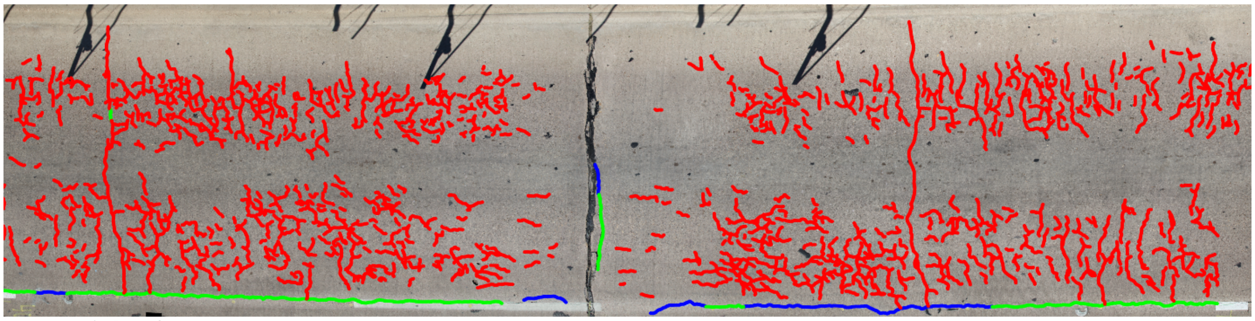
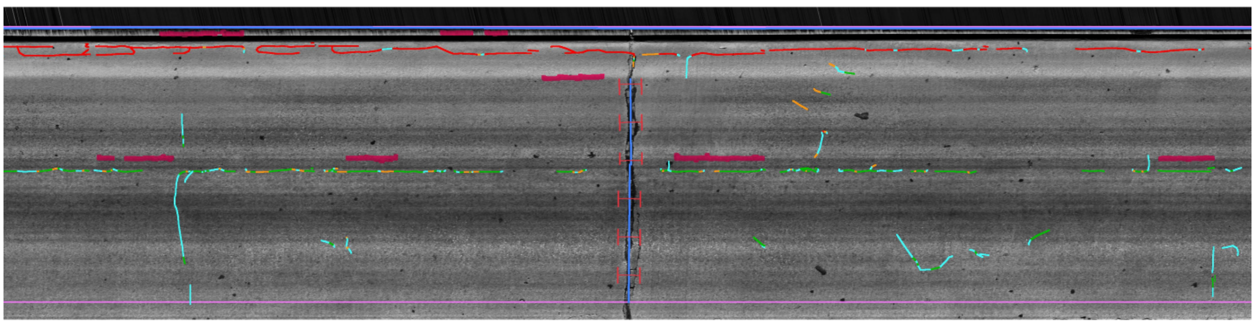


Figure 3.4: Manual, TxDOT, WayLink-OSU, and LTPP MDS Crack Maps Corresponding to US84-1 (Number 17 from Manual DC Order), Station 400-450

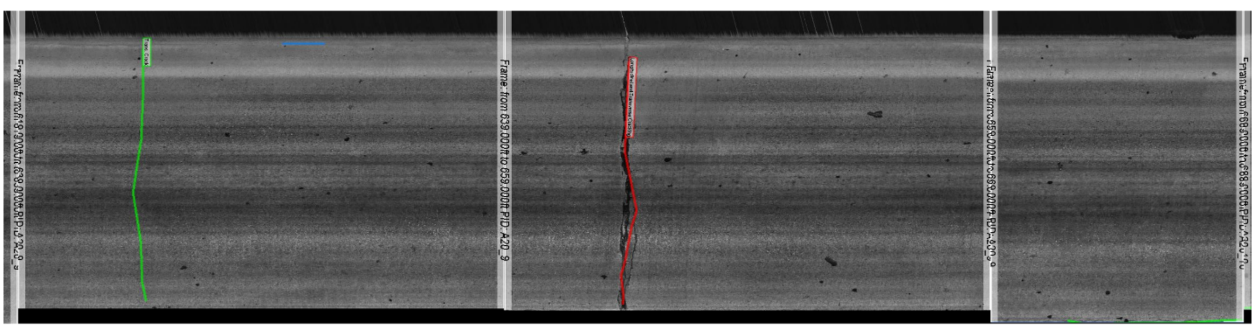
Section 17 /// Station 400-450



Manual Crack Map



Dynatest (Fully Automated)

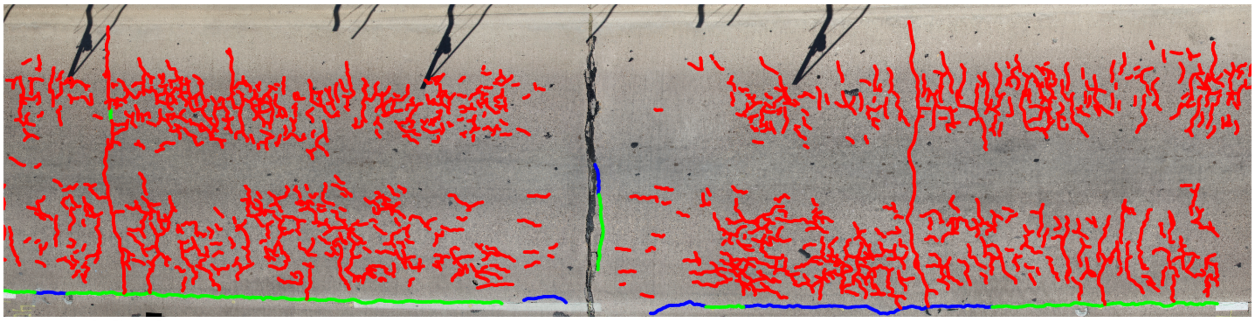


Dynatest (Semi Automated)

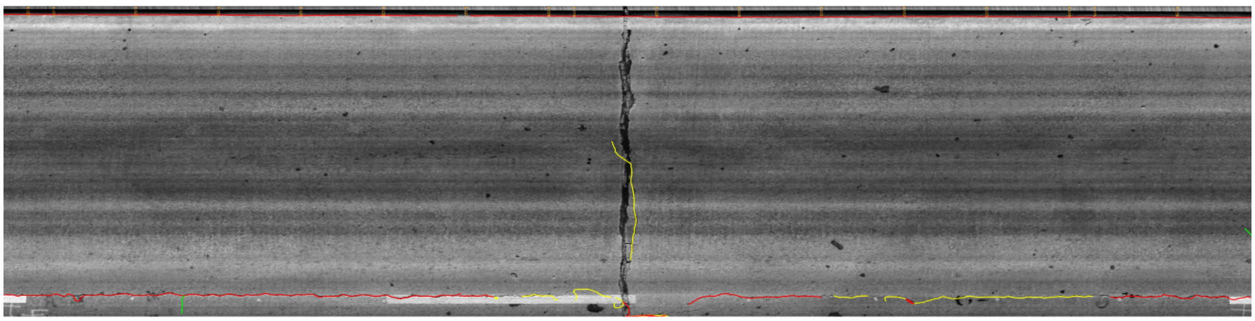
LTPP Manual Distress Survey

Figure 3.5: Manual & LTPP MDS Crack Map along with Dynatest Crack Maps Before and After Manual Intervention, Corresponding to US84-1 (Number 17, Manual DC Order), Station 400-450

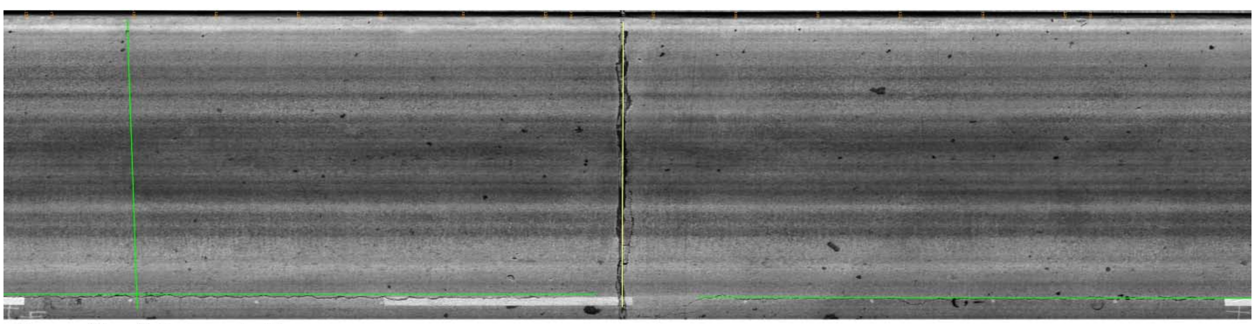
Section 17 /// Station 400-450



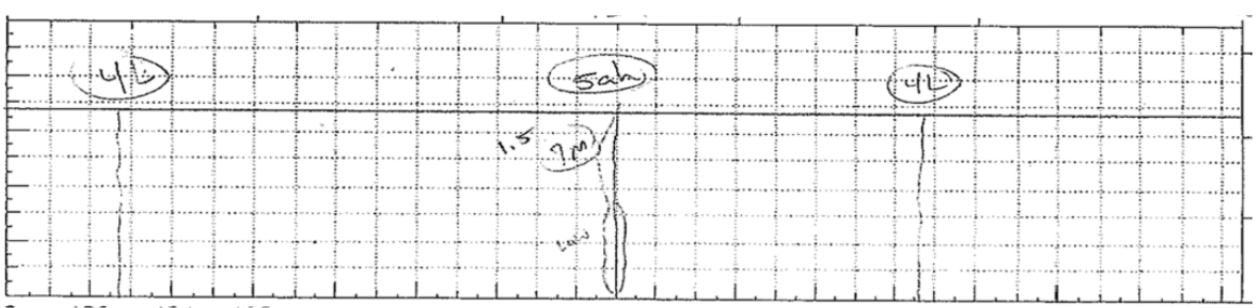
Manual Crack Map



Fugro (Fully Automated)



Fugro (Semi Automated)



LTPP Manual Distress Survey

Figure 3.6: Manual & LTPP MDS Crack Map along with Fugro Crack Maps Before and After Manual Intervention, Corresponding to US84-1 (Number 17 from Manual DC Order), Station 400-450

The following list presents the main observations from the qualitative analyses of the reported crack maps by the four automated systems for all sections and delivery types:

- Dynatest Crack Maps:
    - Significant improvement occurred after manual intervention (from fully automated to semi-automated delivery).
    - In particular, the number of missed cracks was larger for the cracks less than 3 mm wide.
    - Good detection of sealed cracks occurred in the fully automated data set. The sealed cracks reported in the fully automated crack maps were reported as unsealed cracks (if not removed) in the semi-automated data set.
    - The false positive cracks observed on the crack maps corresponding to Section 10 might be explained by the presence of indentations in the pavement surface potentially caused by overweight rural equipment.
    - Failure cracks from Section 9 were reported as sealed cracks for the fully automated delivery but corrected after manual correction.
    - Few false positives were observed on the PFC surface (Section 11) for the fully automated delivery.
    - The vegetation area seems to be classified as sealed for the fully automated delivery.
    - A large number of fine cracks were missed on rigid pavements sections.
    - Transverse (Section 17) and longitudinal (Section 19) joints were wrongly identified as cracks even after manual intervention.

- Fugro Crack Maps:
    - The quality of crack maps was improved after manual intervention by removing false positives and missed cracks and adding patches.
    - Patches were reported only in the semi-automated delivery.
    - In particular, the number of missed cracks was larger for the cracks less than 3 mm wide.
    - Sealed cracks were not detected in the fully automated delivery but many of them were reported as unsealed cracks in the semi-automated data set.
    - Good assessment of cracks occurred on PFC surface section (Section 11). However, a few false positives were introduced after manual intervention.
    - The fine cracks in the rigid pavement section (Section 17 and 19) were missed. However, a great improvement was observed after manual intervention for Section 19.

  - Transverse (Section 17) and longitudinal (Section 19) joints were wrongly identified as cracks for the fully automated delivery but corrected after manual intervention.

- WayLink-OSU
  - There were very few false positives (PFC section) observed but large number of missed cracks in some sections (e.g., Section 4 and 6).
  - Very good assessment of crack width was obtained on asphalt sections but large number of cracks were missed in the <3 mm category in rigid pavements (Section 17 and 19).
  - Transverse and longitudinal joints on rigid pavements were not misidentified as cracks, unlike with the rest of the participants. In addition, the identification of the cracks nearby the joint was very similar to the manual crack maps.
  - There was no classification of sealed cracks.

- TxDOT
  - No categorization of crack widths or other types of distresses was provided.
  - A large number of unsealed crack were missed; the assessment of sealed cracks was better.
  - A large number of the failure longitudinal cracks in Section 9 were missed or wrongly identified as sealed cracks.
  - False positives were observed on drop-offs and rumble strips.
  - Very few false positives were observed on PFC surface (Section 11).
  - A large number of cracks were missed on rigid pavements. Also, transverse (Section 17) and longitudinal (Section 19) joints were wrongly identified as cracks.

3.1.2 Surface Distresses Statistics as Defined by LTPP Protocol

This section presents the comparative analyses between the statistics of the pavement surface distresses, as defined by the LTPP protocol (Miller et al., 2003) and reported by manual raters and by the different participating vendors (Fugro, Dynatest, and WayLink-OSU). The results of the analyses are presented separately for the different pavement surface types.

The manual assessment of the LTPP distresses at each section was carried out by experienced raters who walk through the section taking measurements of each distress extent and severity every 50 ft. Each vendor reported the distresses statistics summarized for the 11 50-ft subsections per section from the data collected at highway speeds. The LTPP distresses data collection was documented in Chapter 2.

The following appendices report all summary tables with the reported distresses statistics for every vendor and section:

- Appendix B.1 – Distresses Statistics for ACP sections
- Appendix B.2 – Distresses Statistics for JCP sections
- Appendix B.3 – Distresses Statistics for CRCP sections

The tables presented in Appendices B.1 to B.3 include only the types of LTPP distresses for which at least one vendor, or the manual raters, reported data. The numbers used to label each test sections are the ones corresponding to the manual DC order (see Table 2.2). The following parts of this section list the observations made by the researchers for the three types of pavement surfaces. The analyses conducted on the LTPP distresses were performed without accounting for severity levels; i.e., by analyzing the total extent reported for each distress type.

Asphalt Concrete Pavements

Figures 3.7 to 3.10 present the total extent reported by manual raters and every vendor for different types of LTPP distresses for the 15 ACP test sections of the study. The manual measurements are reported in black, Fugro in green, Dynatest in red, and WayLink-OSU in blue. For the cases of Fugro and Dynatest, the darker and lighter tones for the bars colors indicate the reported measurements before and after manual intervention, respectively. The following list presents the main observations from the tables provided in the appendices and from the summarized information presented in Figures 3.7 to 3.10:

- Fatigue cracking (Figure 3.7)
    - Both Dynatest and Fugro consistently increased the fatigue cracking area after manual intervention. Furthermore, the proportional change from before to after manual intervention for the two vendors was similar to each other for several sections. It should be noted that these two vendors used hardware developed by the same manufacturer (both used INO LCMS sensors). Considering the enhancement of results achieved after manual intervention observed from the crack maps analyses, this observation suggests that the vendors used by these vendors tend to underestimate fatigue cracking.
    - WayLink-OSU tended to consistently underestimate fatigue cracking with respect to all other automated systems.
    - No good match was observed between measurements reported by manual raters and vendors. The comparison between manual and automated measurements did not present a clear pattern. The lack of correlation between these two data type may be explained not only by missed cracks and false positives but also by the different criteria for classifying distresses; e.g., longitudinal cracks in the wheel path correctly detected by all participants might have been classified as such by some vendors or manual raters while classified as fatigue cracking by others.
- Longitudinal cracking (Figure 3.8)
    - There is no good match between the measurements reported by Dynatest and Fugro. Also, there is no clear pattern between the change in reported longitudinal cracking before and after manual intervention.

    - Values reported by manual raters were significantly lower than the ones reported by the automated systems for the majority of the ACP test sections.
    - No clear pattern among the different automated systems was observed for this type of distress. This observation is probably due to the different criteria used to classify distresses, as pointed out for fatigue cracking as well.
    - Fugro largely overestimated the extent of longitudinal cracking for the semi-automated delivery on SPUR484, which is a section with few distresses and coarse macro-texture.
- Transverse Cracking
    - Number of transverse cracks
        - A large number of false positives were observed for the Fugro fully automated data set. These false positives are drastically reduced after manual intervention.
        - A good match among manual raters, Fugro semi-automated data set, and WayLink-OSU was observed.
        - Dynatest did not report the number of transverse cracks (only the total length).
    - Total length of transverse cracks (Figure 3.9)
        - Manual raters and WayLink-OSU reported less extent of transverse cracks than Dynatest and Fugro.
        - Both Fugro and Dynatest report a large total length for transverse cracks both before and after manual intervention at Sections 12 and 14. This observation may be explained by raters classifying sealed cracks as unsealed.
        - A drastic change between the fully and semi-automated datasets was observed for Fugro. The change is not as drastic for Dynatest.
- Edge cracking
    - Drastic increase of reported edge cracking by Fugro occurred after manual intervention. A very good match between manual raters and Fugro semi-automated data set was observed for several sections.
    - Dynatest reported (or correctly classified) edge cracking in only one section, while WayLink-OSU did not report edge cracking for any section.
- Patching (Figure 3.10)
    - WayLink-OSU and Fugro semi-automated always reported a smaller number and area of patches than did the manual raters.
    - Dynatest did not report the number of patches and Fugro only reported them for the semi-automated data set.

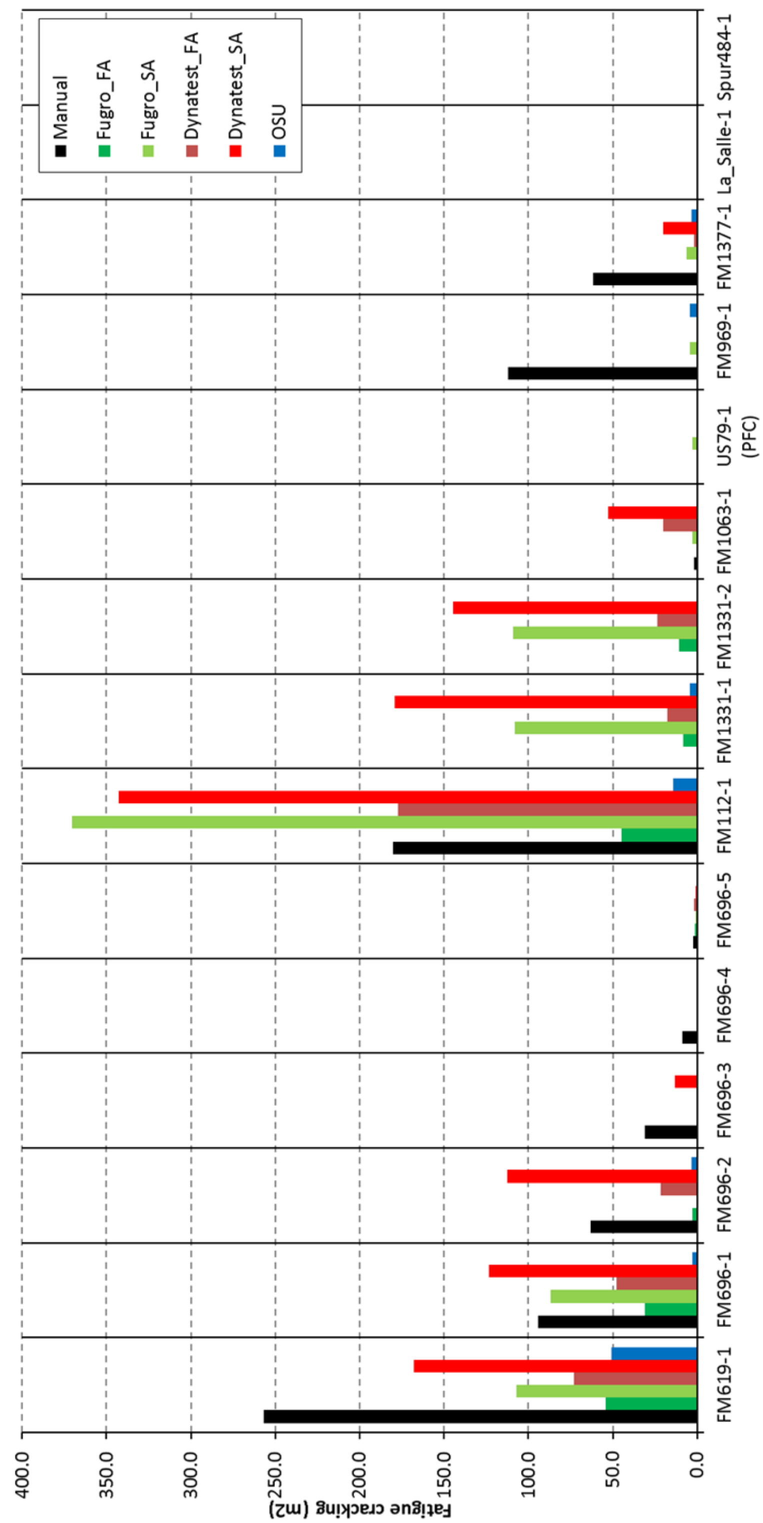


Figure 3.7: Comparison of LTPP Fatigue Cracking on ACP Sections

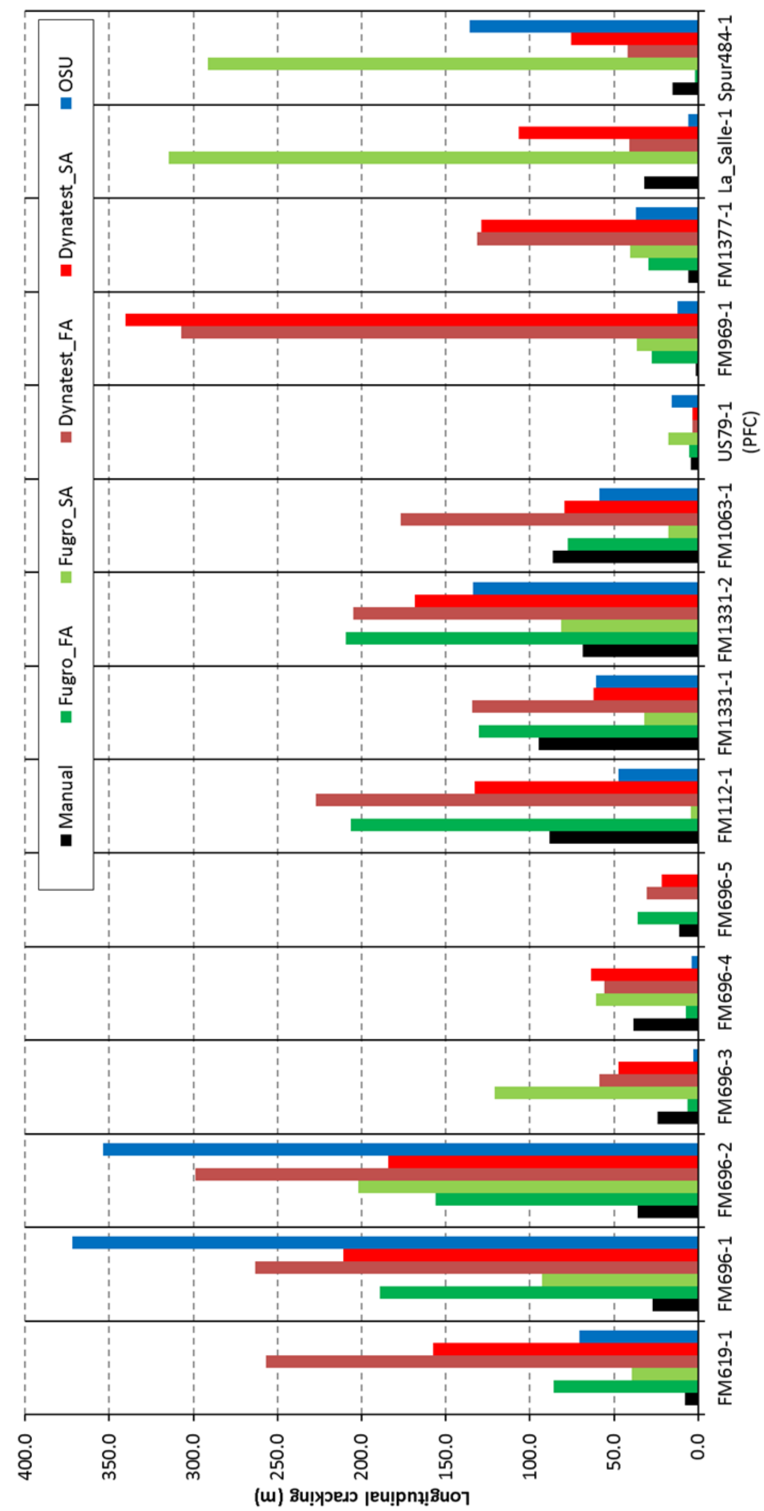


Figure 3.8: Comparison of LTPP Longitudinal Cracking on ACP Sections

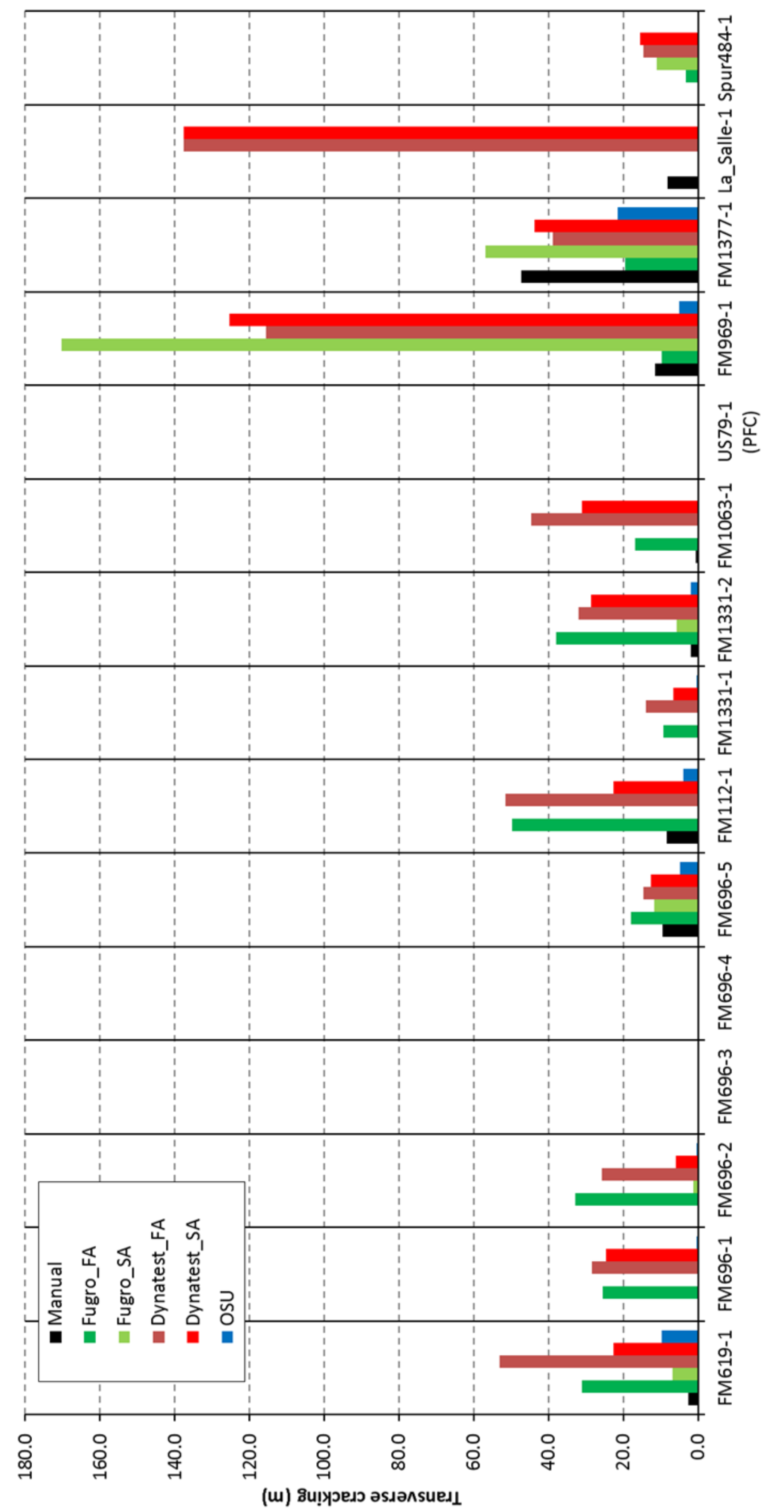


Figure 3.9: Comparison of LTPP Transverse Cracking on ACP Sections

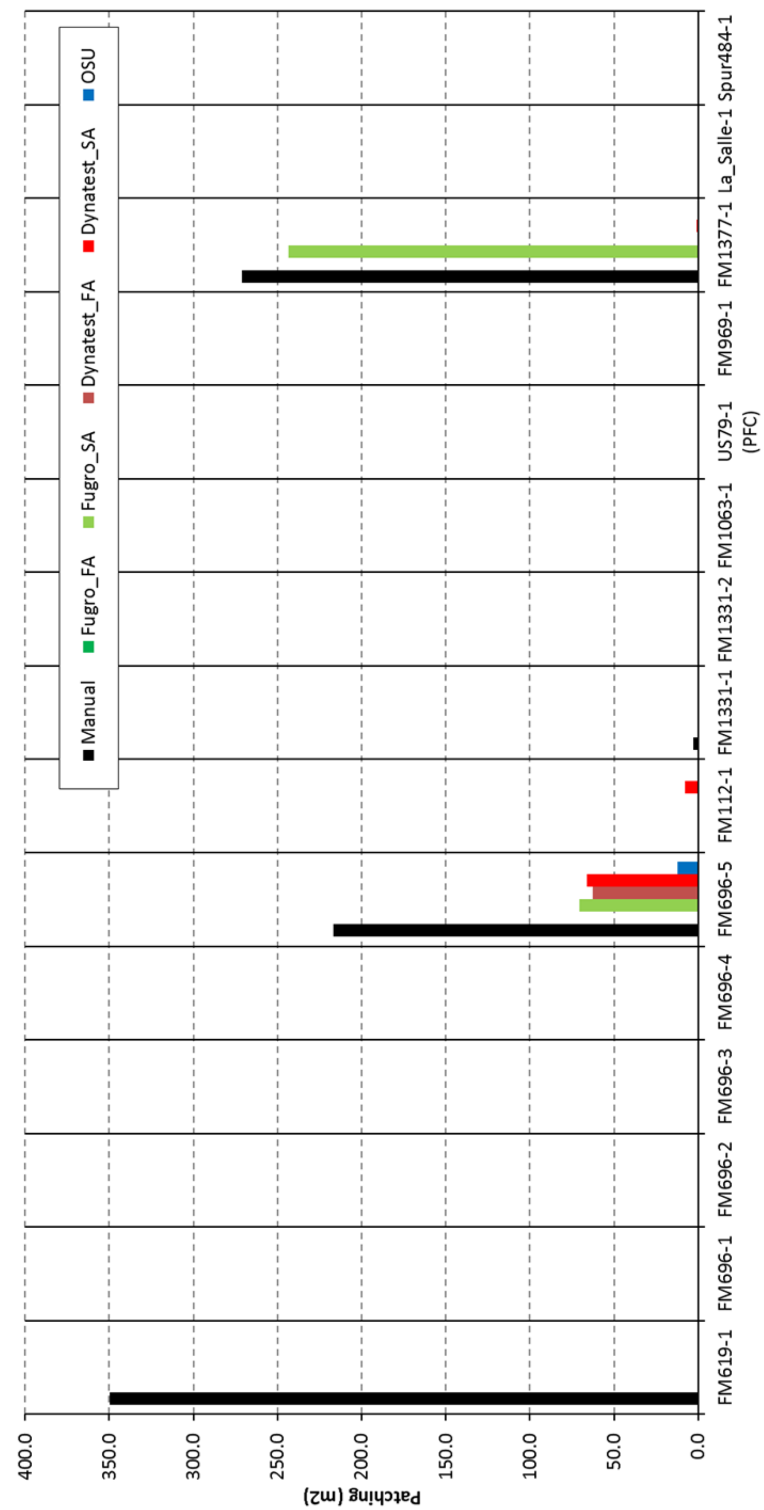


Figure 3.10: Comparison of LTPP Patching on ACP Sections

Jointed Concrete Pavements

Table 3.1 presents the LTPP distress statistics reported by each vendor, along with the manual ratings, for the two JCP sections of the study. The following list presents the main observations from the values reported in Table 3.1:

- Longitudinal cracking
    - Both Dynatest and Fugro reduced the extent of longitudinal cracking after manual intervention. The crack maps of Section 17 illustrate how some longitudinal cracks correctly detected and classified in the fully automated delivery were removed after manual correction. This observation suggests that manual intervention might also introduce errors to the crack maps.
    - Manual raters reported the lowest values of longitudinal cracking compare with WayLink-OSU and the semi-automated data sets of Fugro and Dynatest.
    - WayLink-OSU reported drastically larger values than the rest. It should be noted, however, that WayLink-OSU presented the best assessment of cracks from the crack maps comparison of rigid pavement sections.
- Transverse Cracking
    - No clear pattern is observed for the number and extent of crack maps in these two JCP sections. A possible inconsistency of the distresses reported by Fugro is noted: they reported zero transverse cracks for the semi-automated dataset while the extent is not zero for the same delivery type. Further analyses should be performed on the data reported for this distress type.

Table 3.1: Comparison of LTPP Distresses on JCP Sections

		Longitudinal_m	Transverse_#	Transverse_m	Spalling_of_Long_Joints_m	Spalling_of_Trans_Joints_#	Spalling_of_Trans_Joints_m	Patching_#	Patching_m2	Map_Cracking___
S16	***Manual***	**22.5**	**0.0**	**0.0**	**23.5**	**21.0**	**33.4**	**13.0**	**20.0**	**0.0**
	Fugro_fully_autom	25.6	25.0	16.3	0.0	0.0	0.0	0.0	0.0	0.0
	Fugro_semi_autom	21.1	0.0	12.0	7.2	19.0	66.3	20.0	31.9	2.0
	Dynatest_fully_autom	54.9	5.0	1.3	0.0	0.0	0.0	0.0	30.2	0.0
	Dynatest_semi_autom	47.5	0.0	0.0	15.8	0.0	46.7	0.0	30.1	0.0
	OSU	992.5	4.0	15.3	10.0	29.0	15.8	9.0	10.1	0.0
S17	***Manual***	**1.3**	**28.0**	**94.2**	**0.0**	**9.0**	**18.5**	**0.0**	**0.0**	**12.0**
	Fugro_fully_autom	44.1	52.0	43.2	0.0	0.0	0.0	0.0	0.0	0.0
	Fugro_semi_autom	5.6	0.0	45.5	154.9	9.0	33.9	0.0	0.0	0.0
	Dynatest_fully_autom	93.8	22.0	32.5	0.0	0.0	0.0	0.0	0.0	0.0
	Dynatest_semi_autom	0.7	26.0	65.1	106.4	0.0	25.7	0.0	0.0	0.0
	OSU	157.3	46.0	45.7	3.6	8.0	7.8	0.0	0.0	0.0

Continuously Reinforced Concrete Pavements

Table 3.2 presents the LTPP distress statistics reported by each vendor, along with the manual ratings, for the three CRCP sections of the study. The following list presents the main observations from the values reported in Table 3.2:

- Longitudinal cracking
    - No clear pattern was observed among the different automated systems and the manual ratings. Also, no clear pattern was observed for the change in reported values before and after manual intervention for Fugro and Dynatest.
- Transverse Cracking
    - The number and extent of transverse cracks drastically increase after manual intervention for both Fugro and Dynatest data sets. No clear pattern was observed for this distress type among the vendors and manual raters.

Table 3.2: Comparison of LTPP Distresses on CRCP Sections

		Longitudinal_m	Transverse_#	Transverse_m	Patching_#	Patching_m2	Punchouts_#	Spalling_of_Long_Joints_m	Longitudinal_Joint_Seal_Damage_	Longitudinal_Joint_Seal_Damage__m
S18	***Manual***	**90.7**	**90.0**	**304.7**	**8.0**	**3.2**	**0.0**	**0.0**	**5.0**	**74.5**
S18	*Fugro_fully_autom*	149.3	38.0	21.2	0.0	0.0	0.0	0.0	0.0	0.0
S18	*Fugro_semi_autom*	63.6	55.0	155.0	12.0	334.4	4.0	63.2	1.0	36.2
S18	*Dynatest_fully_autom*	183.6	77.0	87.3	16.0	12.1	0.0	0.0	0.0	0.0
S18	*Dynatest_semi_autom*	55.2	81.0	138.2	0.0	5.2	8.0	57.7	0.0	0.0
S18	*OSU*	103.7	67.0	114.1	8.0	2.5	22.0	60.4	0.0	0.0
S19	***Manual***	**148.2**	**148.0**	**532.0**	**17.0**	**45.8**	**0.0**	**0.5**	**11.0**	**167.8**
S19	*Fugro_fully_autom*	64.6	50.0	28.2	0.0	0.0	0.0	0.0	0.0	0.0
S19	*Fugro_semi_autom*	80.8	151.0	459.0	20.0	49.2	7.0	7.0	0.0	0.0
S19	*Dynatest_fully_autom*	74.5	97.0	188.7	21.0	14.7	0.0	0.0	0.0	0.0
S19	*Dynatest_semi_autom*	59.0	158.0	338.1	0.0	20.0	11.0	68.6	0.0	0.0
S19	*OSU*	66.6	124.0	153.7	9.0	2.5	1.0	4.6	0.0	0.0
S20	***Manual***	**91.4**	**126.0**	**457.1**	**4.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**
S20	*Fugro_fully_autom*	27.2	11.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0
S20	*Fugro_semi_autom*	53.6	127.0	444.6	0.0	1.3	0.0	0.0	0.0	0.0
S20	*Dynatest_fully_autom*	37.0	142.0	347.6	3.0	1.2	0.0	0.0	0.0	0.0
S20	*Dynatest_semi_autom*	81.3	172.0	452.5	0.0	1.6	11.0	0.0	0.0	0.0
S20	*OSU*	44.7	274.0	296.4	0.0	0.0	14.0	5.1	0.0	0.0

3.1.3 Surface Distresses Statistics as defined by PMIS Protocol

TxDOT distress measurements were compared to the PMIS reference ratings. Tables 3.3, 3.4, and 3.5 show the summary of the reference (labeled as PMIS) and TxDOT distress data for

HMA sections, JCP sections, and CRCP sections respectively. Bar charts of the PMIS manual ratings and TxDOT results are shown in Appendix C.

For the HMA and surface-treated sections (labeled "ACP" in Appendix C bar charts), the following distresses were reported by TxDOT and/or the PMIS reference:

- Alligator cracking (%)
- Longitudinal cracking (ft.)
- Transverse cracking (count)
- Patching (%)
- Raveling (rating code)
- Failures (count)

For the JCP sections, these distresses were reported by TxDOT and/or the PMIS reference:

- Alligator cracking (%)
- Longitudinal cracking (ft.)
- Transverse cracking (count)
- Failed Joints & Cracks (count)
- Failures (count)
- Apparent Joint Spacing (ft.)

For the CRCP sections, these distresses were reported by TxDOT and/or the PMIS reference:

- Alligator cracking (%)
- Longitudinal cracking (ft.)
- Transverse cracking (count)
- Patching (%)
- Block (%)
- Spalled Cracks (count)
- Concrete Patches (count)
- Average Crack Spacing (ft.)
- Punchouts (count)

Though alligator cracking was reported as a possible distress in all pavement types, the PMIS *Rater's Manual* does not include alligator cracking as a JCP or CRCP distress type.

Some observations are noted:

- TxDOT reported three types of distresses for all sections: alligator cracking, longitudinal cracking, and transverse cracking.
- Sometimes values for transverse (17 out of 20 had <20 count difference) or longitudinal (4 out of 20 had <20 ft. difference) cracking are fairly close between PMIS and TxDOT data. Usually, the transverse cracking (19 out of 20) or longitudinal cracking (16 out of 20) was higher for TxDOT readings, but part of this may be because TxDOT reported cracking for both sealed and non-sealed cracks.
- PMIS data was reported as a total value (without sealed and non-sealed cracks distinguished); however, PMIS may have counted fewer sealed cracks than TxDOT on some sections. If only the TxDOT non-sealed cracks are counted, the TxDOT value will be closer to the PMIS value (31 out of 40 cases found this to be true).

Table 3.3: Summary of PMIS Manual Rating and TxDOT 3D System Distress Data for HMA Sections

Ratings - ACP	Alligator (% alligator) cracking area		Longitudinal (feet per 100 ft. station)				Transverse (# per 100 ft. station)				Patching (% patching area)		Raveling (raveling rating code)		Failures (# for entire section)	
Section	PMIS	TXDOT	PMIS	TXDOT (non-sealed)	TXDOT (sealed)	TXDOT (non-sealed + sealed)	PMIS	TXDOT (non-sealed)	TXDOT (sealed)	TXDOT (non-sealed + sealed)	PMIS	TXDOT	PMIS	TXDOT	PMIS	TXDOT
AutoDC1_FM969-1	1	0	205	66	157	223	5	34	5	39	0	0	0	0	0	0
AutoDC2_FM1377-1	20	0	48	36	201	237	2	44	3	47	57	0	0	0	0	0
AutoDC3_FM696-1	39	0	79	20	125	145	0	4	1	5	0	0	0	0	0	0
AutoDC4_FM696-3	17	0	37	3	31	34	0	1	0	1	0	0	0	0	0	0
AutoDC5_FM696-4	7	0	35	8	82	90	0	1	0	1	0	0	0	0	0	0
AutoDC6_FM696-2	22	0	82	35	171	207	0	7	3	10	0	0	1	0	0	0
AutoDC7_FM696-5	0	0	2	8	23	30	0	5	2	7	42	0	0	0	0	0
AutoDC8_FM619-1	63	0	42	50	241	291	0	10	5	15	67	0	1	0	0	0
AutoDC9_FM112-1	69	0	95	106	363	468	0	5	9	14	5	0	0	0	0	0
AutoDC10_FM1331-1	15	0	86	49	130	179	0	3	2	5	0	0	0	0	4	0
AutoDC11_FM1331-2	15	0	126	33	121	155	0	5	5	10	0	0	0	0	0	0
AutoDC12_FM1063-1	7	0	57	13	60	73	0	7	3	10	47	0	0	0	0	0
AutoDC13_US79-1	0	0	4	13	10	24	0	8	3	11	0	0	0	0	0	0
AutoDC15_Spur484-1	0	0	55	2	28	29	1	1	0	1	0	0	0	0	0	0
AutoDC17_La_Salle-1	0	0	161	10	92	102	7	6	5	11	0	0	0	0	0	0

Table 3.4: Summary of PMIS Manual Rating and TxDOT 3D System Distress Data for JCP Sections

Ratings - JCP	Alligator (% alligator) cracking area		Longitudinal (feet per 100 ft. station)				Transverse (# per 100 ft. station)				Failed Joints & Cracks (# for entire section)		Failures (# for entire section)		Apparent Joint Spacing (feet, average from two 200' areas)	
Section	PMIS	TXDOT	PMIS	TXDOT (non-sealed)	TXDOT (sealed)	TXDOT (non-sealed + sealed)	PMIS	TXDOT (non-sealed)	TXDOT (sealed)	TXDOT (non-sealed + sealed)	PMIS	TXDOT	PMIS	TXDOT	PMIS	TXDOT
AutoDC16_US77-1	0	0	0	49	54	103	0	11	7	18	10	0	4	0	15	0
AutoDC20_US84-1	0	0	0	22	15	37	0	3	1	5	9	0	0	0	60	0

Table 3.5: Summary of PMIS Manual Rating and TxDOT 3D System Distress Data for CRCP Sections

Ratings - CRCP	Alligator (% alligator) cracking area		Longitudinal (feet per 100 ft. station)				Transverse (# per 100 ft. station)				Patching (% patching area)		Block (% of lane's total surface area)		Spalled Cracks (# for entire section)		Concrete Patches (# for entire section)		Average Crack Spacing (feet, average from two 200' areas)		Punchouts (# for entire section)	
Section	PMIS	TXDOT	PMIS	TXDOT (non-sealed)	TXDOT (sealed)	TXDOT (non-sealed + sealed)	PMIS	TXDOT (non-sealed)	TXDOT (sealed)	TXDOT (non-sealed + sealed)	PMIS	TXDOT	PMIS	TXDOT	PMIS	TXDOT	PMIS	TXDOT	PMIS	TXDOT	PMIS	TXDOT
AutoDC14_IH35-3	0	0	0	3	15	19	0	2	0	2	0	0	0	0	1	0	4	0	5	0	0	0
AutoDC18_IH35-1	28	0	127	34	31	65	3	3	1	4	2	0	3	0	2	0	7	0	3	0	1	0
AutoDC19_IH35-2	0	0	0	86	51	137	0	15	9	23	0	0	0	0	4	0	12	0	6	0	2	0

3.2 Analysis of Texture Measurements

The texture results for each section are shown in the following appendices:

- Appendix D.1 – Texture Summary (Inner Wheel Path)
- Appendix D.2 – Texture Summary (Outer Wheel Path)
- Appendix D.3 – Texture Graphs

Appendices D.1 and D.2 show the texture measurement as mean profile depth in mm every 50 ft for each wheel path, as well as the error results (error = reference – vendor). Below each texture graph in Appendix D.3 is an image close-up of the respective section. Table 3.6 presents the summary of texture measurement average errors for each section and vendor. The following observations are noted:

- In most sections, the texture reported by Dynatest (12 out of 20 outer wheel path sections with <.3 mm average error) and Fugro-Roadware (26 out of 40 inner and outer wheel path sections with <.3 mm average error) were close to the reference value, with values close to 0.5 or 1 mm.
- WayLink-OSU texture readings (23 out of 40 inner and outer wheel path sections with 1.00–1.99 mm average error) were slightly higher in magnitude, with values close to 1.5 or 2 mm (sometimes higher).

- TxDOT readings (15 out of 20 outer wheel path sections with 1.00–2.99 mm average error) were also usually higher in magnitude, usually 1.5 mm or higher (sometimes 3 or 4 mm). TxDOT is represented in the graphs as a single straight line because the reading was reported as an average value for the entire 550-ft. section. In many of the sections, the TxDOT average texture graph-line is close to the WayLink-OSU line in magnitude.
- WayLink-OSU and Fugro-Roadware reported values for both wheel paths.
- Though WayLink-OSU is reported at higher magnitudes, in many of the sections the texture graph-line follows a similar trend in shape as the reference, Dynatest, and Fugro-Roadware.

Table 3.6: Summary of Texture Measurement Average Errors for Each Section and Vendor

Section	*Inner* wheelpath (IWP) - MPD Average Error (mm)				*Outer* wheelpath (IWP) - MPD Average Error (mm)			
	Vendors			TxDOT	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU		Dynatest	Fugro	Waylink-OSU	
AutoDC1_FM969-1	-	0.00	-1.55	-	0.02	-0.14	-1.73	-1.26
AutoDC2_FM1377-1	-	0.13	-1.13	-	0.47	0.38	-0.77	-0.79
AutoDC3_FM696-1	-	0.21	-1.45	-	0.45	0.47	-0.98	-3.31
AutoDC4_FM696-3	-	0.01	-1.18	-	0.04	0.06	-0.95	-2.56
AutoDC5_FM696-4	-	-0.01	-1.54	-	0.01	-0.02	-1.12	-1.54
AutoDC6_FM696-2	-	0.03	-1.67	-	0.04	0.09	-1.53	-0.48
AutoDC7_FM696-5	-	0.32	-0.98	-	0.36	0.37	-0.82	-1.76
AutoDC8_FM619-1	-	0.52	-0.98	-	0.73	0.75	-1.14	-2.38
AutoDC9_FM112-1	-	0.35	-0.95	-	0.19	0.37	-0.65	-2.09
AutoDC10_FM1331-1	-	0.33	-2.38	-	0.63	0.54	-9.51	-2.00
AutoDC11_FM1331-2	-	0.55	-1.32	-	0.45	0.56	-1.98	-1.94
AutoDC12_FM1063-1	-	0.62	-1.30	-	0.52	0.53	-1.08	-1.59
AutoDC13_US79-1	-	0.04	-3.16	-	0.50	0.12	-2.07	-2.75
AutoDC14_IH35-3	-	0.06	-0.98	-	-0.07	0.05	-0.61	-1.32
AutoDC15_Spur484-1	-	0.27	-1.86	-	0.22	0.28	-1.09	-2.02
AutoDC16_US77-1	-	0.28	-1.41	-	0.01	0.27	-0.43	-0.81
AutoDC17_La_Salle-1	-	-0.17	-1.32	-	0.10	-0.06	-1.05	0.48
AutoDC18_IH35-1	-	0.05	-1.38	-	0.04	0.23	-0.87	-1.22
AutoDC19_IH35-2	-	0.01	-1.13	-	-0.08	-0.01	-0.93	-1.15
AutoDC20_US84-1	-	0.01	-1.31	-	-0.12	-0.07	-1.14	-1.20
Average	**-**	**0.18**	**-1.45**	**-**	**0.23**	**0.24**	**-1.52**	**-1.59**

3.3 Analysis of Cross Slopes

The results for the cross slope of each section, with units in percentage, are shown in the following appendices:

- Appendix E.1 – Cross Slope Error Summary
- Appendix E.2 – Cross Slope Graphs

For each section, Fugro and WayLink-OSU reported cross slope values for each 1-ft transverse segment of each 50-ft longitudinal subsection of the entire 550-ft section. The error results of these measurements for these two vendors (error = reference – vendor) are shown in the first two tables of each section in Appendix E.1. Table 3.7 summarizes the average cross slope error for all sections.

TxDOT reported the average cross slope of the entire 550-ft. section for each section, calculated with three different algorithms: AASHTO PP69, two-point, and line fitting algorithm.

Based on a preliminary review of the data, the results were adjusted by the researchers when it appeared that the participants used different sign conventions to report slope values when compared to the reference data. In Appendix E.2, the third table for each section shows the error results every 50 ft (error = reference – vendor) of the cross slopes after they have been adjusted to correct sign direction.

The following observations were made regarding the cross slope graphs:

- In most of the sections (19 out of 20), Dynatest follows a similar trend to the graph-line shape of the reference. Sometimes the Dynatest line has to be flipped in sign to match the reference.
- Sometimes Fugro-Roadware (12 out of 20 sections) follows a similar or partially similar shape to the reference graph-line and many times has to be flipped in sign to match.
- Sometimes WayLink-OSU (7 out of 20 sections) follows a similar or partially similar shape graph-line as the reference, though it is often higher or lower in magnitude. For most of the sections the WayLink-OSU line did not get flipped in sign.
- Sometimes WayLink-OSU cross slope magnitude is closer to Fugro-Roadware's magnitude, although many times Fugro-Roadware is closer to the reference in magnitude (after being flipped in sign). Dynatest and the reference are usually closer in magnitude.
- The TxDOT average cross slope readings are often close to the vendor and reference readings, but sometimes needs to be flipped in sign. The PP69 algorithm graph-line is often farther from the reference (higher in magnitude) than the other two algorithms (two-point and line fitting).

Table 3.7: Summary of Cross Slope Measurement Average Errors for Each Section and Vendor

Section	*Adjusted* Cross Slope - Average Error (percent)						Std. Dev. (percent)		
	Vendors			TxDOT			Vendors		
	Dynatest	Fugro	Waylink-OSU	pp69 algorithm	2 point algorithm	line fitting algorithm	Dynatest	Fugro	Waylink-OSU
AutoDC1_FM969-1	3.09	-0.89	-0.89	2.25	0.85	0.80	0.09	0.23	0.41
AutoDC2_FM1377-1	1.12	1.35	0.52	-1.58	-0.17	-0.16	0.14	1.17	0.72
AutoDC3_FM696-1	3.44	-4.52	-2.30	1.24	0.34	0.64	0.66	2.26	1.03
AutoDC4_FM696-3	3.29	-1.23	-1.59	1.03	-0.37	-0.43	0.15	0.60	0.93
AutoDC5_FM696-4	0.22	-2.93	-3.12	0.84	-0.41	-0.45	0.23	0.52	0.63
AutoDC6_FM696-2	0.17	-2.60	-1.73	0.43	-0.92	-0.67	0.27	2.44	0.89
AutoDC7_FM696-5	0.15	-0.67	-0.91	1.85	0.60	0.72	0.17	0.86	0.77
AutoDC8_FM619-1	0.45	-6.67	-5.91	-7.60	-5.87	-5.93	0.37	0.73	3.13
AutoDC9_FM112-1	-0.16	-1.97	-1.47	1.10	-0.30	-0.58	0.45	1.20	1.04
AutoDC10_FM1331-1	1.79	1.79	1.24	-1.96	-0.83	-1.00	0.65	1.15	0.62
AutoDC11_FM1331-2	2.10	2.10	2.25	-2.18	-1.49	-1.81	0.20	1.00	1.50
AutoDC12_FM1063-1	-0.02	-0.44	-1.01	2.32	1.22	1.27	0.32	1.89	0.58
AutoDC13_US79-1	2.13	2.13	1.58	-1.67	-0.67	-0.58	0.16	0.69	0.62
AutoDC14_IH35-3	0.17	-2.03	-3.93	-0.24	-1.27	-0.63	0.26	0.44	1.61
AutoDC15_Spur484-1	2.65	2.65	2.54	-0.67	0.50	0.62	0.06	0.23	0.20
AutoDC16_US77-1	1.61	1.61	1.65	-0.67	0.45	0.54	0.13	0.29	0.34
AutoDC17_La_Salle-1	1.15	1.21	1.06	-0.86	0.40	0.46	0.12	0.60	0.32
AutoDC18_IH35-1	-0.22	-2.66	-2.75	0.54	-0.47	-0.53	0.26	0.70	0.70
AutoDC19_IH35-2	0.06	-2.50	-2.52	0.04	-0.94	-0.75	0.22	0.67	1.11
AutoDC20_US84-1	1.59	1.07	1.72	-0.68	0.46	0.87	0.28	0.27	0.26
Average	**1.24**	**-0.76**	**-0.78**	**-0.32**	**-0.44**	**-0.38**	**0.26**	**0.90**	**0.87**

Chapter 4. Recommendations for Selection of Automated Distress Measuring Equipment

4.1 Introduction

Phase 2 of TxDOT Research Project 0-6663, *Evaluation of Pavement Rutting and Distress Measurements*, had the objective of evaluating the accuracy and precision of the new automated system developed by a TxDOT research group (composed of staff from the Construction Division's Materials and Pavement Section) for the high-speed measurement of pavement surface distresses, texture, and cross slope. In addition, equipment vendors participated in the study by providing equipment that represents the state of the practice—the automated distress collection vehicle. This equipment is used by other state DOTs for visual distress data collection through either vendor contracts or direct purchase. The implementation of an automated distress measuring system will allow the assessment of the highway condition at both the network and project levels and potentially eliminate the need for manual visual assessments to rate pavement distresses for network-level PMIS applications. Eliminating any subjective elements in visual rating leads to more consistent and reliable data. Consistent and reliable data on the Texas road network will enhance pavement management and, ultimately, allow better utilization of ever-decreasing funds and overall state resources.

As part of this evaluation, the TxDOT system was compared to that of three automated system vendors in order to identify the best equipment for each pavement management data type. This comparison yields the information necessary for the researchers to help TxDOT in further evaluating the selection of automated distress measuring equipment. The high-speed measurements reported by each of the four automated systems that participated in the Phase 2 experiment were compared to manual measurements taken statically by experienced raters. The Phase 2 experiment comprised 20 550-ft-long pavement test sections, including both flexible and rigid pavements, which were selected to represent the main pavement characteristics encountered on the Texas highway network.

The analyses of the automated measurement of surface distresses considered all distress types defined in the TxDOT PMIS and the LTPP protocols. Special focus was placed on the analyses of alligator cracking, longitudinal cracking, transverse cracking, patching, and failures. The only distress type not analyzed in Phase 2 was rutting, which was evaluated during Phase 1. The recommendations for the selection of an automated rut measurement system were provided in the project's product P1: *Recommendations for Selection of Rutting Measuring Equipment* (presented as Chapter 5 of report 0-6663-1).

Phase 2 analyses also included a qualitative comparison between the crack maps produced by the different automated systems at highway speeds and digital crack maps collected statically by manual measurement of the cracks. A comparative analysis of the digital crack maps allowed the researchers to obtain deeper insight into each system's quality of measurements and identify sources of error that cannot be detected by evaluation of summary statistics alone. For instance, this analysis allows for detecting cases for which the number of missed cracks practically compensated for false positives, producing apparently good overall summary statistics, thus creating misleading data for the interpretation of a system's true performance capabilities.

The current state of the practice in automated collection of pavement surface distresses is that, in general, transportation agencies have to choose between prompt delivery of results and enhanced accuracy. Faster distress data delivery is achieved by reporting the distresses detected and classified by the system's algorithms with minimal or no manual processing or corrections. Enhanced quality of results is achieved by the intervention of trained personnel that visually inspect and correct the automated data produced by the system's algorithms. Since an ideal system would produce results with no need of further corrections, each service provider was asked to report their results with different levels of manual intervention in order to capture the difference in accuracy and identify the common types of errors produced by the systems' algorithms. In addition, since some technologies and algorithms were the best for certain types of distresses (e.g., the best system for detecting alligator cracking might not have been the best for detecting patching), the different distress types were analyzed separately, as carried out for texture and cross slope measurements. The recommendations for the selections of distress measuring equipment are based on the individual assessments for each distress type and time frame (level of manual processing), and the qualitative comparison of digital crack maps.

For Phase 3 of the project, two service providers (vendors) collected full network level data as per TxDOT PMIS specifications on the entire network in the Bryan District and in the Houston District. TxDOT asked the research team to evaluate the automated data collected, focusing on network-level processes and applications. As directed by TxDOT, the baseline data for this analysis will be the standard data collected for PMIS using the current methodologies that support the TxDOT PMIS. This phase is currently underway.

4.2 Summary Findings

The researcher team selected 20 550-ft field sections located in the Austin and Waco TxDOT Districts, distributed according to surface type into 15 asphalt concrete pavements (ACPs), 2 jointed concrete pavements, and 3 continuously reinforced pavements. Among the ACP test sections, the surface types were distributed as seven HMAs, seven STs, and one PFC surface. The types of data collected at each section were distresses, texture, cross slope, and crack maps. The first types of data collected were manual measurements of distresses according to PMIS and LTPP protocols, conducted by two crews of raters with extensive years of practical experience in the respective protocols; longitudinal distribution of cross slope values using a FACE® Dipstick inclinometer; and longitudinal distribution of surface texture values for each wheel path, using a circular track meter (CTM).

Once the first set of manual measurements was completed, the different participating systems collected automated measurements at highway speeds on every test section of the study. In addition to the TxDOT 3D system, the following three vendors participated in the experiment: Dynatest (with an INO LCMS), Fugro-Roadware (with an INO LCMS), and WayLink-OSU (with an in-house developed 3D system). In order to capture the difference in accuracy for different levels of manual intervention, every participant was asked to report each data type within the following three different time frames:

- Fully automated with no manual post-processing, for data delivered at the end of a data collection run with no post-processing by the vendor;
- Semi-automated with minimum manual post-processing, for data delivered within 2 business days from the date that the vendor completes data collection on the last test section; and

- Semi-automated with higher manual post-processing, for data delivered within 4 weeks from the date the vendor completes data collection on the last test section.

Data reported for the first time frame represents the accuracy offered by the vendor if prompt delivery is a priority, whereas data reported for the third time frame represents the most accurate data interpretation possible. The number of days for each time frame was defined upon agreement with TxDOT and the participating vendors during a webinar conducted by the research team.

The last piece of data collected for Phase 2 experiment consisted of reference digital crack maps for the qualitative analyses. The crack maps were manually collected by the researchers at three 50-ft subsections per test section at 10 of the 20 test sections, thus collecting a total of 30 reference crack maps for the analyses. These subsections were selected in order to obtain sample cases for all main experimental variables in the study. The researchers marked the cracks visually detected in the field and categorized them into the following severity levels (crack width): cracks less than 3 mm (.12 in.) wide, between 3 mm and 6 mm (.24 in.) wide, and more than 6 mm wide. The crack width was measured using metallic rulers to determine the correct width category. Once the cracks were marked for the entire length of analysis, the next step consisted of taking digital pictures of the pavement surface every 5 ft. The reference digital photos taken by the research team were collected with a high-end digital camera mounted to a steel frame mounted to the front bumper of a truck. The camera was linked to a laptop operated from inside the truck, which provided controls to trigger the camera and collect the images. The steel frame was designed such that the camera was mounted approximately 12 ft above the pavement, pointing directly downward, and was therefore able to take photos of the entire lane width with minimal lens distortion. These individual pictures were further stitched and processed in order to obtain a unique digital crack map per subsection.

4.2.1 Digital Crack Maps

The crack maps reported by the participants were evaluated qualitatively, as requested by TxDOT, by comparing them to digital crack maps manually collected with the objective of assessing the capabilities of the systems to properly detect cracks and identify their severity level to an accuracy consistent with the needs of the Department and the objectives of the research project. The comparative analyses of the digital crack maps allowed the researchers to detect patterns and sources of error that cannot be detected solely by analyzing the summary statistics.

Only one participant, TxDOT, reported digital crack maps within the first time frame (just after data collection). TxDOT, however, decided to not submit crack map data for the other two time frames (with manual processing) because the TxDOT automated equipment team considers this data as the most realistic and so the most appropriate for our analyses. WayLink-OSU reported crack maps for all test sections within the second time frame (minimum manual processing) but decided to not submit a dataset with higher manual corrections since they did not consider it necessary for improving the accuracy of their product. Dynatest and Fugro-Roadware reported crack maps with both minimal post-processing (within 2 days) and higher post-processing (within 4 weeks). WayLink-OSU, Dynatest, and Fugro-Roadware expressed that the crack maps data they reported for the second time frame consist of automated results produced by the systems' algorithms without manual correction. According to these three vendors, the processing performed during the 2 days after collecting the data was limited to only the amount of processing necessary for reporting the digital crack maps in the format requested by the researchers.

Among the crack maps with minimal or no manual post-processing, it was observed that TxDOT and WayLink-OSU tended to miss cracks more than reporting false positives regardless of the surface type, whereas Dynatest and Fugro-Roadware presented maps with cases of both missed cracks and false positives. Therefore, TxDOT and WayLink-OSU system's algorithms tended to underestimate the crack lengths, TxDOT being the participant with the largest number of missed cracks. On several flexible pavements WayLink-OSU outperformed the other participants at detecting cracks; however, they tended to overestimate the crack width. In addition, WayLink-OSU was the only system that did not misidentify transverse or longitudinal joints on rigid pavements as cracks. The amount of missed cracks was greater for cracks less than 3 mm (.12 in.) wide for all participants and surface types. The very fine cracks observed on the rigid pavements were not detected by any automated system. The number of false positives observed from the Dynatest and Fugro-Roadware automated datasets was larger for the case of flexible pavements. In addition, TxDOT and Dynatest presented false positives caused by misinterpreting features such as vegetation, spots with different colors, and rumble stripes.

The automated results generated by Fugro-Roadware and Dynatest systems' algorithms were greatly improved after applying manual correction. In addition, the dataset corresponding to the third time frame also included types of distresses that were not reported in the fully automated data deliveries, such as patching and raveling. These observations show that applying manual processing to automated results even for current state-of-the-art equipment can improve distress detection and elimination of false positives identified by automated algorithms. However, another interesting observation was that manual corrections performed visually by trained raters were also a source of error in some cases. It should be noted that the vendors were not constrained to providing the detailed, manual ratings at 4 weeks (the maximum allowed for the third set of data) if results could be delivered sooner. However, the research team notes that both Dynatest and Fugro-Roadware used the full 4-week period for manual processing of thirty 50-ft-long test subsections. This suggests that manual interpretation of an entire pavement network might be time consuming and will be interesting to evaluate in Phase 3 of this study for the Bryan and Houston Districts.

4.2.2 Distress Statistics

The distresses statistics reported by each participant and by experienced manual raters were compared for every type of distress with the objective of identifying the differences and similarities among the different systems and to observe the changes between the fully automated (or with minimal manual post-processing) and semi-automated results. Due to the cost and time delays associated with developing software systems by the vendors to collect and report distress data in the TxDOT PMIS protocol and for TxDOT to report distress data in the LTPP protocol, it was not possible to compare all four participants directly. The three vendors, which already have data collection software and protocols for LTPP data, were evaluated according to the LTPP protocol whereas TxDOT was evaluated using the PMIS protocol. Each system was compared to statistics manually collected according to the corresponding LTPP or PMIS protocols by experienced raters. As for the case of digital crack maps, TxDOT delivered distress statistics only for the first time frame; WayLink-OSU did it only for the second time frame; while Fugro-Roadware and Dynatest reported summary statistics for the second and third time frames.

The comparative analyses among WayLink-OSU's, Fugro-Roadware's, Dynatest's, and manual raters' LTPP distress statistics were performed for each type of distress separately. There was no clear pattern between manual measurements and the different vendors for any type of distress in flexible pavements except for the case of transverse cracking, for which a good match among the manual raters', WayLink's, and Fugro-Roadware's semi-automated dataset was observed. The lack of correlation for the majority of distresses types is explained, in part, by the differences in criteria used for distress classification; e.g., longitudinal cracks in the wheel path that were correctly detected by all participants might have been classified by either the vendors or manual raters as fatigue cracking rather than longitudinal cracking. In addition, it was observed that WayLink-OSU and Fugro-Roadware semi-automated datasets consistently reported fewer numbers and smaller patch sizes while Fugro-Roadware fully automated Dynatest's fully and semi-automated datasets did not report patching.

Interestingly, Dynatest and Fugro-Roadware (both using INO LCMS) consistently increased the fatigue cracking area after manual intervention by a similar proportion for every flexible pavement. This observation suggests that the Dynatest and Fugro-Roadware systems' algorithms tend to systematically underestimate fatigue cracking. Examples of other significant differences between the fully and semi-automated datasets were a decrease in Fugro-Roadware's transverse cracks and an increase in Dynatest's edge cracking for flexible pavements. Regarding the analysis of rigid pavements, the number and length of transverse cracks drastically increased after manual intervention for both Fugro-Roadware and Dynatest data sets. However, no clear pattern was observed for the different types of cracking among the vendors and manual raters. Also, Fugro-Roadware and Dynatest reported the different types of spalling and joint damage only for the case of semi-automated data.

TxDOT distress readings were compared with the manual PMIS measurements. Only longitudinal cracking and transverse cracking could be reported by TxDOT's current automated equipment set-up, whether the section was asphalt pavement or concrete pavement. On many sections in which TxDOT values were significantly higher than the reference, values became closer to the reference values after TxDOT's sealed crack counts were removed by the researchers during data analysis and interpretation, thus counting only non-sealed cracks. This process was not intended to change the TxDOT analysis results, but only to help understand differences between the reported, automated data and manual reference data.

4.2.3 Texture

Pavement texture was reported as the mean profile depth in mm, every 50 ft for each wheel path. Only TxDOT reported texture data just after data collection. The other three participants reported texture data for the second time frame (within 2 days of completing data collection). In most sections, Dynatest and Fugro-Roadware were close to the reference measurements taken by the research team using a CTM, whereas WayLink-OSU and TxDOT's reported average reading were usually higher in magnitude. WayLink-OSU followed a similar trend in shape as the reference.

4.2.4 Cross Slopes

As for the case of texture data, only TxDOT reported cross slope for the first time frame while the three vendors reported their cross slope values within 2 days of collecting data. The cross slope values were reported every 50 ft, in units of percent. For most (19 out of 20) sections, Dynatest measurements closely match or follow a similar trend to the reference in the graph-line shape and, though for fewer instances, slope magnitude. Fugro-Roadware (12 out of 20 sections) and WayLink (7 out of 20 sections) sometimes match or partially match the reference graph-line shape, though they (WayLink-OSU more than Fugro-Roadware) exhibit variations above and below the reference slope magnitude. TxDOT's average cross slope readings were often close to the reference and the other vendors, though readings with the AASHTO PP69 algorithm were often farther from the reference than the other two algorithms (two point and line fitting) reported by TxDOT.

4.3 Final Recommendations

The University of Texas at Austin has completed Phase 2 of TxDOT Research Project 0-6663, *Evaluation of Pavement Rutting and Distress Measurements*. During this phase,

- A field experiment consisting of 20 sections was developed,
- Static manual distress statistics, texture, cross slopes, and digital crack maps were collected,
- Four participants were invited to collect automated distress, texture, and cross slope measurements at highway speeds, and
- The results were analyzed and compared to assess the difference between automated and manual measurements and evaluate the change in accuracy between fully and semi-automated results.

As a result of the Phase 2 efforts, the research team reached the following preliminary conclusions:

- Among the datasets reported within 2 days, under the conditions evaluated, the WayLink-OSU outperforms the remaining participating systems in terms of crack detection. However, WayLink-OSU tended to overestimate the crack widths, suggesting the need for further adapting and calibrating the system's algorithms for Texas conditions.
- Dynatest and Fugro-Roadware showed a significant improvement in the accuracy of their distress measurements after applying manual post-processing consisting of visual interpretation and correction of the results produced by their systems' algorithms. Additionally, the results reported within 4 weeks included more types of distresses. These observations show the current need for applying manual interpretation to the automated results produced by state-of-the-art equipment.
- The TxDOT crack maps were missing a large number of cracks, suggesting the need for calibrating the algorithms in order to increase system sensitivity for detecting narrower cracks. The researchers noted that adjusting system sensitivity to find more cracks can also result in a greater number of false positives—this is a trade-off that each participant must consider when calibrating their crack detection systems. It is also suggested that TxDOT consider the development of algorithms to quantify crack widths and thus report crack severity levels.

- From the comparative analyses among the distress statistics reported by each participant and the manual raters, no clear, obvious patterns emerged for all types of distresses and time frames. Thus, the researchers could not identify one automated system that was clearly superior to the other. This lack of clear patterns is in part due to the use of different distress classification criteria. It is recommended that an objective and programmable standard or protocol be developed for classifying distresses from automated data in order to increase the consistency of results.
- Several types of distresses, such as patching, punchouts, spalling, and joint damage, were reported only after manual post-processing of the crack maps by Fugro-Roadware and Dynatest, whereas WayLink-OSU reported some of these types of distresses on the 2-day time frame.
- TxDOT did not provide data for all PMIS distress types due in part to ongoing work to improve distress identification algorithms and reporting methods. Apparently, additional time and effort is needed to refine the TxDOT system to provide fully automated, short-time-frame results.
- It is suggested that TxDOT could improve crack identification accuracy by differentiating between sealed and unsealed cracks The number of sealed cracks reported by TxDOT often caused the crack count to be significantly higher than the reference. It could be that either TxDOT is over-counting the sealed cracks, or the reference is under-counting the sealed cracks.
- Dynatest and Fugro produced texture results close to the reference in magnitude with minor error. It is suggested that WayLink-OSU and TxDOT consider updating or calibrating their systems since all measurements presented were greater than the reference values. Note that TxDOT texture results were reported as an average value for each 550-ft section, which is equivalent to the 0.10-mile subsection length used to store and calculate PMIS rating sections values. Revising the TxDOT algorithm to report values on a 50-ft. interval could have resulted in a different conclusion.
- Dynatest reported cross slope measurement results closest to the reference in graph-line shape and magnitude. Fugro results are fairly close to the reference in magnitude at certain points, although the graph-line shape is not always close to the reference. WayLink-OSU can sometimes deliver a graph-line shape similar to the reference, although often the magnitude is higher or lower than the reference.
- TxDOT cross slope was evaluated with average values per entire section, so a precise comparison could not be evaluated. The researchers suggest that further work is needed to improve analysis of cross slope data based on the results from the three algorithms used by TxDOT.

Chapter 5. Quantification of Impact on PMIS Scores

5.1 Introduction

This chapter reports the results of the analyses conducted by the research team in order to quantify how improved measurements of pavement surface distresses will potentially affect current distress and condition scores. The first section of the chapter describes the approach adopted for evaluating the impact of a change in the pavement distresses measurement system on the assessment of the pavement network condition. The proposed methodology was applied using the measurement errors assessed in previous tasks of this research project on models and indices defined in PMIS. The second part of the chapter reports the quantified impact on the PMIS scores, along with a list of main observations and conclusions.

5.1.1 Background

The collection of accurate pavement distress data (such as rutting and cracking data) is important for the success of pavement management systems (PMS). Distress data is used in PMSs for assessing the condition of the pavements in the network, which is used for prioritizing candidate projects at the network level as well as selecting the best maintenance and rehabilitation (M&R) treatment at the project level (Zhang et al. 1999). Also, historical and current condition data is used to calibrate and monitor the performance models used to forecast the deterioration of pavement and schedule M&R activities. A change in accuracy and precision of pavement condition data will affect the PMS outputs, possibly resulting in misleading information about the performance of the pavement network. For instance, the larger number of distresses captured by transitioning to a more precise measurement system will cause an apparent increase in the deterioration of the pavement network. Therefore, it is necessary to quantify the impact of upgrading the distresses measurement system on the PMS outputs in order to assess for the actual pavement network condition.

Buchheit et al. (2005) documented that errors in pavement condition data are unavoidable. The magnitude of the impact of pavement condition data errors on a PMS depends on the severity, amount, and type of errors themselves. Manzella and McNeil (2006) concluded that such errors could directly lead to inappropriate project prioritization by incorrectly assessing current pavement conditions. Previously, Garza et al. (1998) reported that a PMS with incorrect pavement condition data is also prone to predicting the future pavement conditions incorrectly. Ng et al. (2011) introduced the price of uncertainty to capture the impact of uncertainty and showed that uncertainty can significantly increase maintenance costs. Most recently, Saliminejad and Gharaibeh (2012) investigated the effect of pavement condition data errors on PMS outputs and reported that accumulated errors in current pavement condition data disorient the M&R policies by falsely predicting future pavement conditions.

<u>Definition of Error in Pavement Distresses Data</u>

Measured data error can be divided into systematic error (or bias) and random error (or precision). ASTM E177 defines the former as "a consistent or systematic difference between a set of test results from the process and an accepted reference value of the property being measured;" and the latter as "the closeness of agreement between test results obtained under prescribed like conditions from the measurement process being evaluated." In other words, the *bias* refers to the degree of closeness between a measured value and the true value whereas *precision* refers to the closeness between consecutives measurements. The higher the accuracy of an instrument, the lower the systematic error; and the more precise the instrument is, the lower the random error. Regarding the effect of error type in pavement condition data on the assessed pavement network condition, Saliminejad and Gharaibeh (2012) suggested that systematic errors have a higher impact on the PMS outputs than do random errors.

Description of TxDOT PMIS

Budget allocations for the different TxDOT districts are made on the basis of the PMIS condition scores and ratings. This study uses the TxDOT PMIS distresses data and rating system for determining the condition of the pavement sections in the network. The Condition Score (CS) represents the average person's perception about the road network (Stampley et al., 1995). A CS greater than or equal to 70 is considered a "good or better" pavement condition. Equation 5.1 presents the expression to calculate the CS for a given PMIS pavement section; where CS is the condition score, DS is the distress score, and U_Ride is the utility value for ride quality.

$$CS = 100 * DS * U_{Ride} \qquad \text{(Eq. 5.1)}$$

TxDOT PMIS uses Ride Score (RS) and Distress Score (DS) for assessing the pavement based on how comfortable and safe it is to drive in a particular pavement section (Stampley et al., 1995). Utility curves are basically empirically drawn trend lines depicting distress or loss of ride quality. These curves are used for determining usefulness of pavements and depend on factors such as the type of pavement and traffic volume. The utility value for ride quality is based on the average daily traffic, the design speed for the particular road facility, and the pavement's RS. The DS is determined by multiplying the utility values corresponding to each of the surface distresses found in the type of pavement under consideration. As an example, the expression to calculate the DS for flexible pavements is presented in Equation 5.2, where U_i is the utility value for each type of distress (e.g., rutting, patching, alligator cracking, longitudinal cracking, transverse cracking, and failures). The definition and complete list of surface distresses defined for each type of pavement in Texas can be found in the PMIS *Rater's Manual* (TxDOT, 2010).

$$DS = 100 * U_{Rut} * U_{Patch} * U_{AligCrack} * U_{LCrack} * U_{TCrack} * \ldots * U_{Failures} \qquad \text{(Eq. 5.2)}$$

The utility function for each of the different distress types allows the system to weight the effect of different distresses according to the impact they have on the overall condition of the pavement. For example, the effect of shallow rutting will not be as pronounced as deep rutting. The general expression of the PMIS utility curves is presented in Equation 5.3, where L_i is the amount of distress measured on section "i", and α, β, and ρ are shape parameters controlling for the maximum amount of usefulness, the rate of utility lost in the middle of the curve, and the length of the curve above a certain utility value.

$$U_i = 1 - \alpha e^{-\left(\frac{\rho}{L_i}\right)^{\beta}} \qquad \text{(Eq. 5.3)}$$

The values for α, β, and ρ are tabulated as a function of factors such as the type of distress and the type of pavement. For example, the α, β, and ρ values corresponding to an asphalt concrete pavement with less than 6.40 mm thickness of asphalt concrete layer are 0.31, 1.00, and 19.72 for shallow rutting; 0.69, 1.00, and 16.27 for deep rutting; and 1.00, 1.00, and 45.7 for failures, respectively (Stampley, 1995).

5.1.2 Description of Methodology

Condition is defined as the description of the distresses and ride quality of the pavement. In PMIS, the condition of pavement sections is used to help select treatment levels and to determine the resulting funding needs for maintenance (Preventive Maintenance, as it appears in PMIS) and rehabilitation or reconstruction strategies (Light, Medium, or Heavy Rehabilitation, in PMIS). Therefore, when upgrading the pavement distresses measurement system, it is imperative to assess the possible impact on the PMS outputs. In addition, District Engineers are held accountable for meeting CS goals established for their district and work with their district's Pavement Engineer, Area Engineers, and management staff to develop and update the 4-Year Pavement Management Plan (PMP). The PMP documents the sections that will be treated in the current and next 3-year period based on actual and projected funding allocations. Thus, changes in methodologies for measuring or calculating the PMIS DS and CS may impact District PMP development and project selection.

In addition, under Rider 55 the State Legislature requires TxDOT to submit a report to the governor's office and the Legislative Budget Board showing how allocated funding will impact district and statewide pavement CSs. Under TxDOT project 5-9035-01, this report is currently prepared by Dr. Zhanmin Zhang of CTR; it is submitted to the Maintenance Division for review prior to submission to TxDOT Administration (Zhang 2012) (Liu 2012). Thus, changes to methodology for calculating district and statewide CSs can potentially affect district and statewide funding allocations.

The methodology described in this section was developed to quantify the difference in overall network condition due to a change in the automated measurement system (AMS) for rut measurement. A future report will document the impacts in CS in consideration of both rutting and visual distress measurements.

Figure 5.1 presents a schematic representation of the proposed methodology. Two types of data will be used in our approach:

- Field rutting measurements, from the field surveys performed for previous tasks of this research study; and
- PMIS condition data, which consist of recent measurements taken with the current measurement system used to populate the TxDOT PMIS distress databases.

The first type of data will be used to model the distribution of the difference in measured distress value, ΔD, between the current AMS and the TxDOT 3D AMS evaluated in this study. The modeled distributions will account for the uncertainties of each measurement system and will be used to perturb the current PMIS Rut Data. The current and past distress measurements data will be extracted from the PMIS attribute databases.

As Figure 5.1 illustrates, the next analysis will consist of estimating the PMIS outputs simulating the use of the proposed new measurement system. This analysis will be carried out in two steps. The first step consists of perturbing each value in the current database by the modeled difference in measured distress ΔD. The new perturbed distress database would represent the distress values that would be obtained if the proposed measurement system were adopted. The second step consists of computing the PMIS outputs using the estimated distress data perturbed by the modeled ΔD. Since the difference in distress value between the current and proposed measurement system has an associated uncertainty, the PMIS outputs will be treated as random variables. In order to capture this variability, a Monte Carlo simulation will be conducted to estimate the distribution of the PMIS outputs and make inferences about the impact on the pavement network condition.

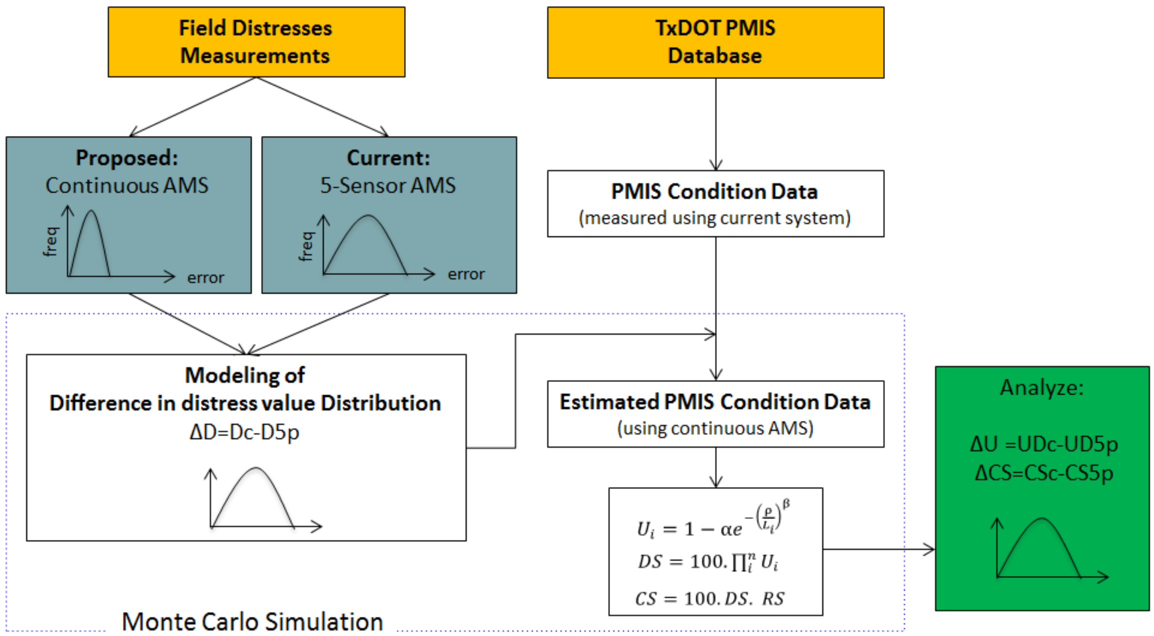


Figure 5.1: Schematic Representation of Proposed Methodology

5.2 Impact of Measurement Errors on PMIS Scores

The study carried out consisted of estimating the change in CS, as defined on the TxDOT PMIS, due to using two different methodologies for the automated measurement of rutting. The two different automated rut measurement systems (ARMS) considered were a five-sensor and a continuous system. The former has been used by TxDOT for the last 15 years to measure rutting data at network level and populate the PMIS condition database. The continuous system was developed by TxDOT with the objective of replacing the five-sensor systems.

According to the literature, five-sensor systems tend to underestimate the rut depth (RD) values whereas the continuous systems are expected to produce more accurate and precise results. Therefore, the continuous system is expected to produce higher RD values and consequently lower CS. This section describes how the presented methodology was applied in order to quantify the drop in TxDOT's PMIS CS that would occur when transitioning from the current five-sensor discrete system to a continuous one.

5.2.1 Description of Data Types

The rutting data used in our study is divided into two main types: experimental field measurements of rutting and PMIS rutting data. The former comprise detailed rutting data obtained from the Phase 1 field survey of this research study, used in our analysis to model the difference in RD values between the two ARMS. The latter consist of the rutting data stored in the TxDOT PMIS Condition Databases. The following paragraphs describe in detail these two types of rutting data and the processing applied to them.

Experimental Field Measurements of Rutting

The experimental field measurements consists of RD values measured in the field at the same locations by three different methodologies: manual measurements using a 6-ft straight-edge, RDmanual; measurements calculated simulating the use of a discrete five-point automated system, RD5p; and measurements using the TxDOT continuous automated system, RDc. The methodologies and criteria adopted to collect both the manual and the automated measurements during Phase 1 field survey are detailed in the Phase 1 report (Serigos et al., 2012b).

The automated measurements were performed at highway speeds by the TxDOT optical 3D system that scanned the pavement surface coordinates of contiguous transverse profiles along the travelled direction. The RDc values for both wheel paths were calculated every 25 ft on the entire scanned transverse profile (more than 1,000 coordinates) using an algorithm developed by the authors that simulates the criteria and processes carried out during the manual data collection. Therefore, the set of calculated RDc comprised a total of 1,104 values (= 24 sections * 23 profiles per section * 2 RD values per profile). The RD values produced by the calibrated algorithm were evaluated using the set of RDmanual values as the benchmark reference, obtaining an accuracy of -0.51 16th in. and a precision of 1.79 16th in. Therefore, the RDc values tended to underestimate the manual measurements, in average, for less than one 16th of an inch.

The RD5p values were calculated using the same transverse profiles used for the calculation of the RDc values, but the researchers selected only five coordinates of each profile in order to simulate the use of a five-sensor automated system. Figure 5.2 shows an example of a continuous transverse profile scanned by the ARMS in green, and the sensors location of the simulated discrete system with yellow circles. The locations at which the five coordinates were sampled replicated the sensor location of TxDOT's discrete system; i.e., -4 in., -2.5 in., 0 in., 2.5 in., and 4 in., zero being the center of the survey vehicle's front. The algorithm developed to calculate the RD5pts values simulated 300 runs of the discrete system at each transverse profile, varying the lateral placement of the survey vehicle in order to account for the effect of lateral wandering on the measurement error. The lateral placement of the sensors at each run was randomly generated using a normal distribution with mean and standard deviation equal to -2.36 in. and 4.92 in. respectively, zero being the middle point of the transverse profile.

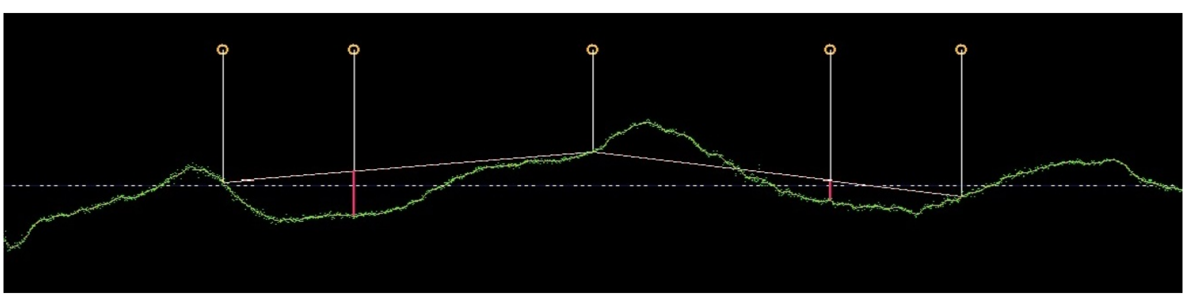


Figure 5.2: Schematic Representation of Proposed Methodology

PMIS Rutting Data

The PMIS Rutting data was obtained from the PMIS "Condition Summary" table. This table contains historical information necessary to assess the pavement condition at each year of the entire TxDOT's highway network. Some of the information contained in the table includes summarized pavement surface distresses and ride data, as well as the calculated CS, DS, and RS for each TxDOT pavement section. The information used in our study comprised the CS (Equation 5.3), RS, and rutting data of the entire network for the Fiscal Year 2011.

The rutting data stored in the PMIS database consist of the distribution of measured RD values falling into each of the five rut severity levels for each pavement section; i.e., percentage of No Rut, Shallow, Deep, Severe, and Failure Rutting. The RD measurements were collected at highway speeds by TxDOT's fleet of five-sensor discrete systems. The "Condition Summary" table was processed in order to eliminate the PMIS sections not presenting valid values or missing rutting measurements. The final dataset used in our analysis comprised FY2011 CS, RS, and rutting data of 202,718 PMIS sections covering the 25 TxDOT Districts.

5.2.2 Estimation of Difference in RD value Distribution

Once the RD values for both the discrete and continuous ARMS were obtained, the next step in our analysis consisted of estimating the distribution of the difference in RD value, ΔRD, defined as shown in Equation 5.4:

$$\Delta RD = RDc - RD5p \qquad \text{(Eq. 5.4)}$$

The difference in measured RD was computed for each profile and run, obtaining a total of 331,200 ΔRD values (= 1,104 RD values * 300 runs). Since the available rutting data covered a wide range of RD values, the distribution of ΔRD was estimated for each of the four PMIS Rut Severity Levels separately. The histograms of ΔRD categorized into the four rutting categories are presented in Figure 5.3. The ΔRD summary statistics for each of the categories are presented in Table 5.1.

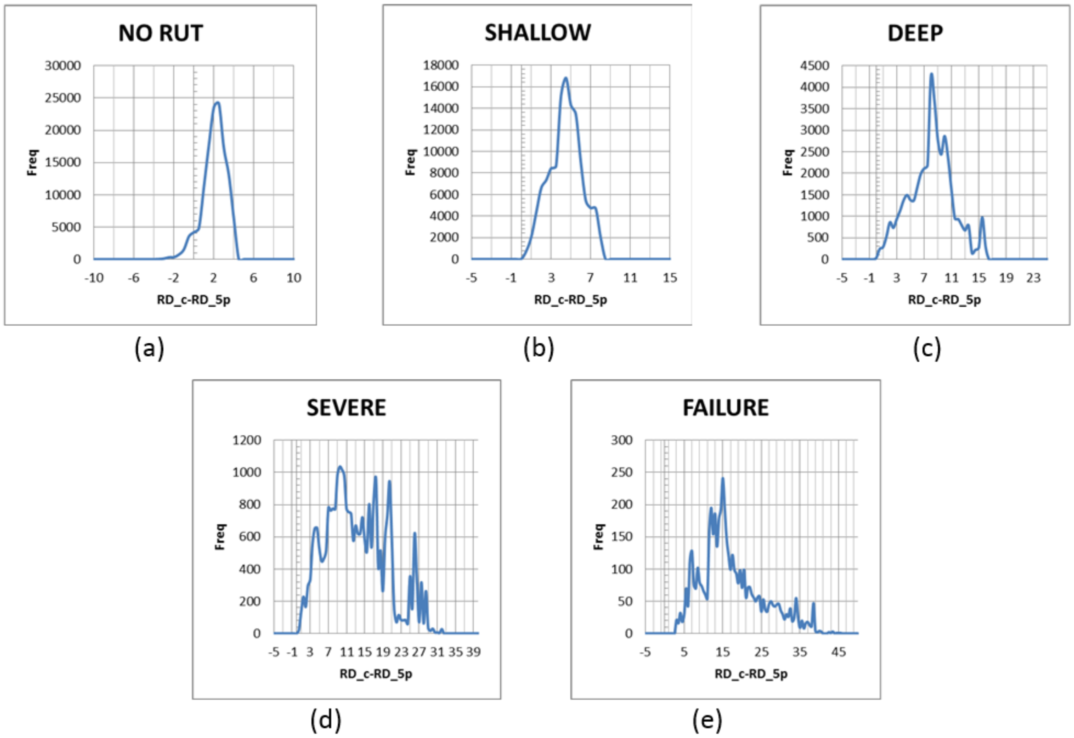


Figure 5.3: Histograms of ΔRD Categorized into the Four PMIS Rut Severity Levels

Table 5.1: Summary Statistics of Difference in RD due to Upgrading the ARMS

	PMIS Rut severity level				
	No Rut	**Shallow**	**Deep**	**Severe**	**Failure**
count	129000	123900	44400	28800	5100
median	2.17	4.43	8.21	12.26	15.38
mean	2.04	4.45	8.06	13.16	17.18
std	1.20	1.64	3.23	6.63	8.02
COV	0.59	0.37	0.40	0.50	0.47

After analyzing the distributions for the rut severity levels and considering the nature of the estimated parameters (measurement errors), the research team decided to assume a normal distribution to model the difference in RD value due to upgrading the ARMS. Therefore, the ΔRD distribution for each rut level category was modeled as a Gaussian bell curve determined by the corresponding sample mean and standard deviation presented in Table 5.1.

5.2.3 Estimation of TxDOT Network Condition Simulating Use of Continuous ARMS

As presented in the proposed methodology, the next analysis consisted of estimating the PMIS outputs simulating the use of continuous ARMS. This analysis was carried out in two steps. The first step consisted of estimating the PMIS rutting data as if it were measured using continuous instead of discrete ARMS. The second step consisted of computing the TxDOT PMIS outputs using the estimated rutting data at network level.

Perturbation of PMIS Rutting Database

The PMIS rutting data simulating the use of continuous ARMS, referred to as PMIS_RUT_cont, was estimated by perturbing the actual FY2011 PMIS Rutting data, referred to as PMIS_RUT_5pts, using the modeled ΔRD distribution. Since the table PMIS_RUT_5pts does not contain the measured RD values but instead the percentages of rutting in each rut category, an auxiliary table, referred to as PMIS_RD_5pts, was created to convert each percentage into RD values. For simplicity, the RD value adopted to represent each rut severity level was the middle value of each category's range; i.e., RDNO_RUT = 1/8 in., RDSHALLOW = 3/8 in., RDDEEP = 3/4 in., RDSEVERE = 1.5 in., and RDFAILURE = 3 in.

The auxiliary table PMIS_RD_5pts was formed by 202,718 columns (one per PMIS section) and 100 rows, reproducing the distribution of rutting into the five severity levels. Thus, if the PMIS_RUT_5pts table indicated that a particular section presented 30% shallow rutting, then the RDSHALLOW value was inputted into 30 elements of the corresponding column of the PMIS_RD_5pts table, resulting in 100 rows. The table containing the perturbation of the RD values, referred to as DELTA_RD, was similarly formed inputting perturbing values randomly generated using the modeled ΔRD distributions for each rut severity level. Therefore, the DELTA_RD table was also formed by 202,718 columns and 100 rows, containing the corresponding ΔRD to perturb each RDCAT value. The auxiliary table PMIS_RD_cont was computed using Equation 5.5.

$$PMIS\_RD\_cont = PMIS\_RD\_5pts + DELTA\_RD \qquad \text{(Eq. 5.5)}$$

The elements of table PMIS_RD_cont represent estimates of the RD values simulating the use of a continuous system. These values were then categorized into the five rutting severity levels for each PMIS sections to obtain the PMIS_RUT_cont table, necessary to estimate the condition of the network that would be addressed by using the proposed 3D measurement system.

Calculation of TxDOT PMIS Outputs

For the second step of the analysis, the PMIS outputs simulating the use of continuous ARMS were calculated using the estimated PMIS rutting data. The calculated PMIS outputs were the Rutting Utility Value, URUT_cont, and the CS CScont. The former was computed using Equation 5.6 and the latter was computed using Equation 5.7.

$$U_{RUT\_cont_s} = U_{Shallow\_cont_s} * U_{Deep\_cont_s} * U_{Failure\_cont_s} \qquad \text{(Eq. 5.6)}$$

Where "s" is the PMIS section analyzed; the Rutting Utility Factors for Shallow, Deep, and Failure Rut were calculated using Equation 5.1, obtaining the Li values from PMIS_RUT_cont and adopting the α, β, and ρ parameters corresponding to a pavement type 06 (Stampley, 1995).

$$CS_{cont_s} = 100 * DS * RS = U_{RUT\_cont_s} * \left(\frac{CS_{5pts_s}}{U_{RUT_{5pts_s}}}\right) \qquad \text{(Eq. 5.7)}$$

Where the URUT_5pts were calculated using Equation 5.1, obtaining the Li values from PMIS_RUT_5pts; the CS5pts were obtained from the TxDOT FY2011 PMIS Condition Database.

5.3 Results from Monte Carlo Simulation

Since the difference in RD value between the discrete and continuous measurement system has an associated uncertainty, the PMIS outputs should be treated as a random variable. In order to capture this variability, a Monte Carlo Simulation was conducted to estimate the distribution of the PMIS outputs and make inferences.

The analyses carried out to estimate the TxDOT network condition simulating the use of a continuous ARMS were repeated a large number of times, changing the values of the perturbing table DELTA_RD. The elements of DELTA_RD for each iteration were determined using a random generator function following a normal distribution with the mean and standard deviation for the corresponding rut severity level (Table 5.1). The PMIS outputs, calculated at each iteration, consisted of the change in Rutting Utility value (Equation 5.8) and the change in CS (Equation 5.9).

$$\Delta U_{RUT_{i,s}} = U_{RUT\_5pts_s} - U_{RUT\_cont_{i,s}} \quad \text{(Eq. 5.8)}$$

Where URUT_5pts_s and URUT_cont_s,i are the Rutting Utility values using the discrete and the continuous ARMS respectively calculated for section “s” at iteration “i”. Note that the Utility value for the case of the five-sensor system is fixed throughout the iterations.

$$\Delta CS_{i,s} = CS_{5pts_s} - CS_{cont_{i,s}} = \Delta U_{RUT_{i,s}} * \prod_{i \neq RUT} U_{i_s} = \Delta U_{RUT_{i,s}} * \left(\frac{CS_{5pts_s}}{U_{RUT_{5pts_s}}} \right) \quad \text{(Eq. 5.9)}$$

Where CS5pts_s and CScont_s,i are the CS using the discrete and the continuous ARMS respectively calculated for section “s” at iteration “i”. Note that the CS for the case of the five-sensor system is fixed throughout the iterations.

Figure 5.4a and 5.4b present the histograms of the change in Rutting Utility value, ΔURUT, CS, and ΔCS, respectively, considering all sections and iterations. Figure 5.4b indicates that the ΔCS distribution presents a fatter tail towards the positive side. This observation can be explained by analyzing Equation 5.9, in which the change in CS is expressed as the multiplication between the change in Rutting Utility value and the Utility values for all other distresses. The second term can vary from a value close to zero, when the analyzed section presents a large number of distresses, and close to or equal to 1, when the section does not present distresses. Therefore, the set of ΔCS comprises scaled values of ΔURUT, where the scaling factor varies for each particular section. The summary statistics for the distribution of both ΔURUT and ΔCS are presented in Table 5.2. The table indicates that both confidence intervals have negative values, indicating that the transition from a five-sensor to a continuous ARMS causes a drop in the CS with more than 97.5% confidence.

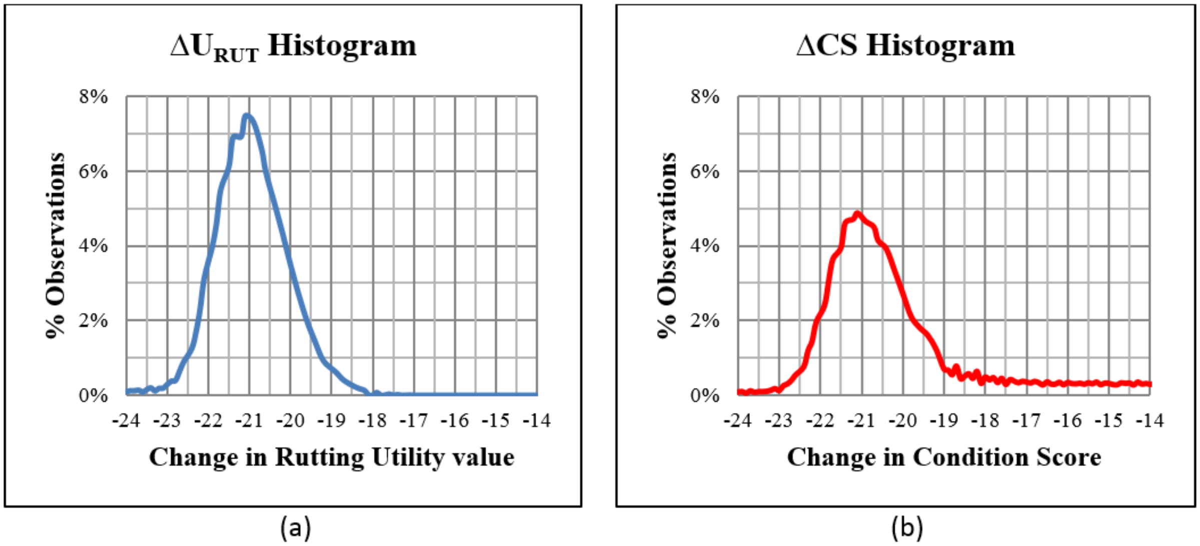


Figure 5.4: Histograms of (a) ΔURUT and (b) ΔCS from Monte Carlo simulation

Table 5.2: Summary Statistics of the Impact of Upgrading ARMS on PMIS Outputs

Impact of upgrading ARMS on		**median**	**mean**	**std**	**95% CI**	
Rutting Utility	ΔU_{RUT}	-21.22	-21.35	2.01	-26.00	-19.16
Condition Score	ΔCS	-20.56	-19.23	4.14	-24.35	-8.02

5.4 Main Observations and Conclusions

The analysis and results reported in this chapter address the Task 8 objective of quantifying the impact of upgrading the pavement surface distress measurement system on TxDOT PMIS scores. A general methodology was proposed for analyzing the propagation of inaccuracies of measurement systems throughout PMS models. The proposed methodology was applied to estimate the impact of upgrading the rut measurement system from a five-sensor discrete ARMS to the continuous TxDOT 3D ARMS on the condition assessment of TxDOT's highway network. The quantified change in the assessed pavement network condition provides key information for designing strategies to mitigate the sudden apparent increase in the deterioration of the highway network caused by upgrading the measurement system.

Following are the main observations and conclusion from this study:

- The proposed methodology was effective in estimating the impact of rutting measurement inaccuracies on the assessed condition of the pavement network. The methodology is general enough to be applied in the analysis of other types of measurement systems, type of pavement distresses, or information management systems.
- Transition from a five-sensor discrete ARMS to a continuous ARMS yielded the following results:
    - The Utility Value and the CS dropped with more than 97.5% confidence;
    - The drop in Utility Value was, on average, 21.35 points and the 95% confidence interval ranged between 26.00 and 19.16; and

- The drop in CS was, on average, 19.23 points and ranged from a high of 24.35 points to a low of 8.02 points with a 95% confidence level.

The research team will assess the impacts on the DS and CS of converting from the current, manual method for collecting visual distress measurements (including cracking, patching, failures, and other distress types) to an automated procedure. The total impact on PMIS DS and CS will be determined based on both rutting and visual distress and reported in a future report.

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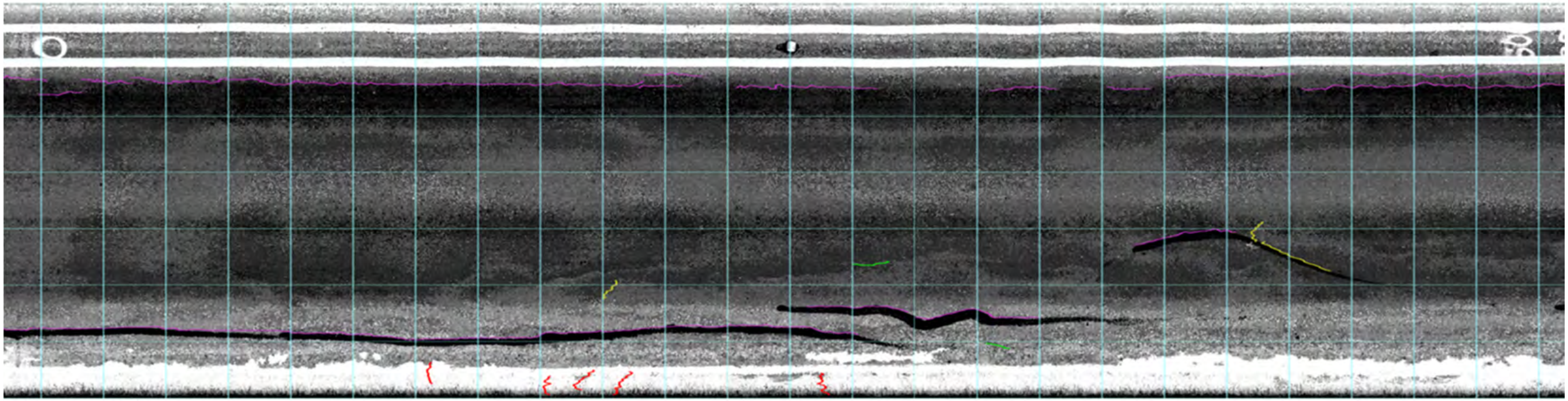
Appendix A.1

Crack Maps Comparison

TxDOT
fully automated

Section 2 /// Station 000-050

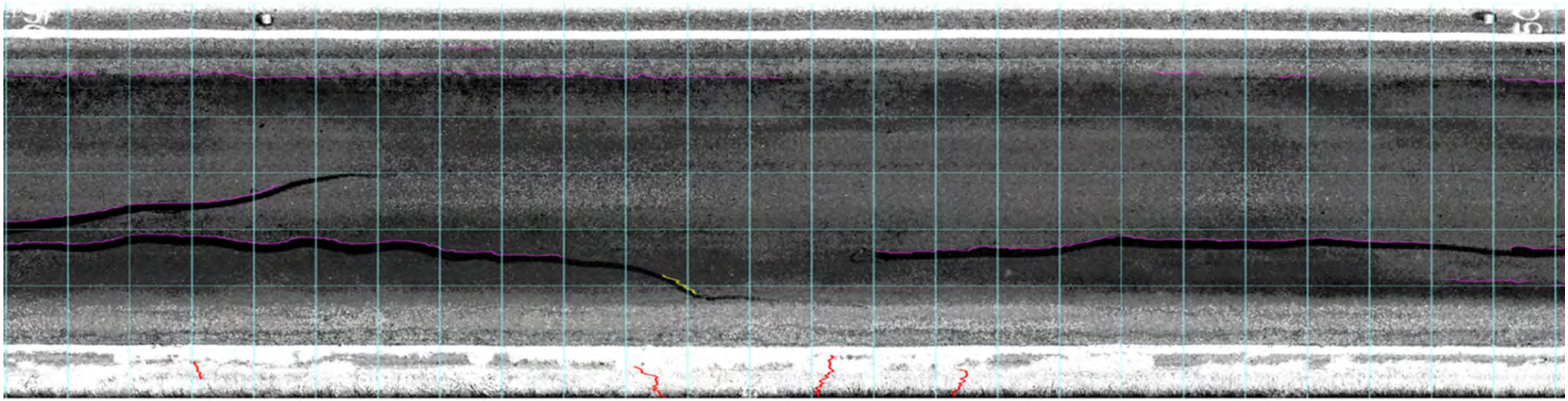
Manual Crack Map



TxDOT (Fully Automated)

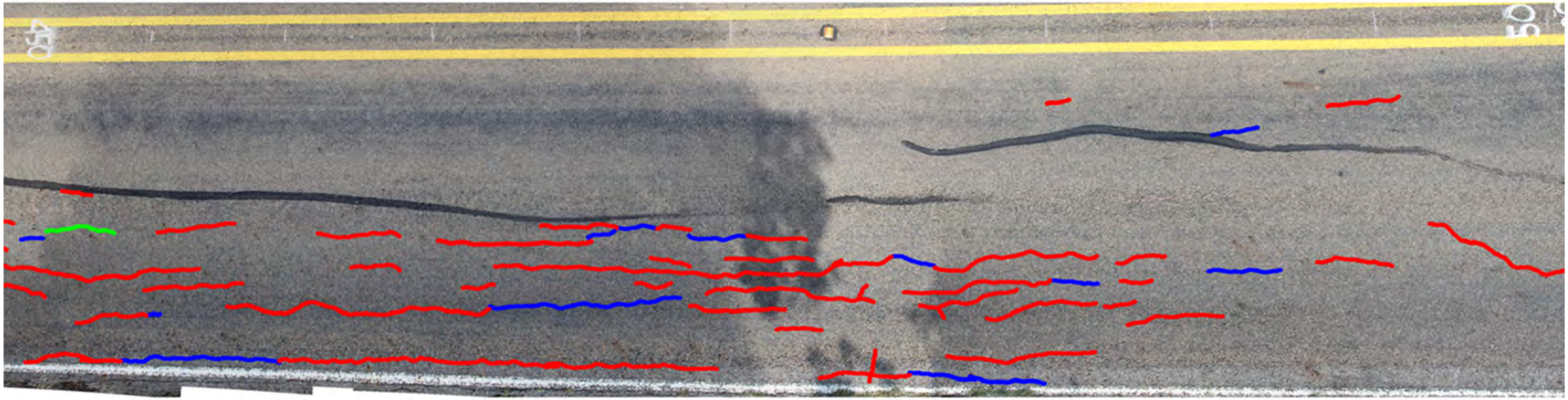
Section 2 /// Station 350-400

Manual Crack Map

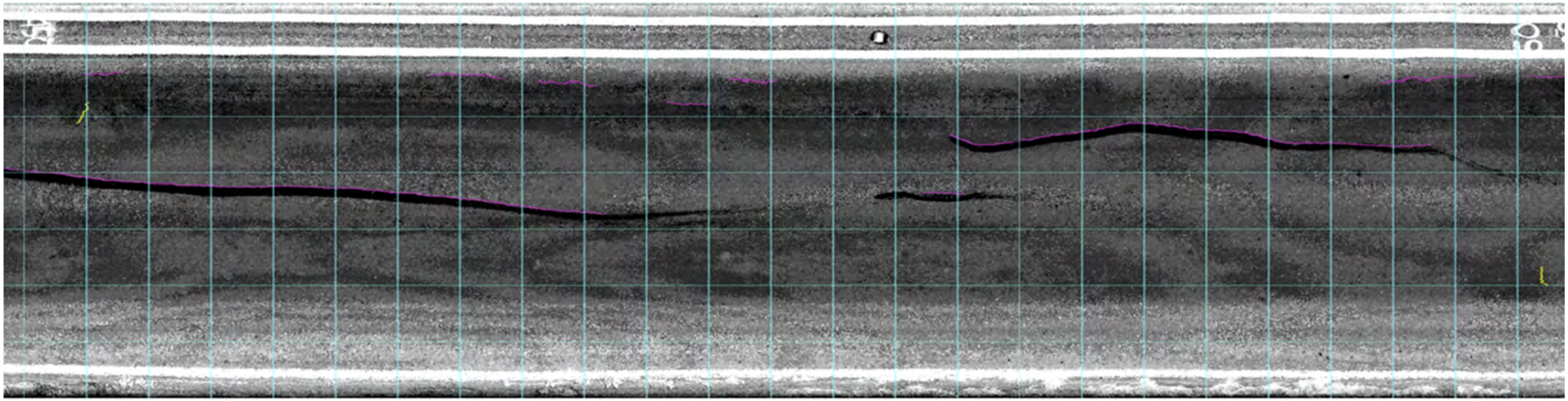


TxDOT (Fully Automated)

Section 2 /// Station 450-500

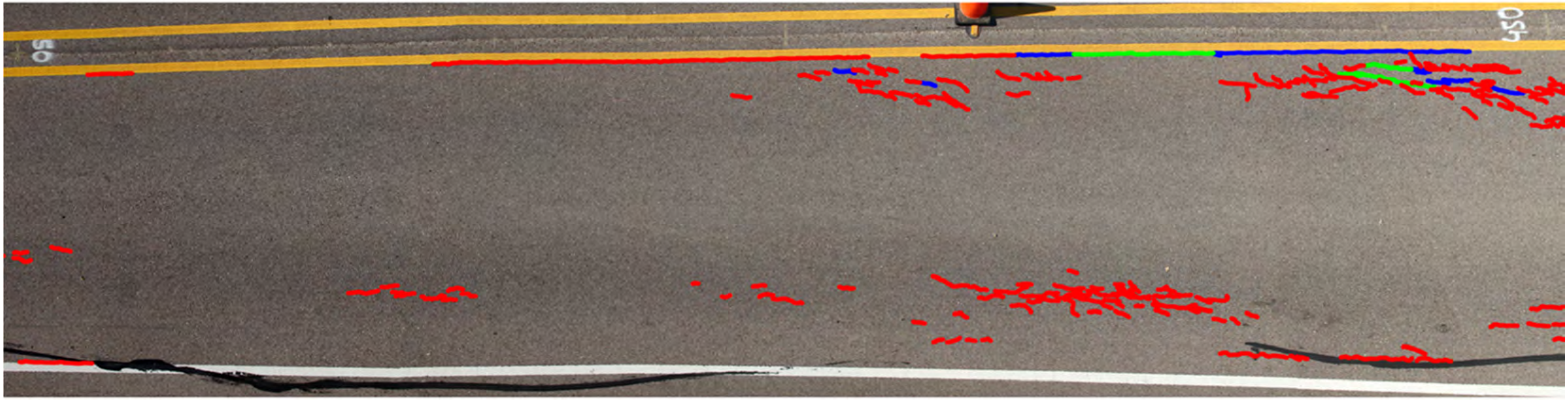


Manual Crack Map



TxDOT (Fully Automated)

Section 4 /// Station 050-100



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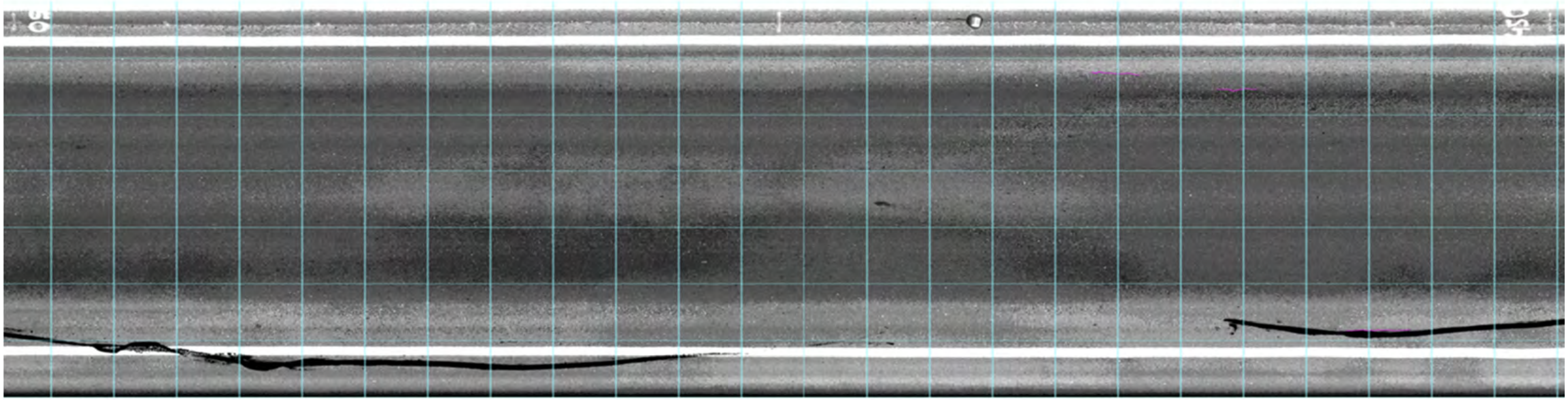

TxDOT (Fully Automated)

Section 4 /// Station 250-300

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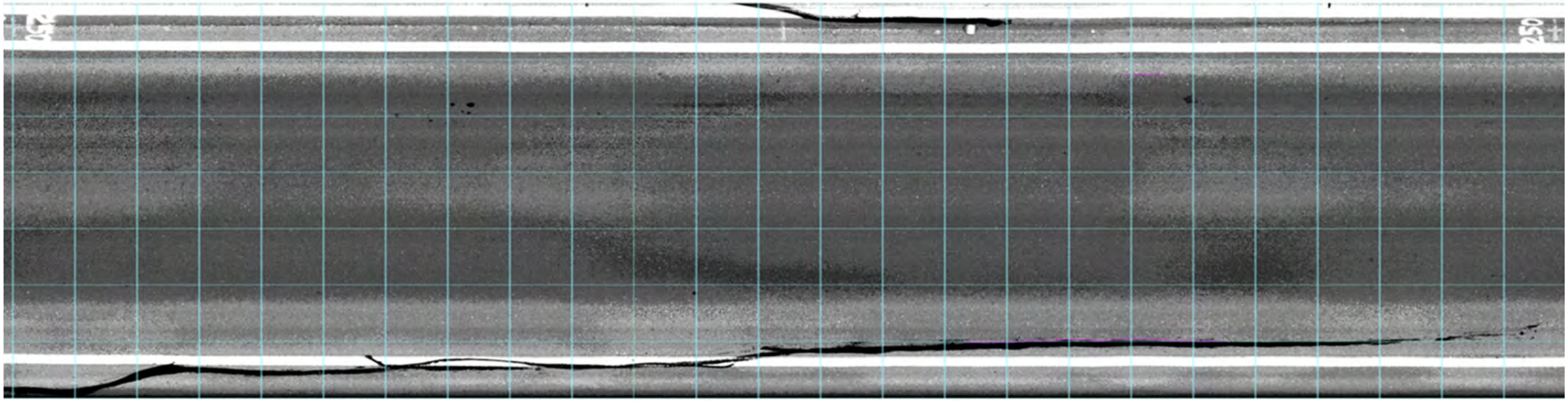
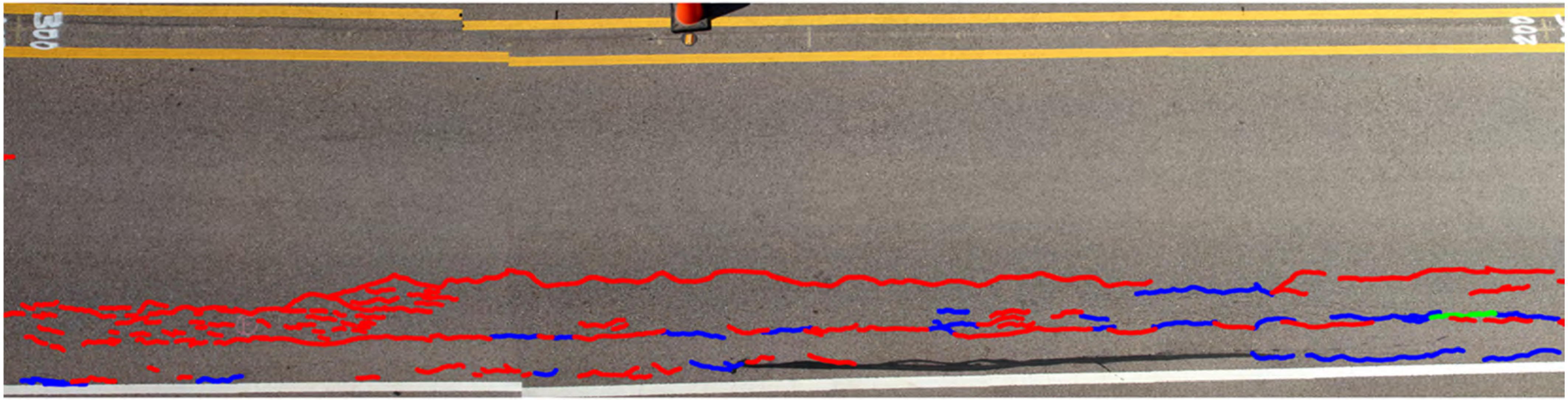


TxDOT (Fully Automated)

Section 4 /// Station 300-350



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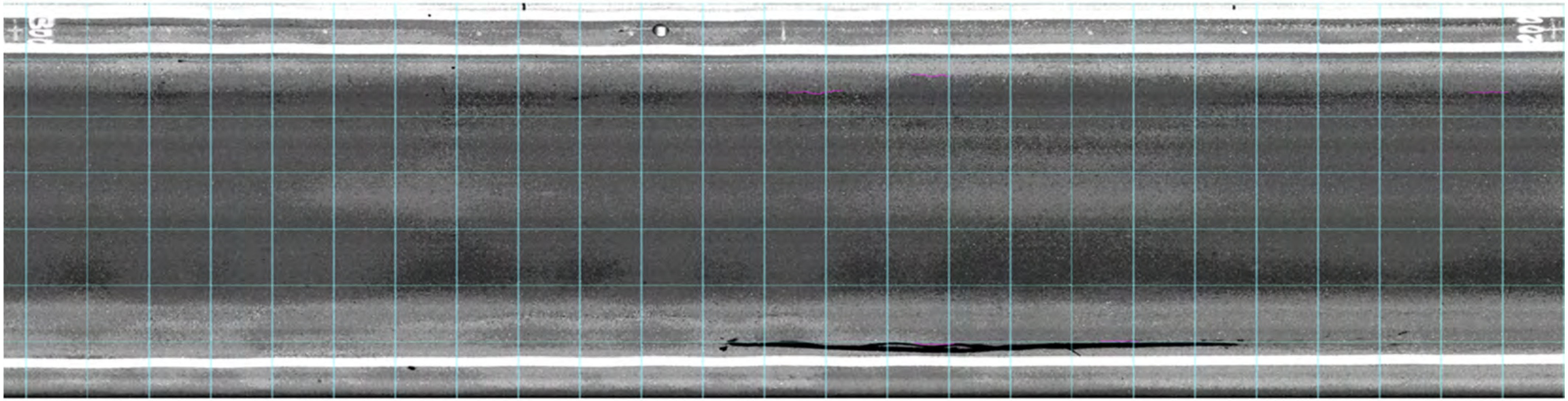
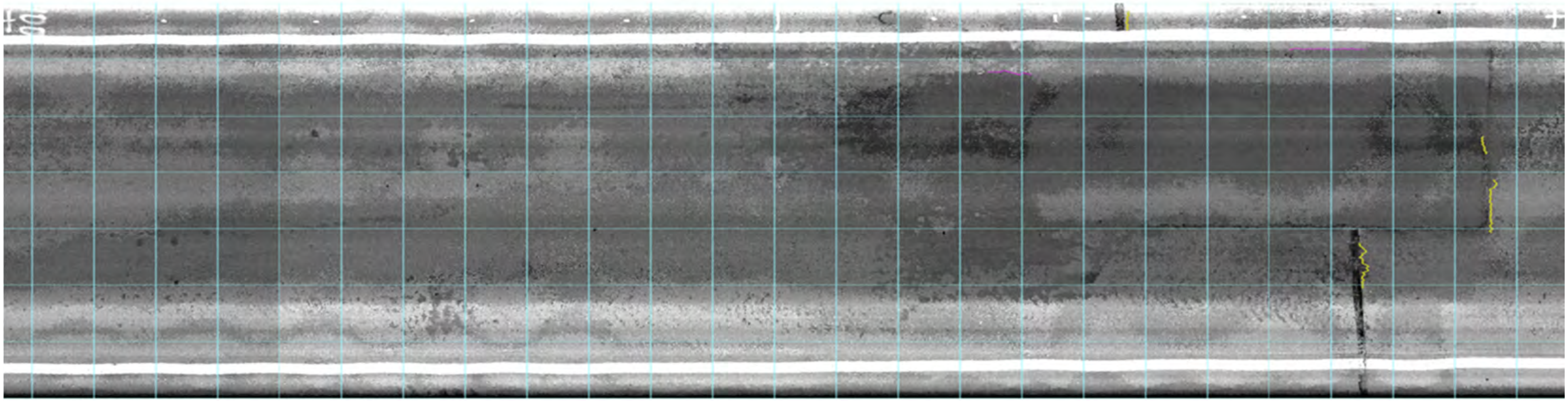


TxDOT (Fully Automated)

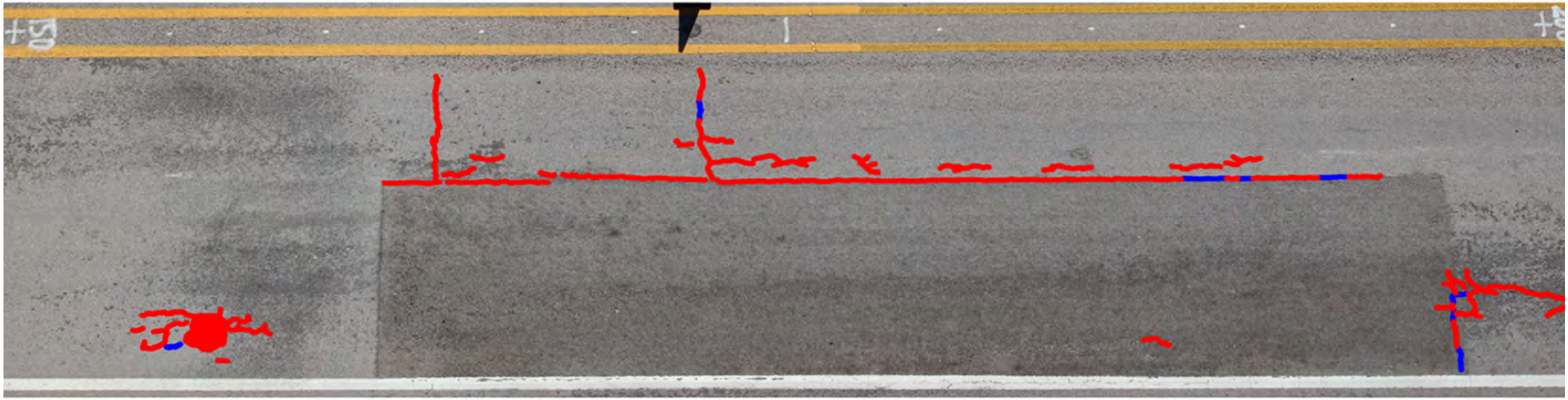
Section 6 /// Station 100-150

Manual Crack Map



TxDOT (Fully Automated)

Section 6 /// Station 150-200



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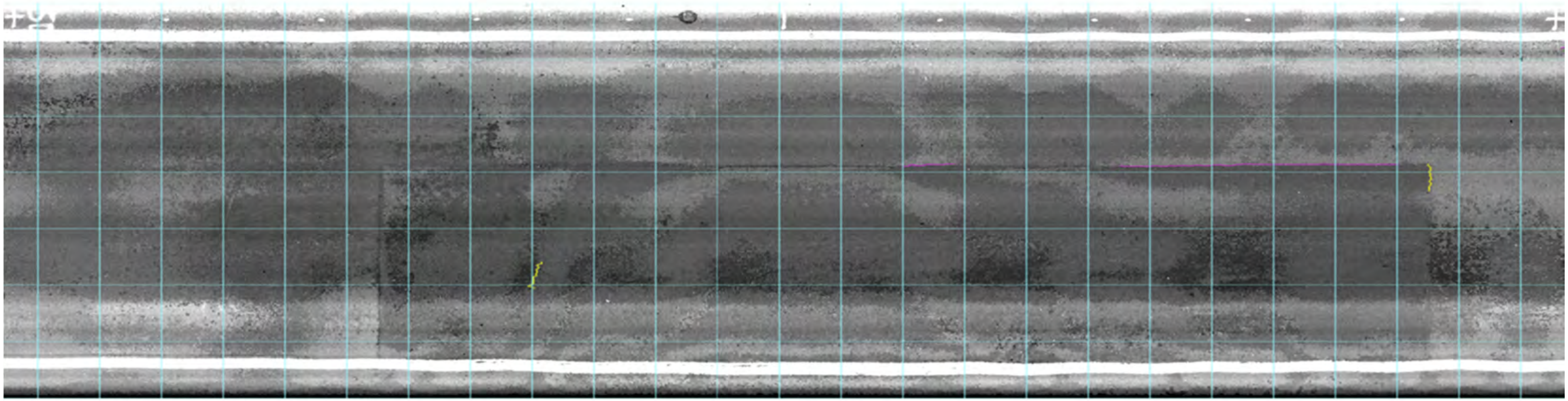
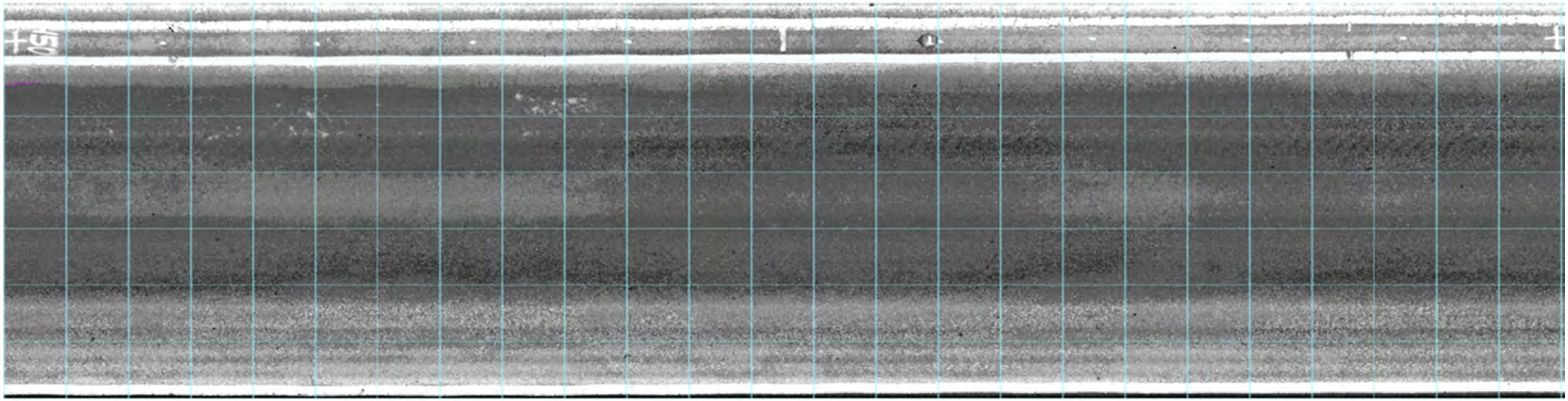


TxDOT (Fully Automated)

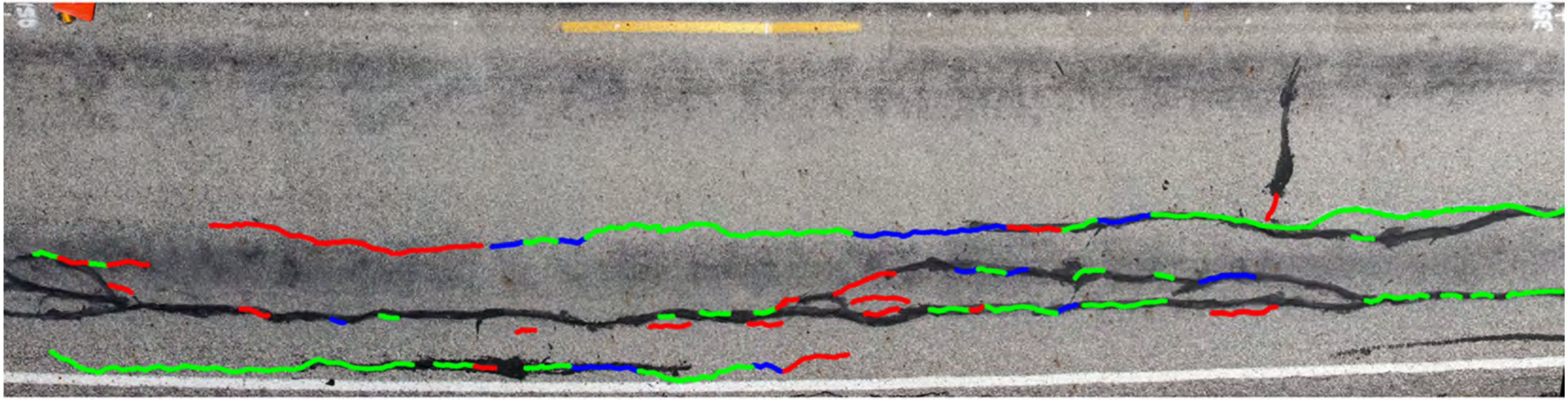
Section 6 /// Station 450-500

Manual Crack Map

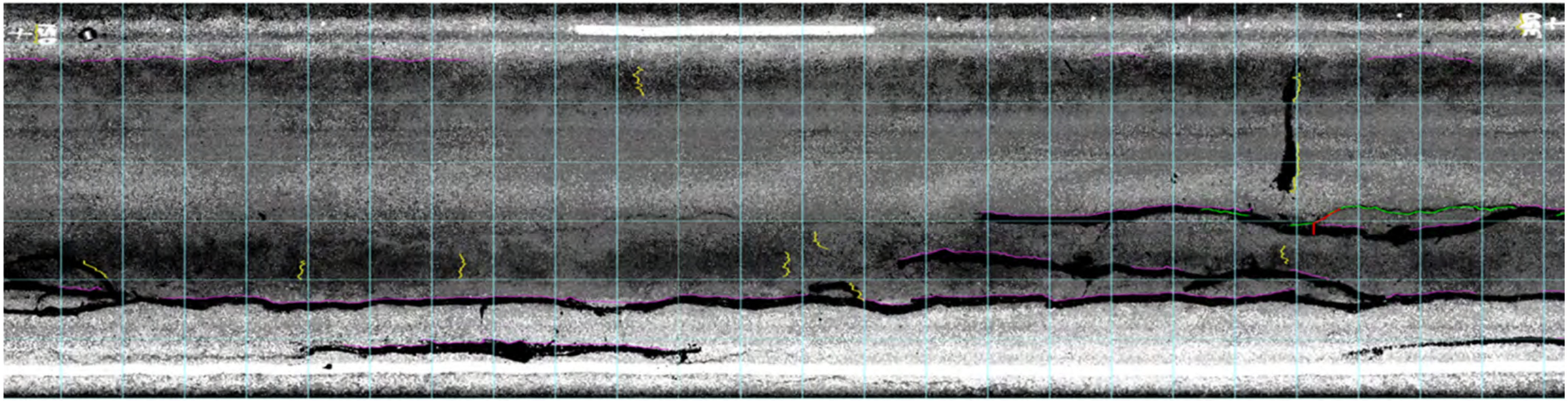


TxDOT (Fully Automated)

Section 9 /// Station 150-200

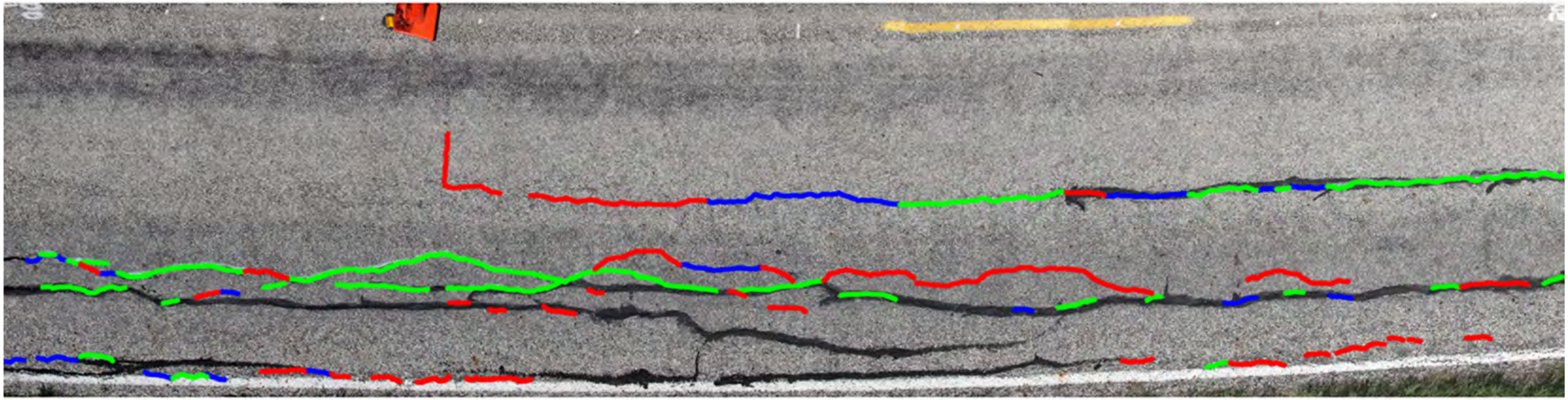


Manual Crack Map



TxDOT (Fully Automated)

Section 9 /// Station 300-350



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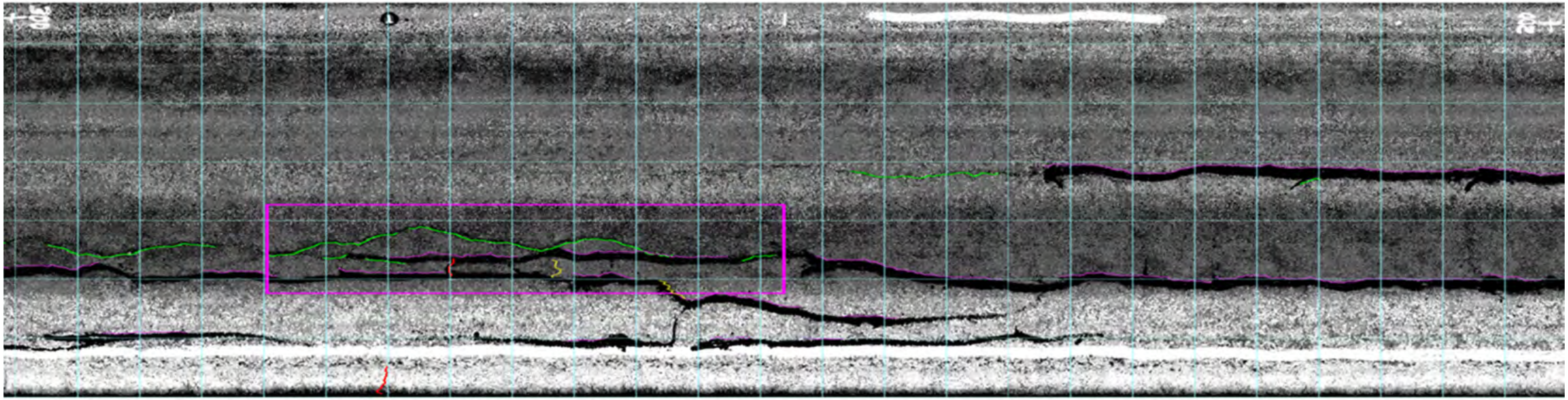
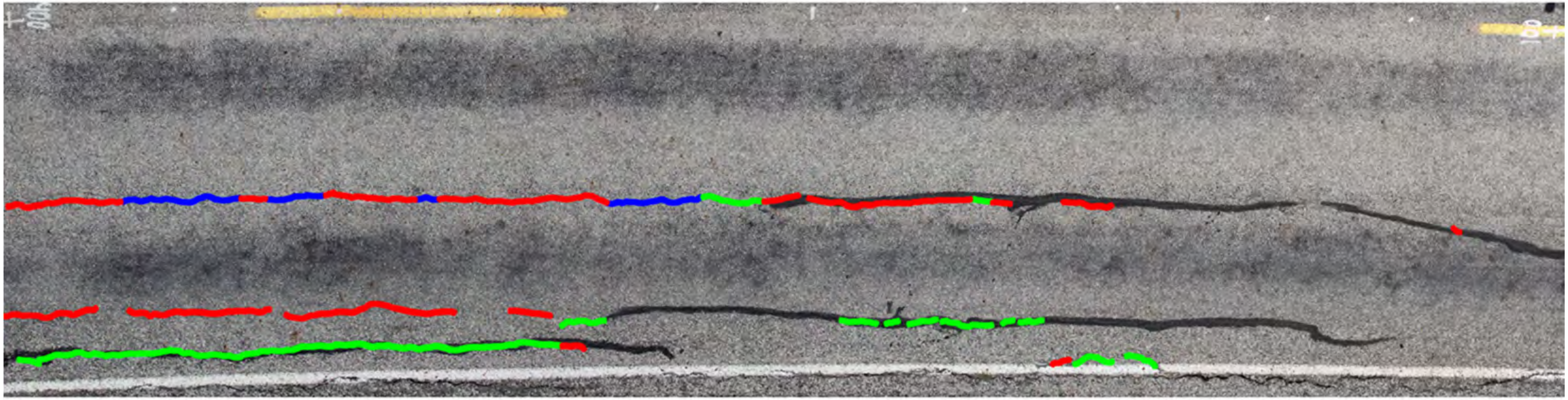


TxDOT (Fully Automated)

Section 9 /// Station 400-450



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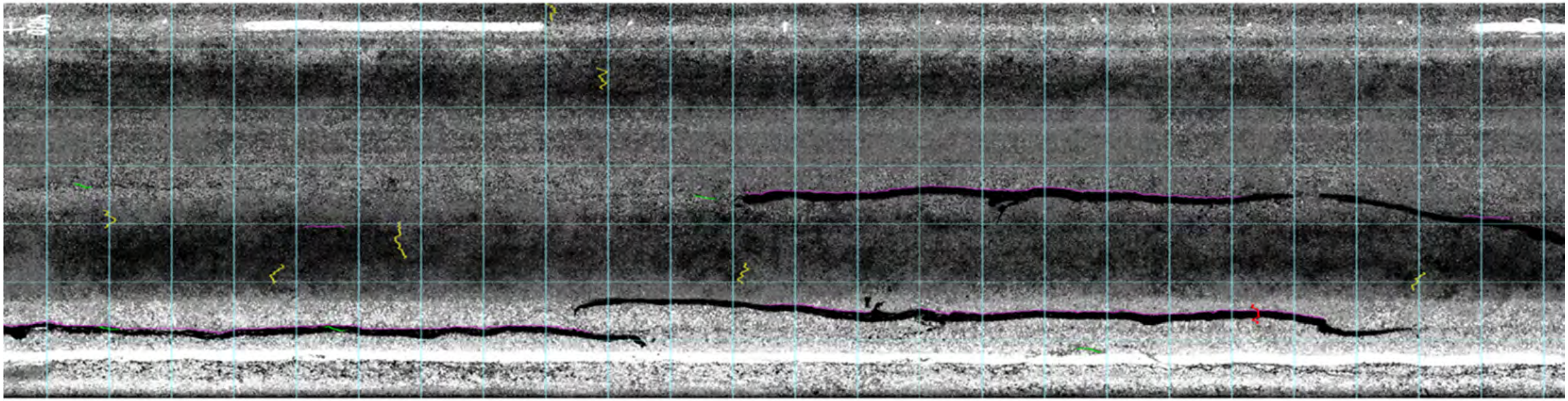
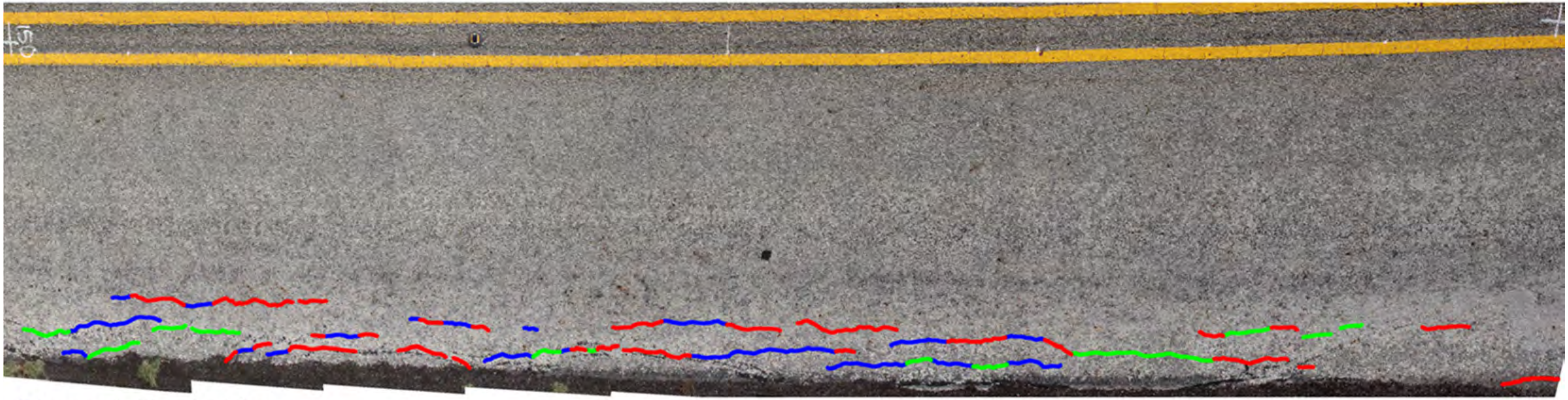


TxDOT (Fully Automated)

Section 10/// Station 150-200



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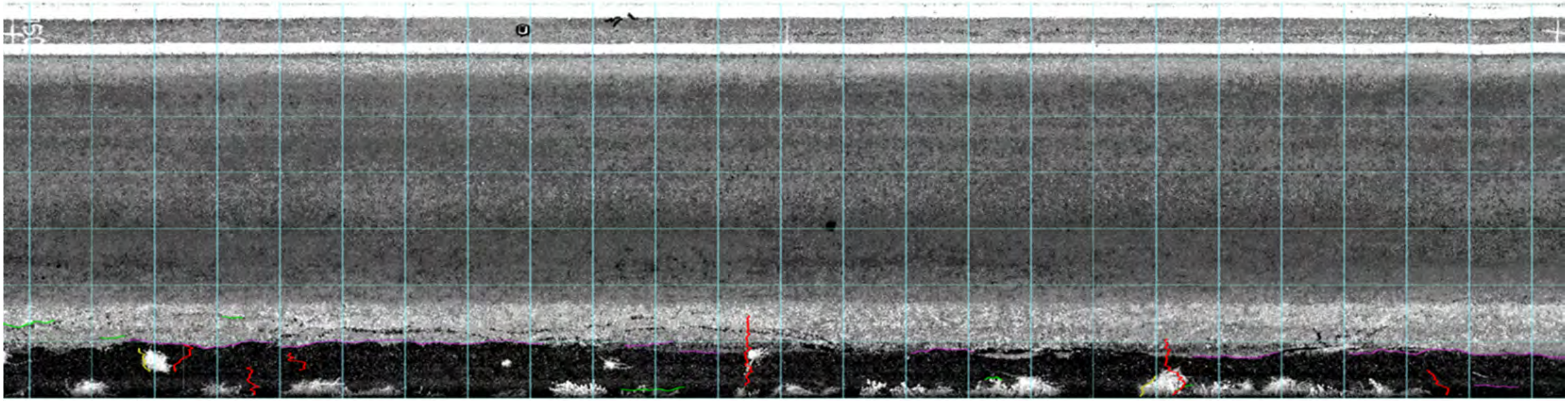
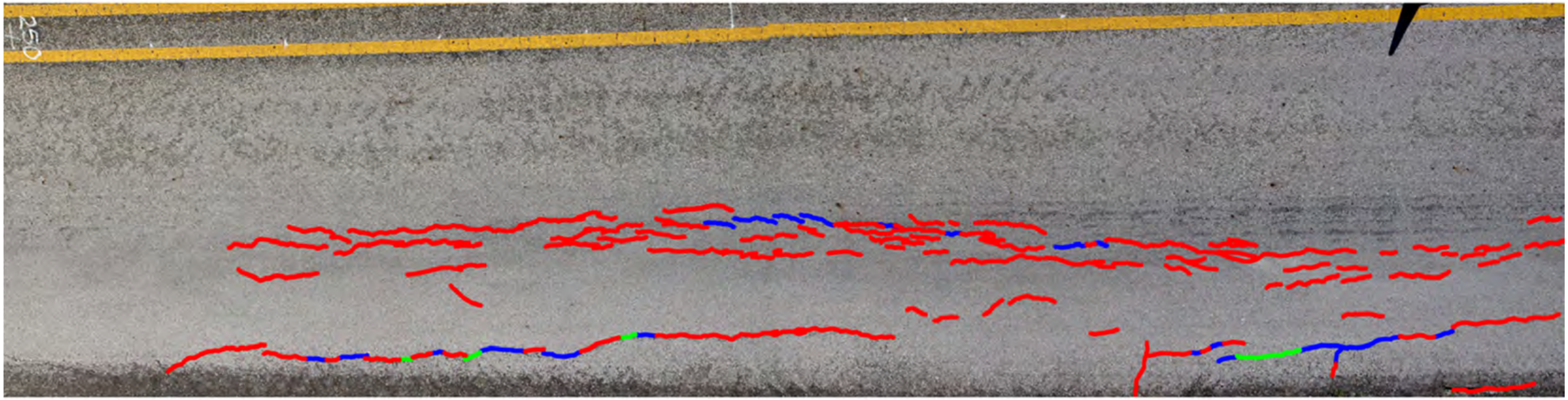


TxDOT (Fully Automated)

Section 10/// Station 250-300



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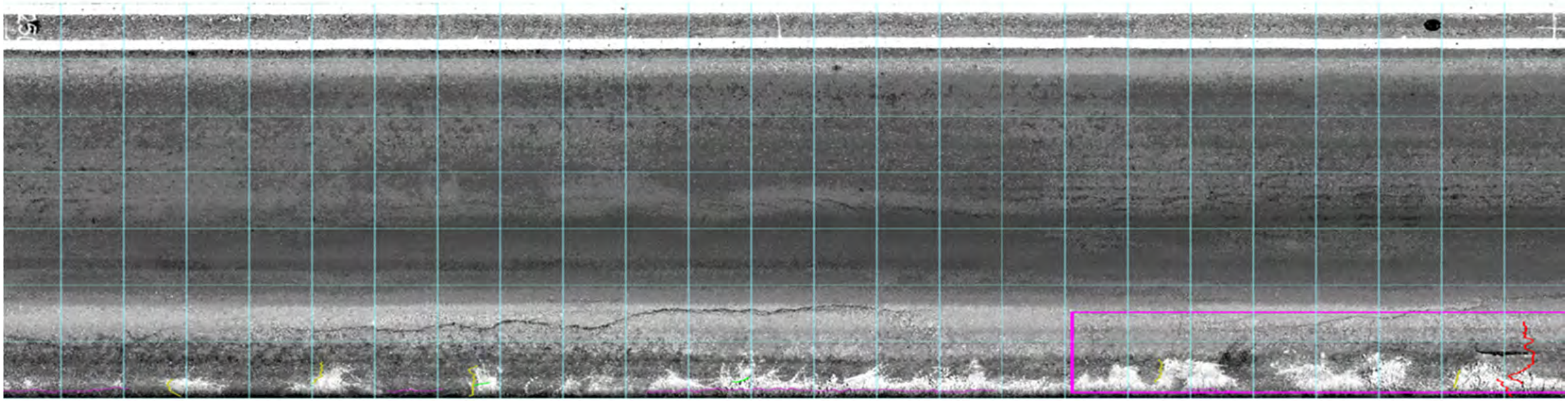
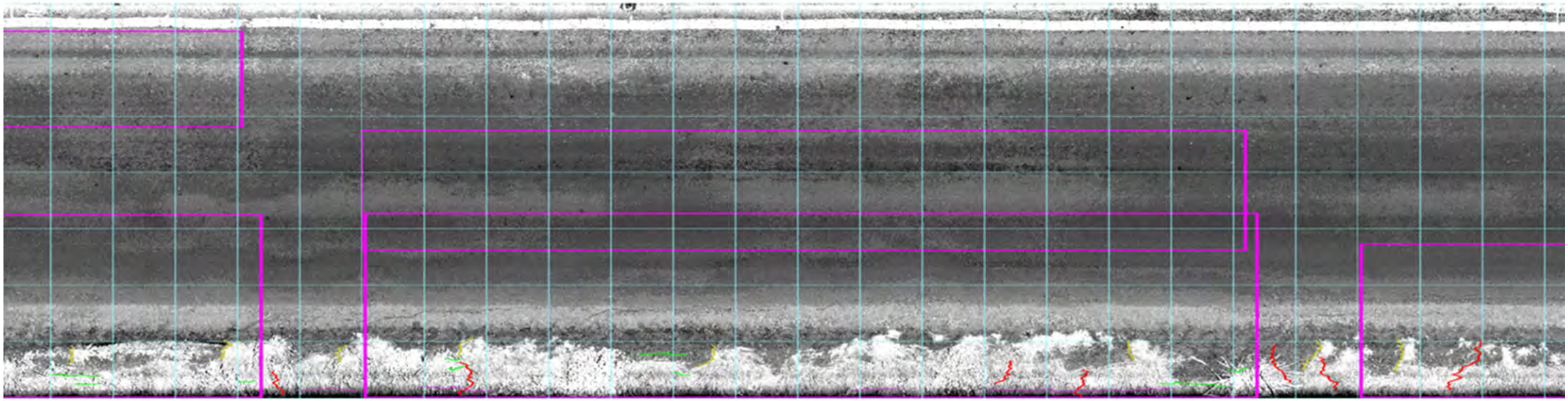


TxDOT (Fully Automated)

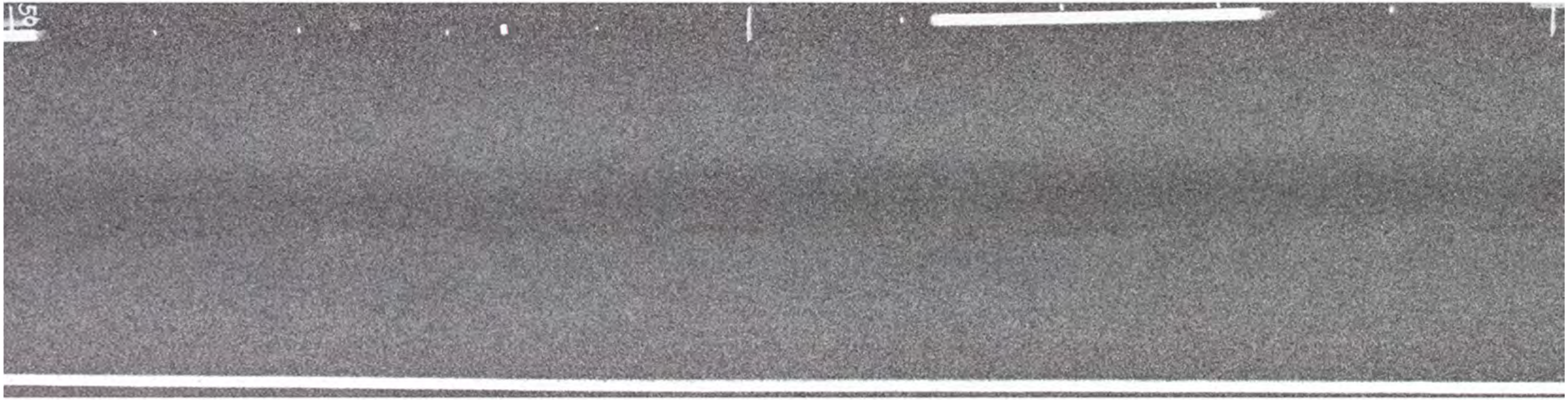
Section 10 /// Station 400-450

Manual Crack Map



TxDOT (Fully Automated)

Section 11 /// Station 050-100



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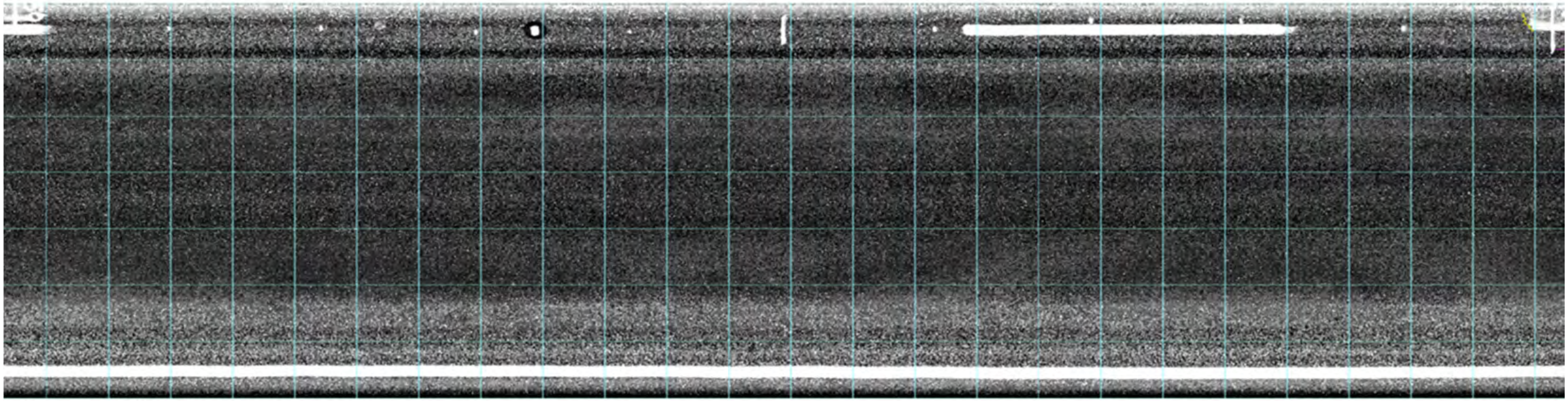
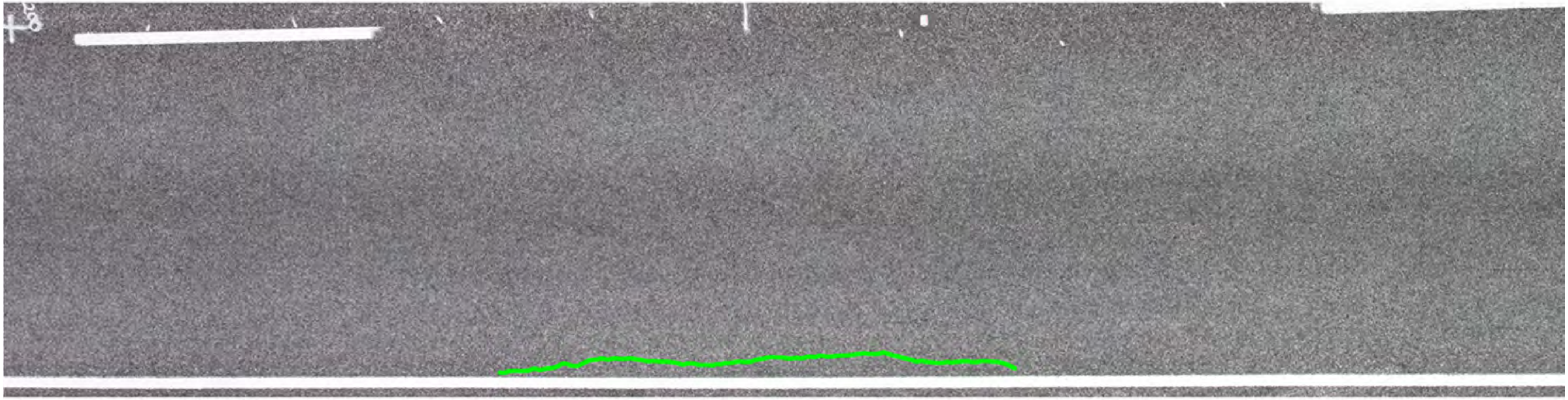


TxDOT (Fully Automated)

Section 11 /// Station 200-250



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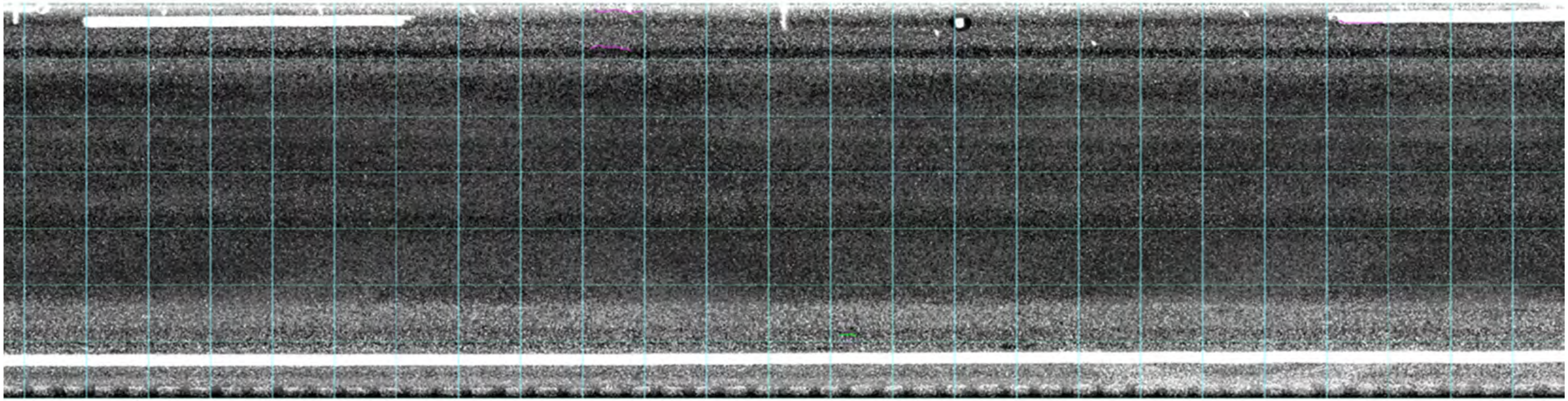
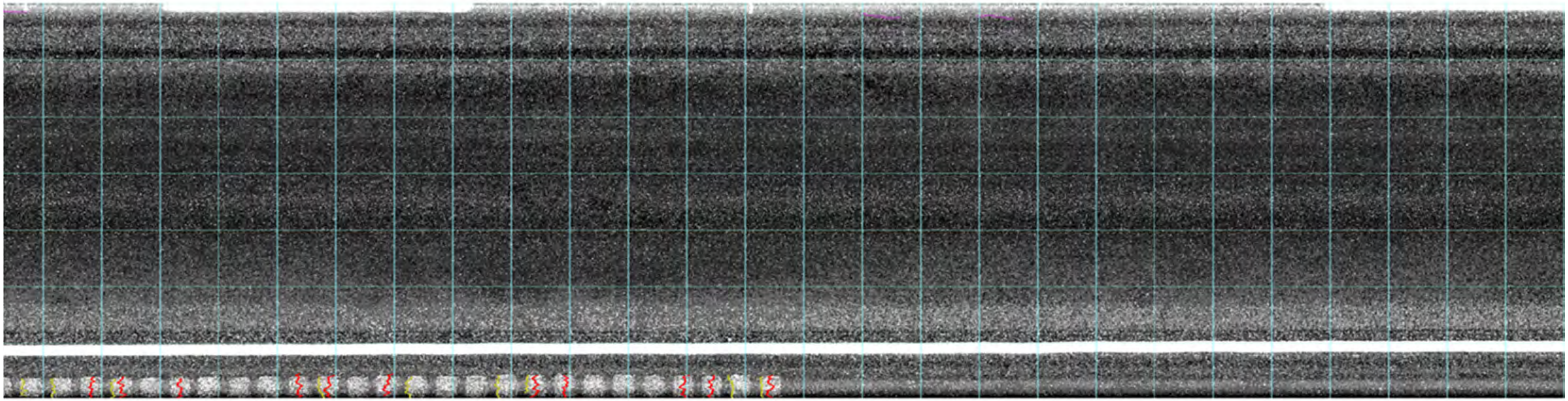


TxDOT (Fully Automated)

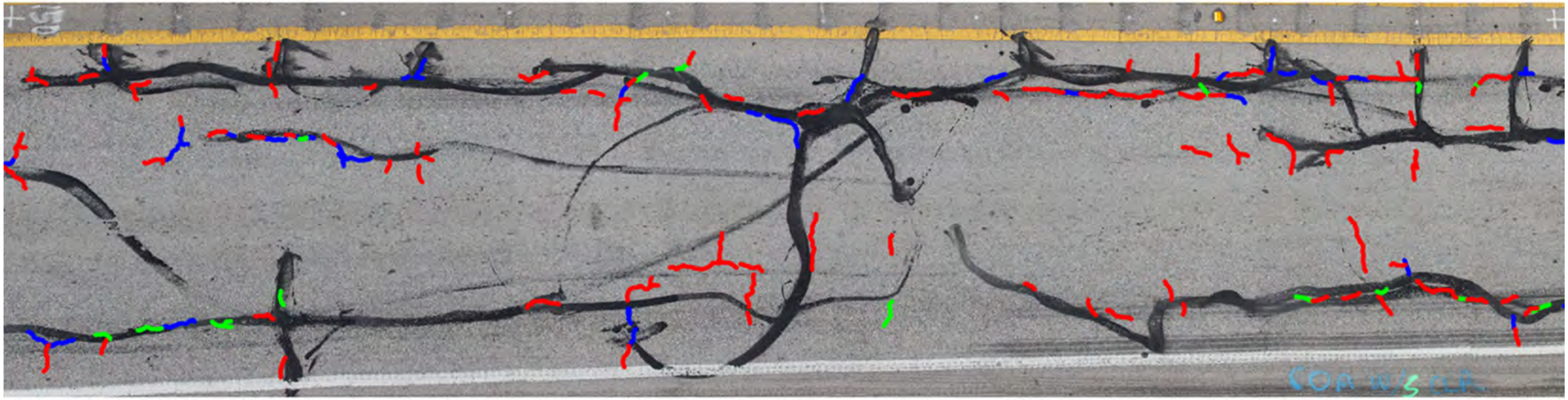
Section 11 /// Station 400-450

Manual Crack Map

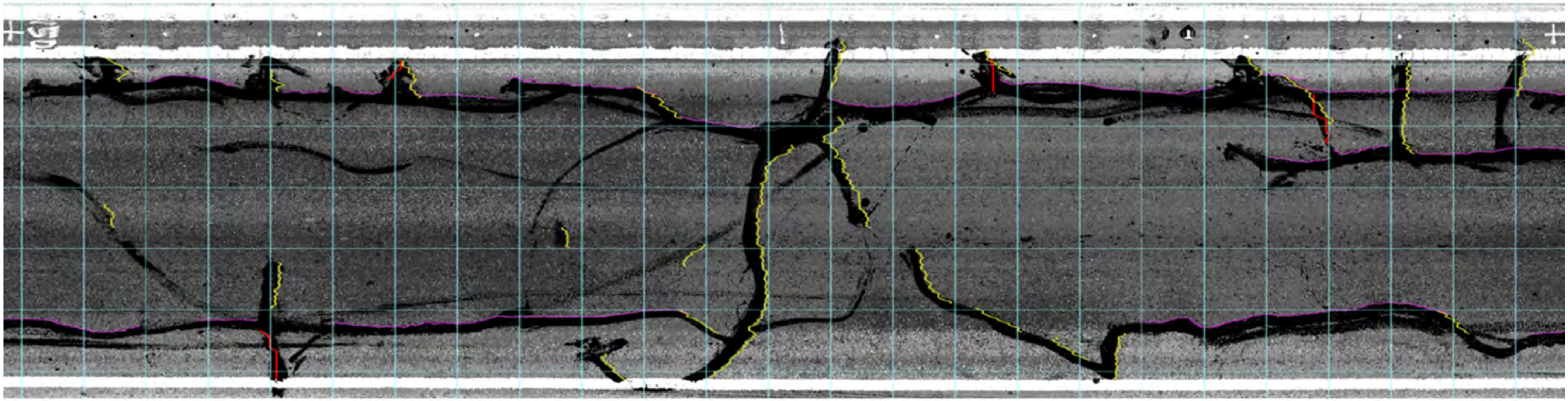


TxDOT (Fully Automated)

Section 12 /// Station 150-200



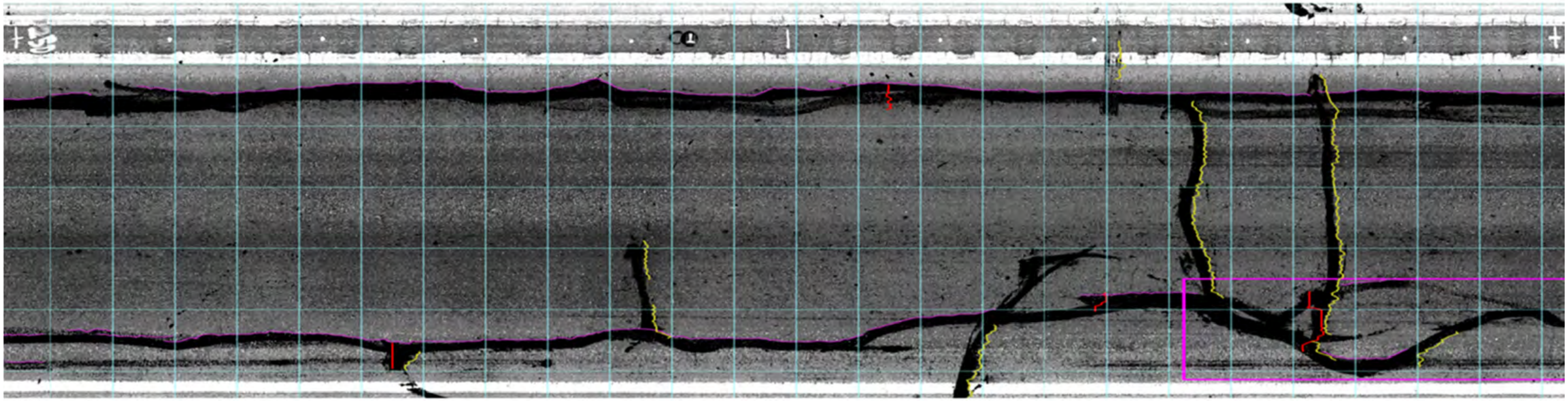
Manual Crack Map



TxDOT (Fully Automated)

Section 12 /// Station 250-300

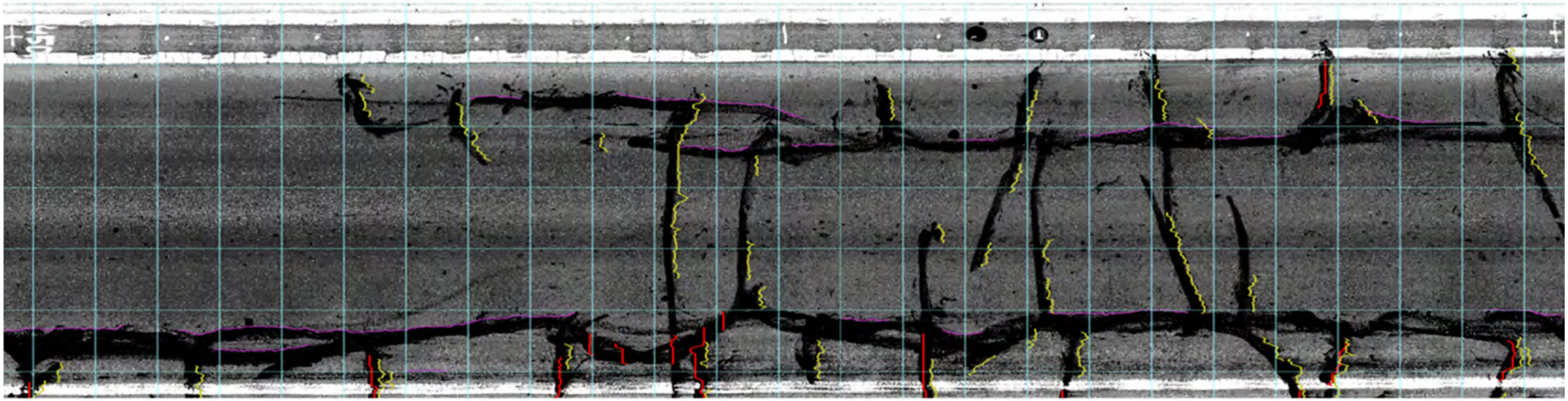
Manual Crack Map



TxDOT (Fully Automated)

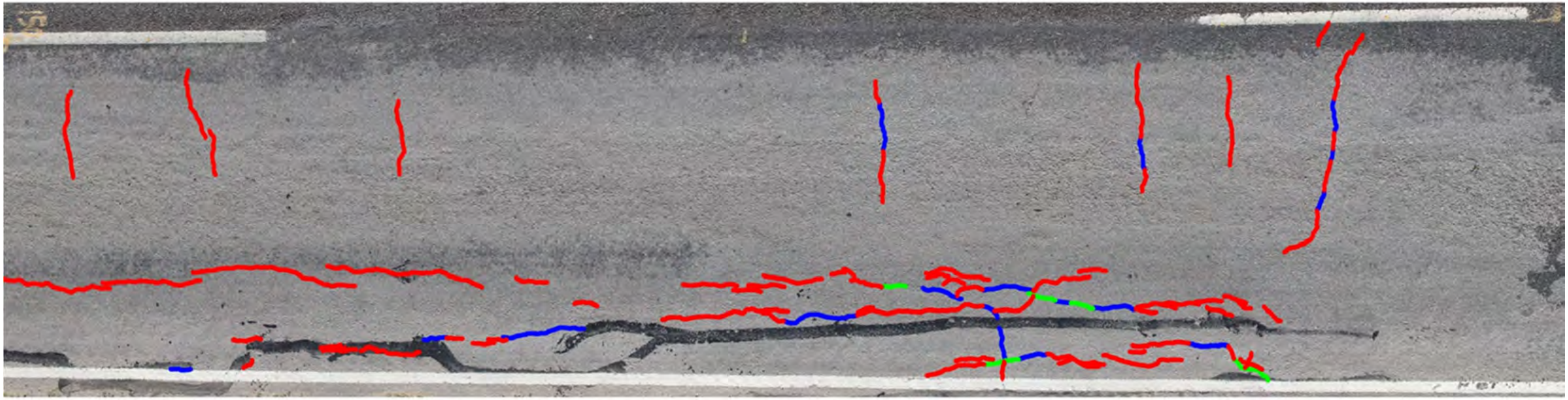
Section 12 /// Station 450-500

Manual Crack Map



TxDOT (Fully Automated)

Section 13 /// Station 150-200



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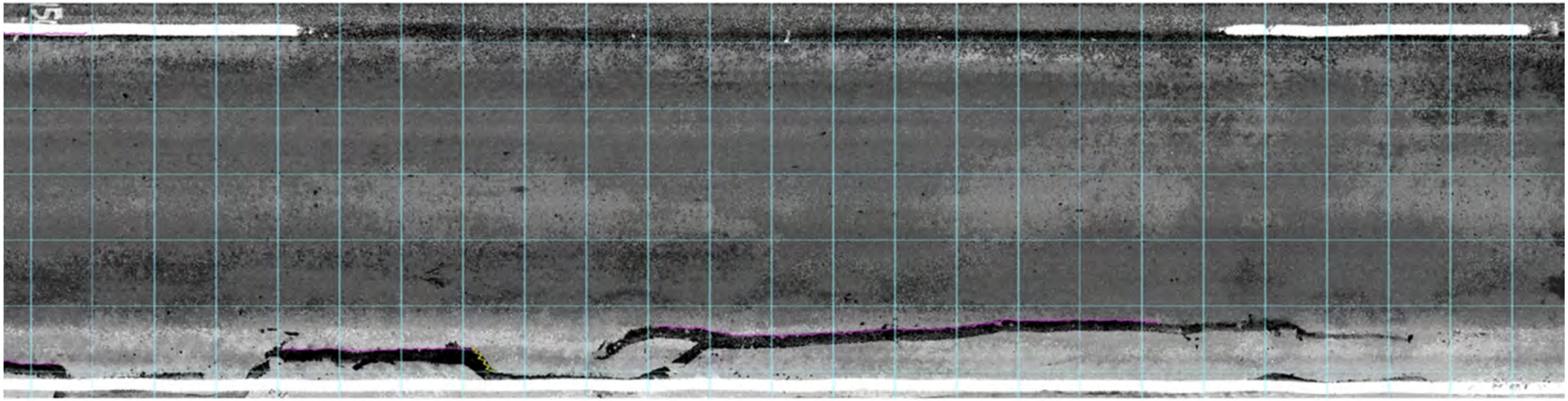
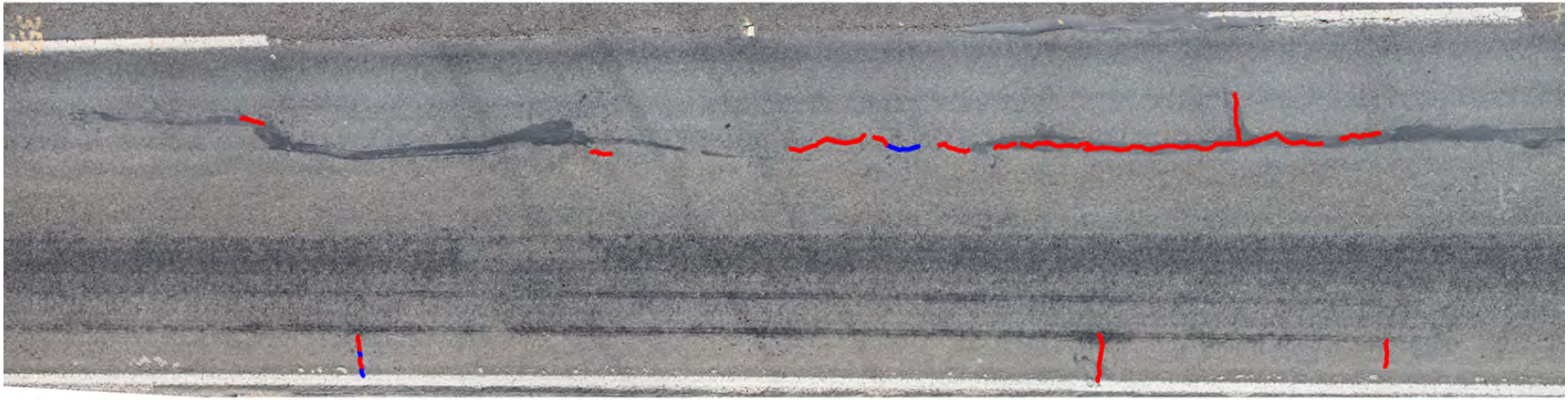


TxDOT (Fully Automated)

Section 13 /// Station 350-400



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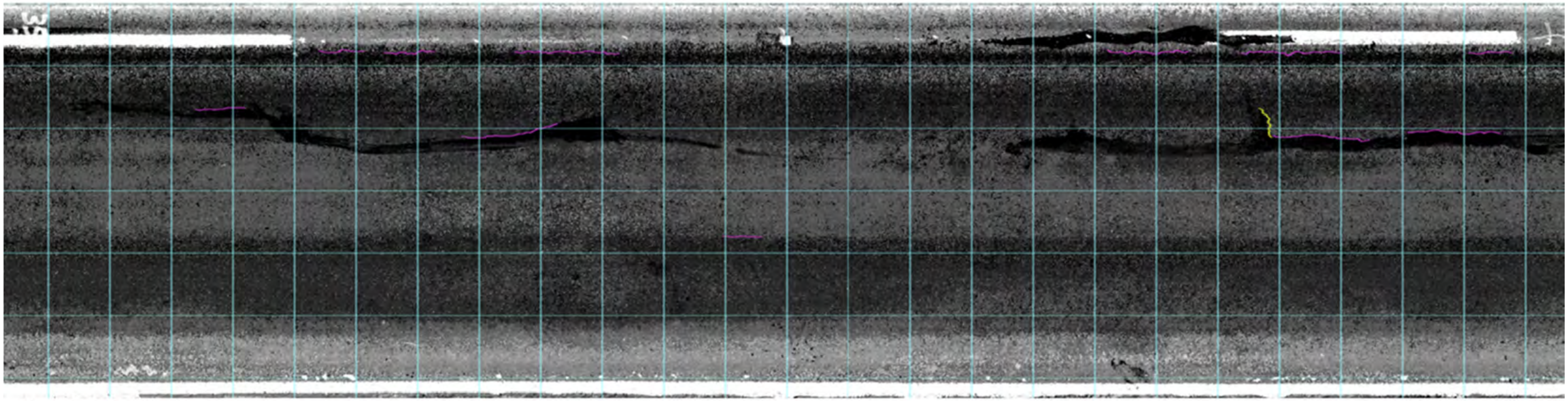
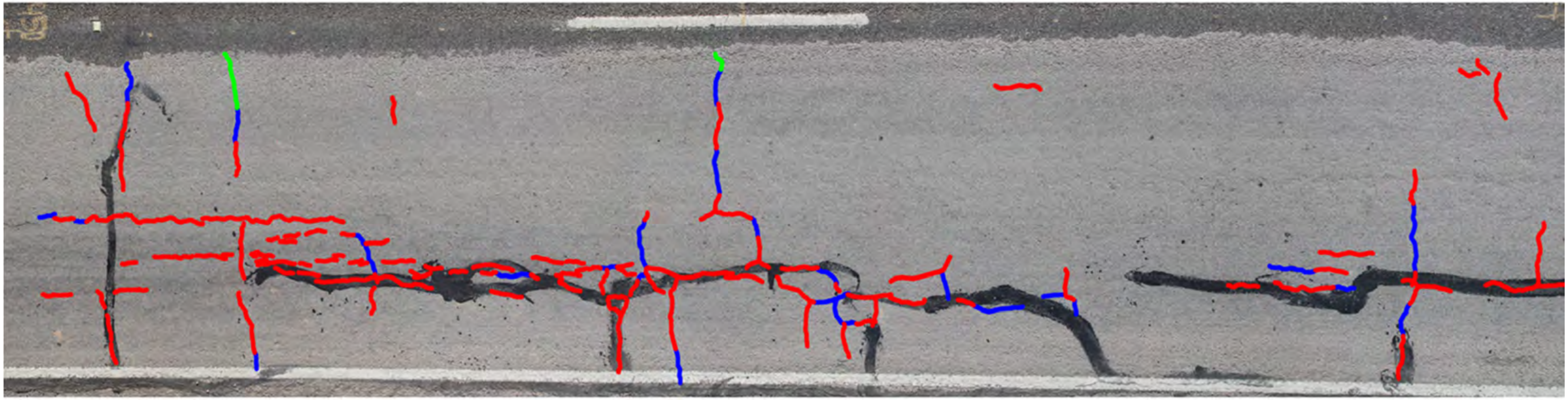


TxDOT (Fully Automated)

Section 13 /// Station 450-500



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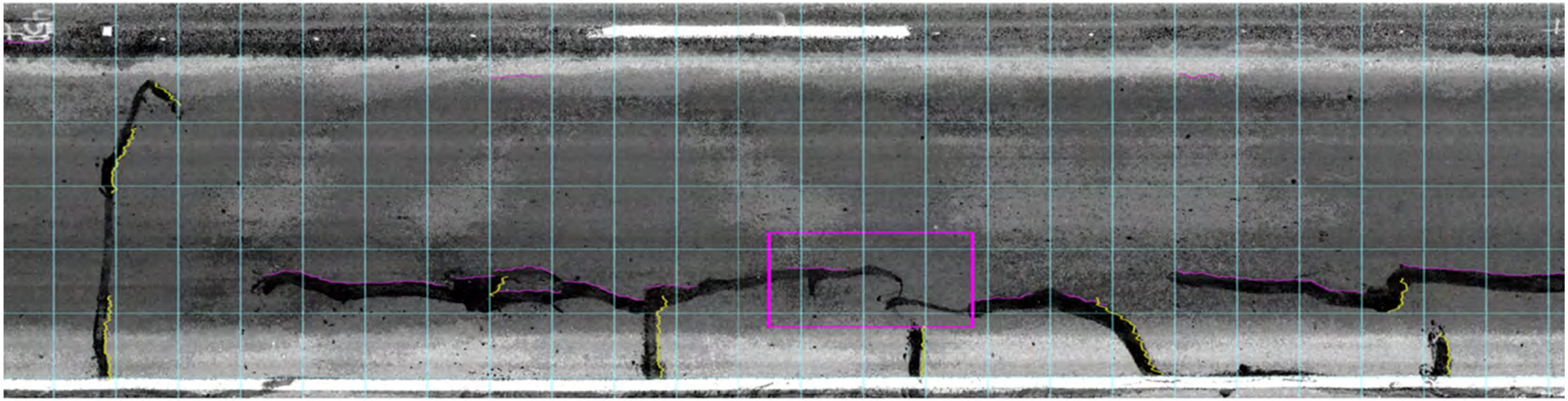
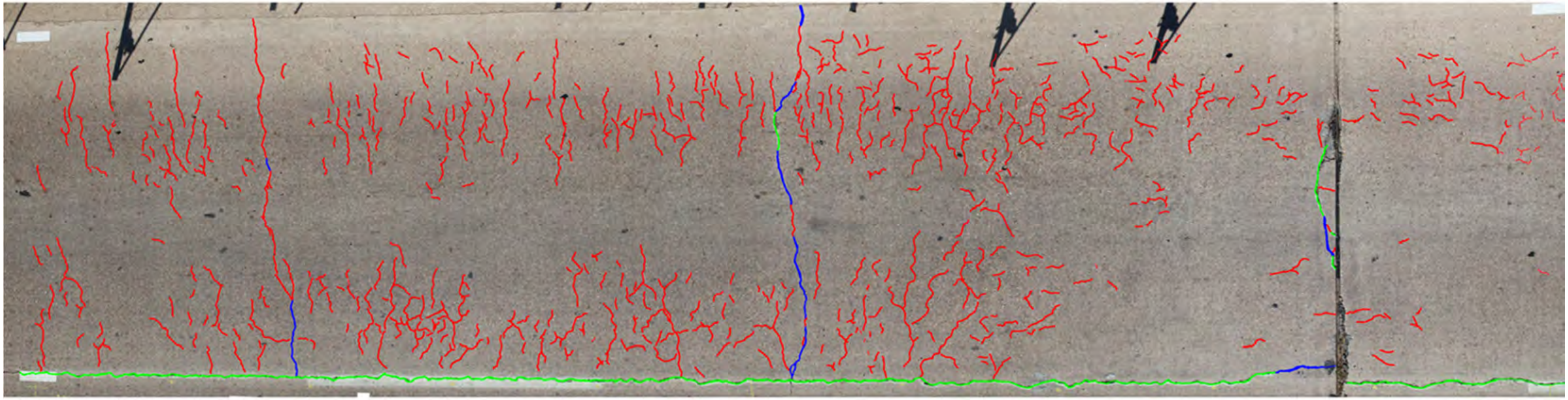


TxDOT (Fully Automated)

Section 17 /// Station 050-100



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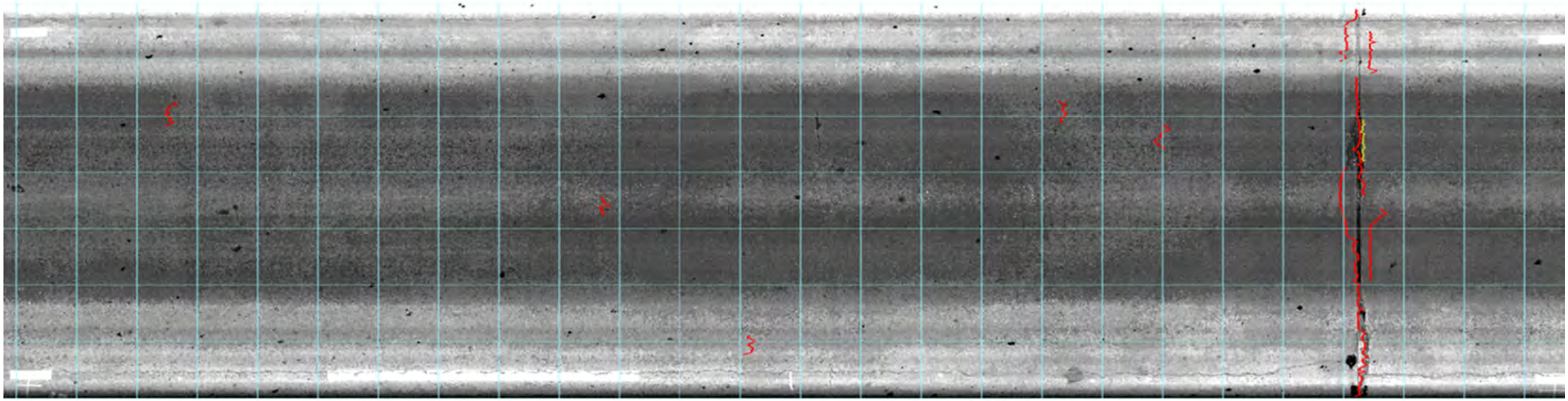
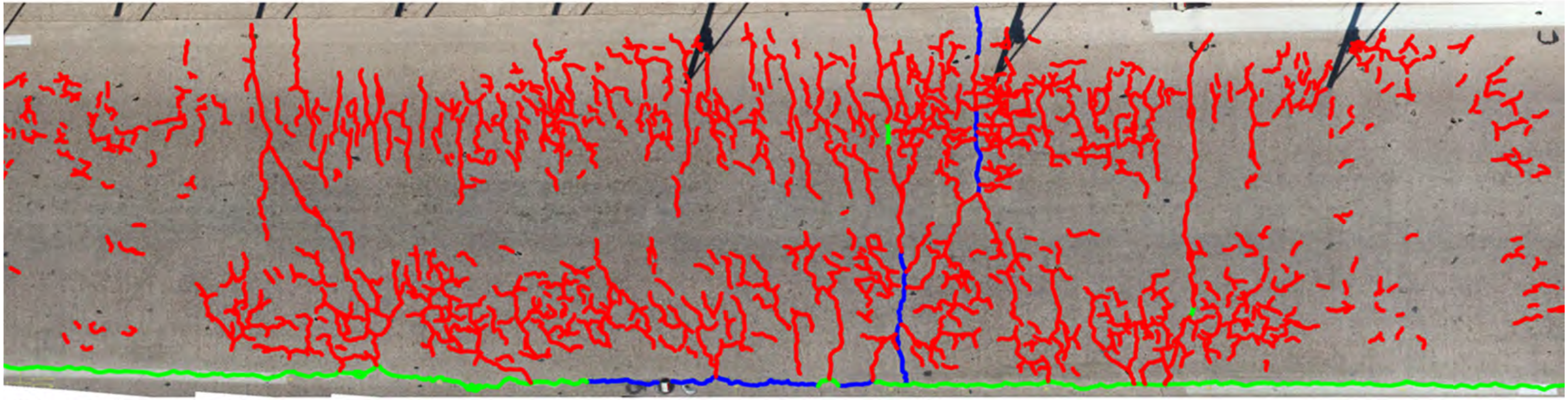


TxDOT (Fully Automated)

Section 17 /// Station 100-150



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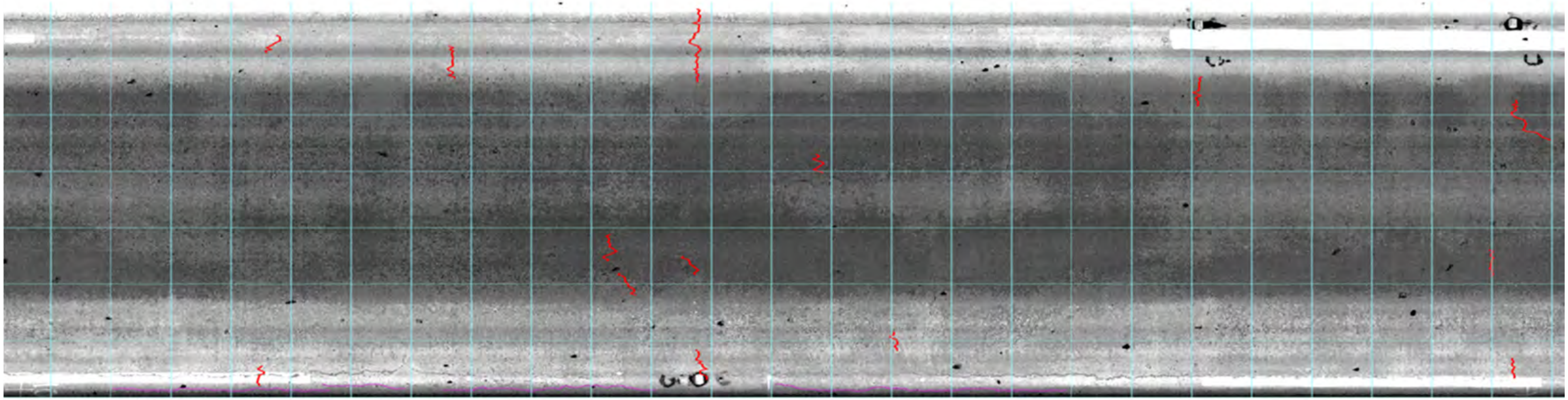
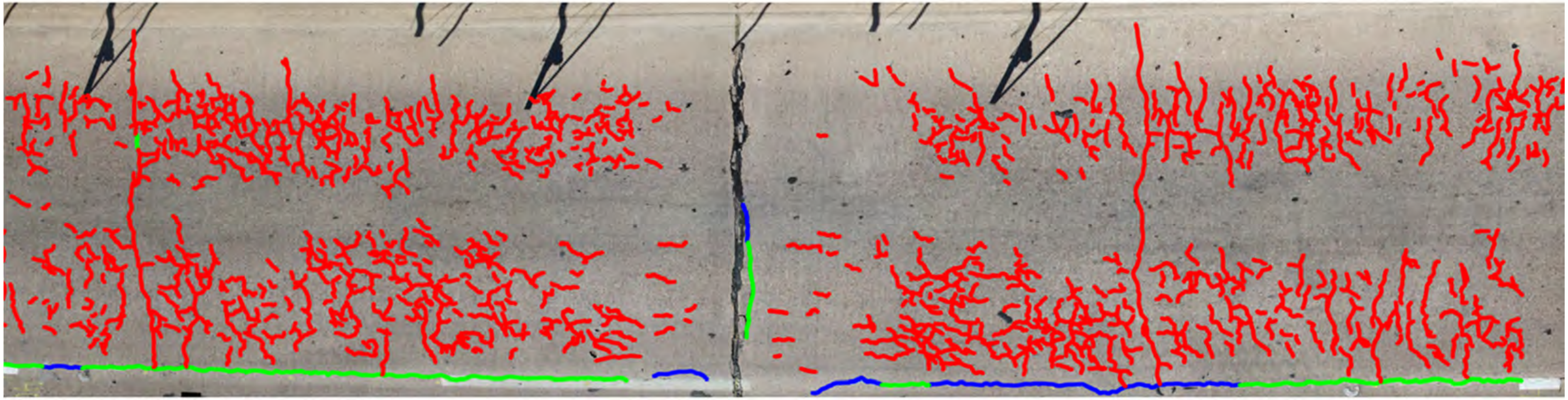
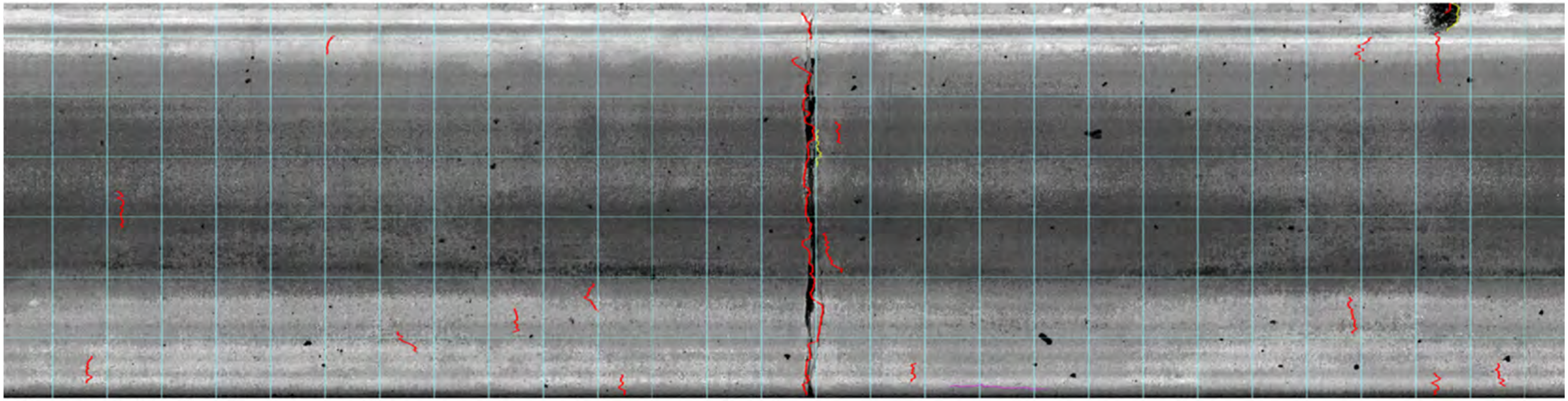


TxDOT (Fully Automated)

Section 17 /// Station 400-450

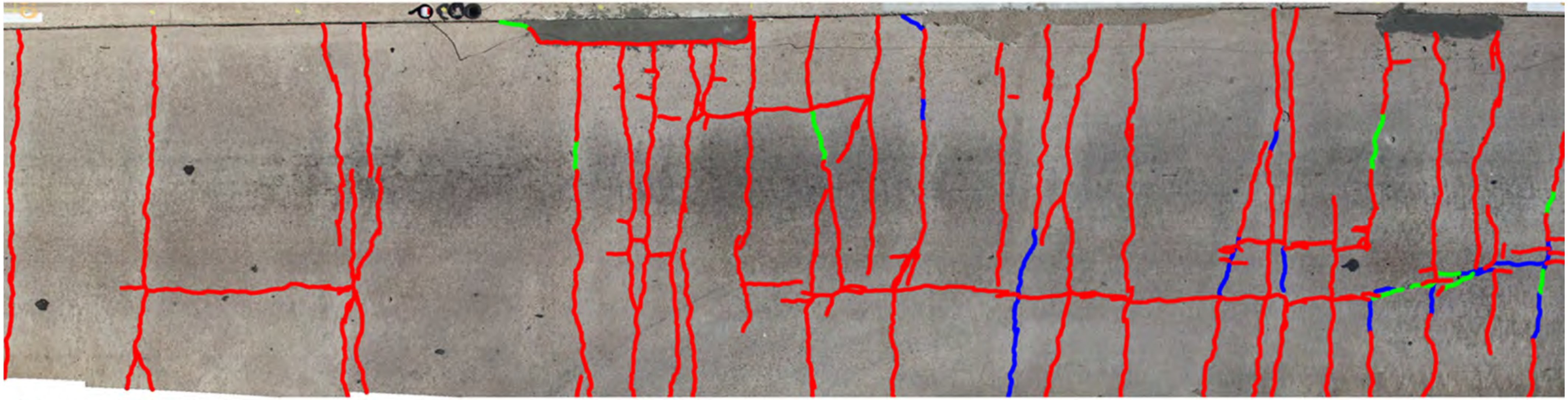


Manual Crack Map

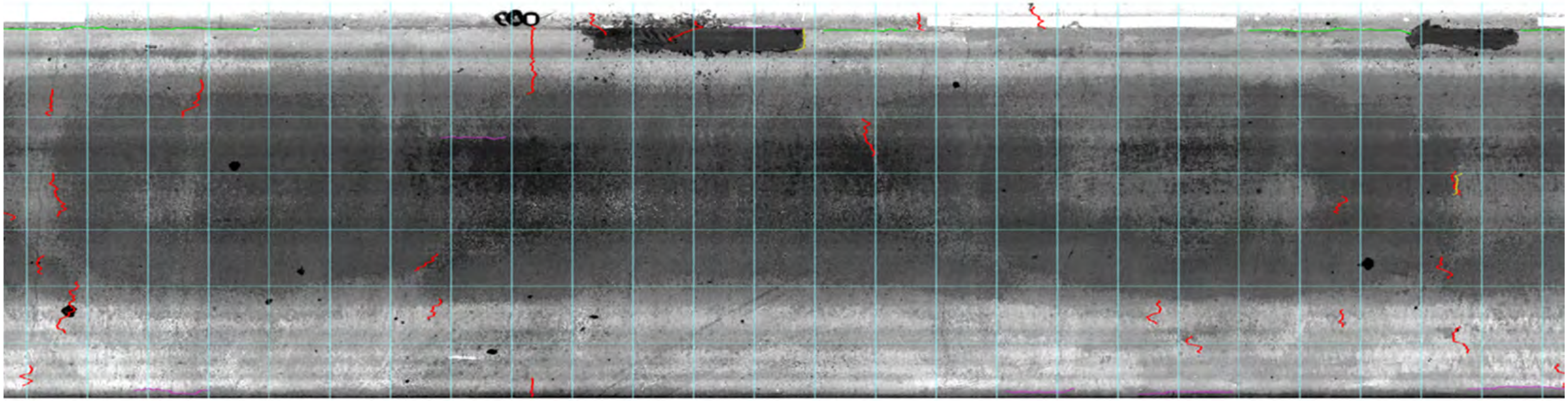


TxDOT (Fully Automated)

Section 19 /// Station 150-200



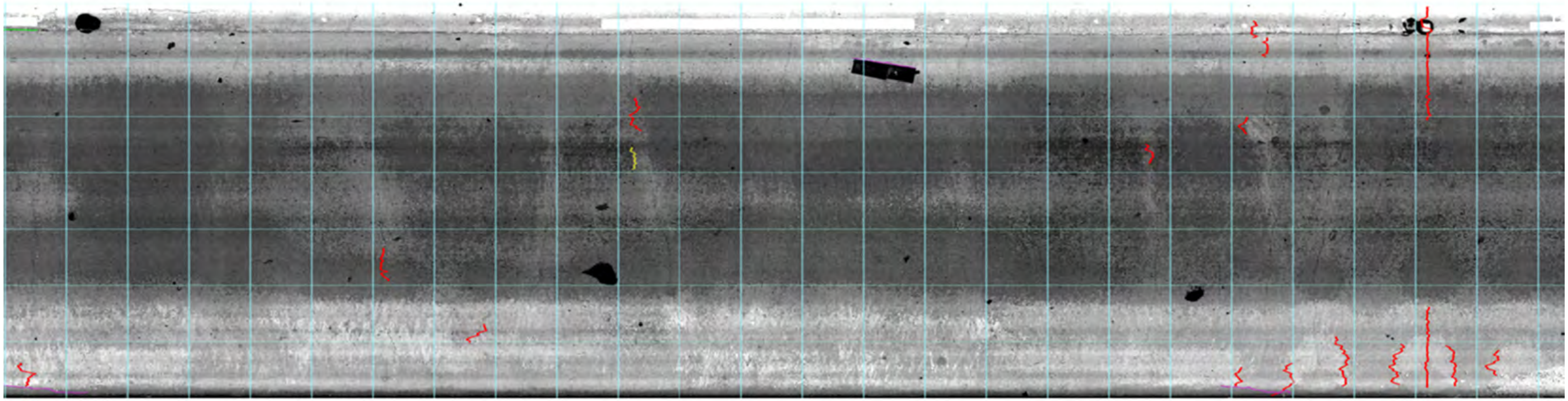
Manual Crack Map



TxDOT (Fully Automated)

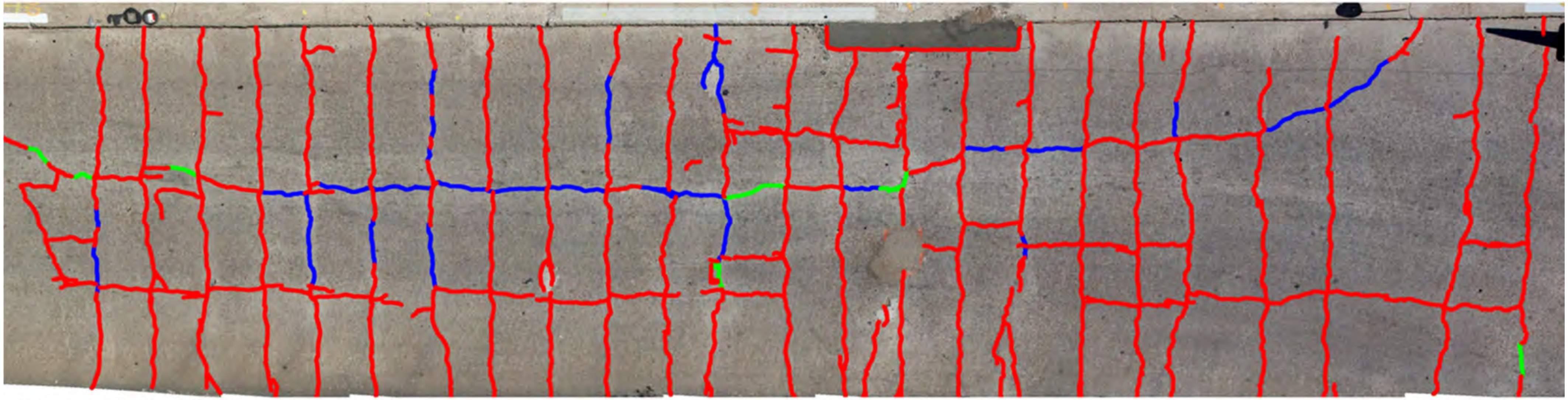
Section 19 /// Station 200-250

Manual Crack Map

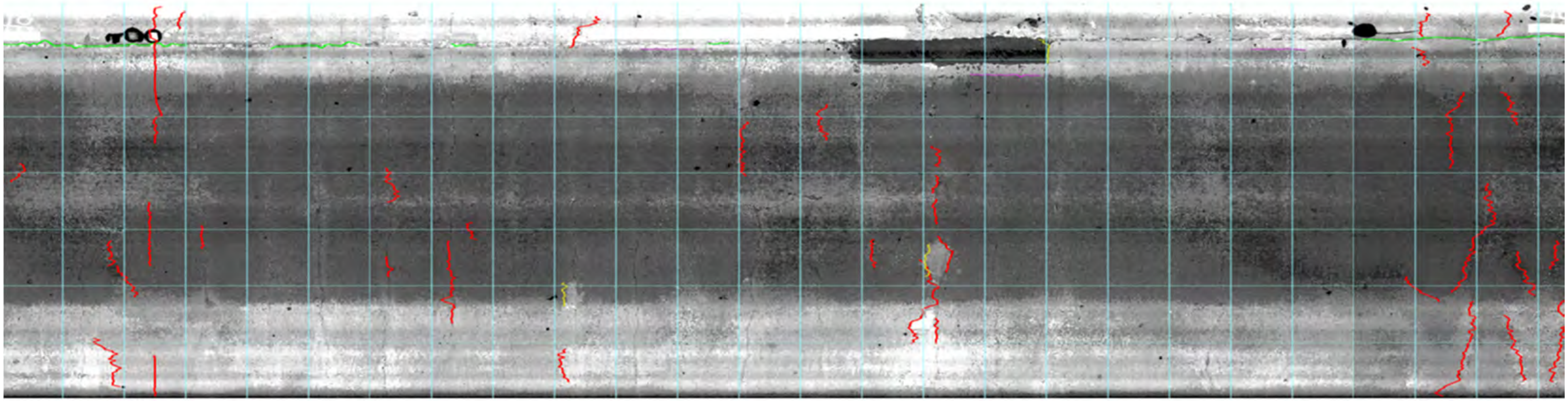


TxDOT (Fully Automated)

Section 19 /// Station 400-450



Manual Crack Map



TxDOT (Fully Automated)

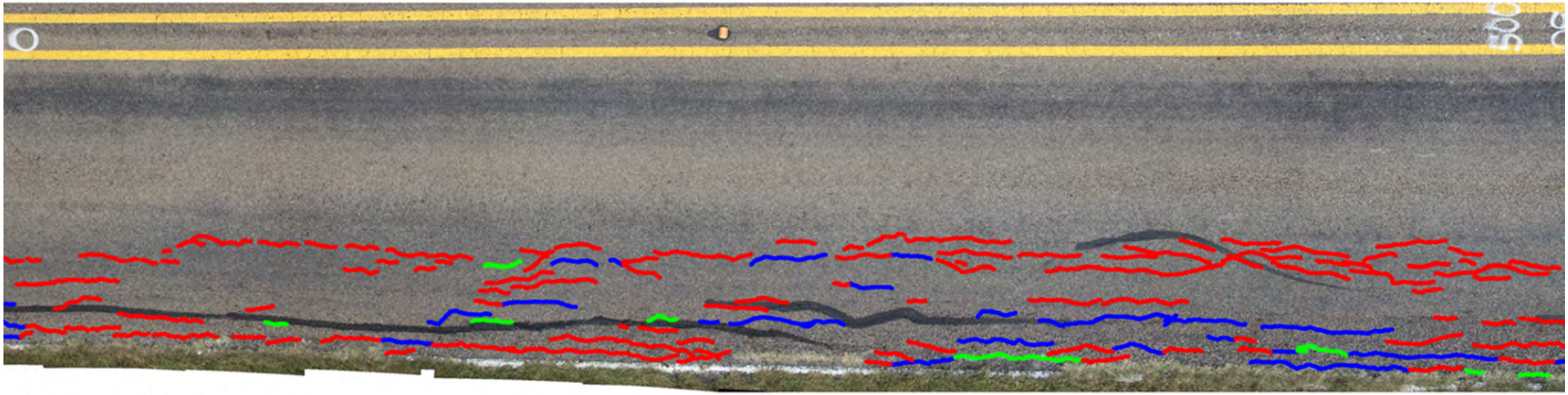
Appendix A.2

Crack Maps Comparison

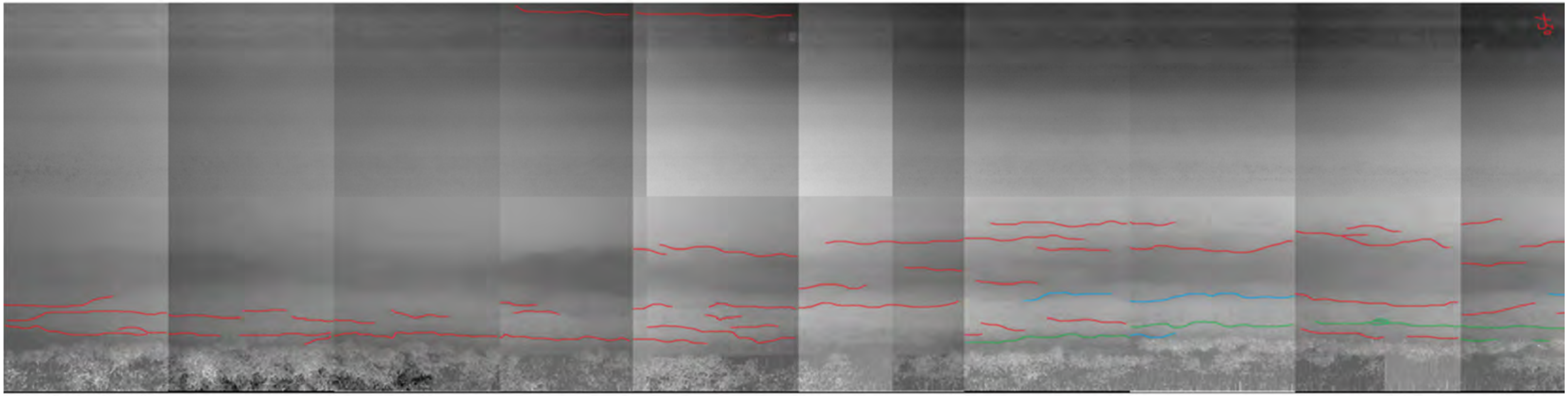
Waylink-OSU

fully automated

Section 2 /// Station 000-050



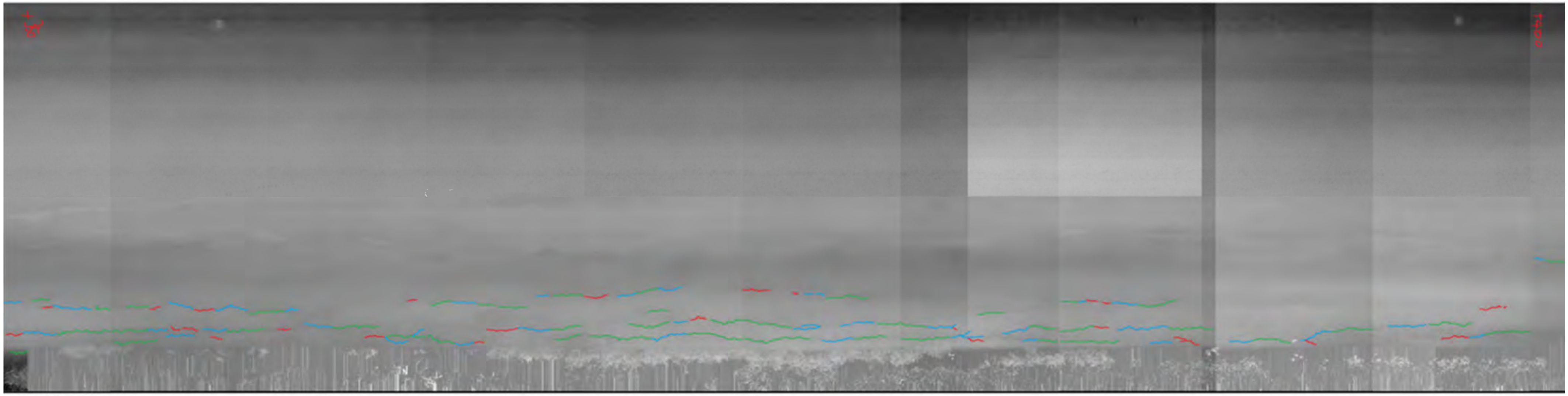
Manual Crack Map



OSU (Fully Automated)

Section 2 /// Station 350-400

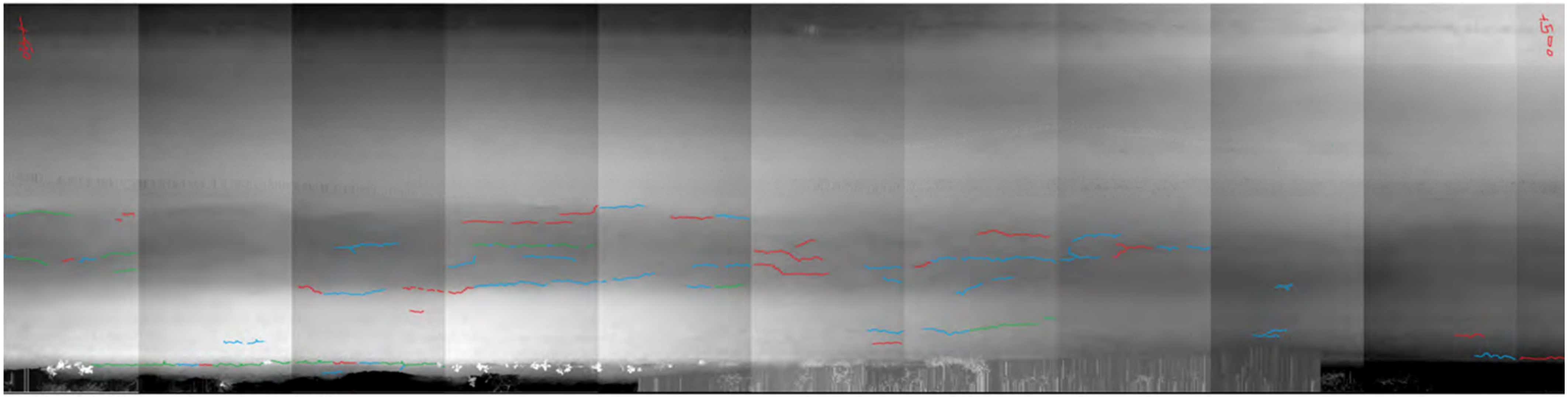
Manual Crack Map



OSU (Fully Automated)

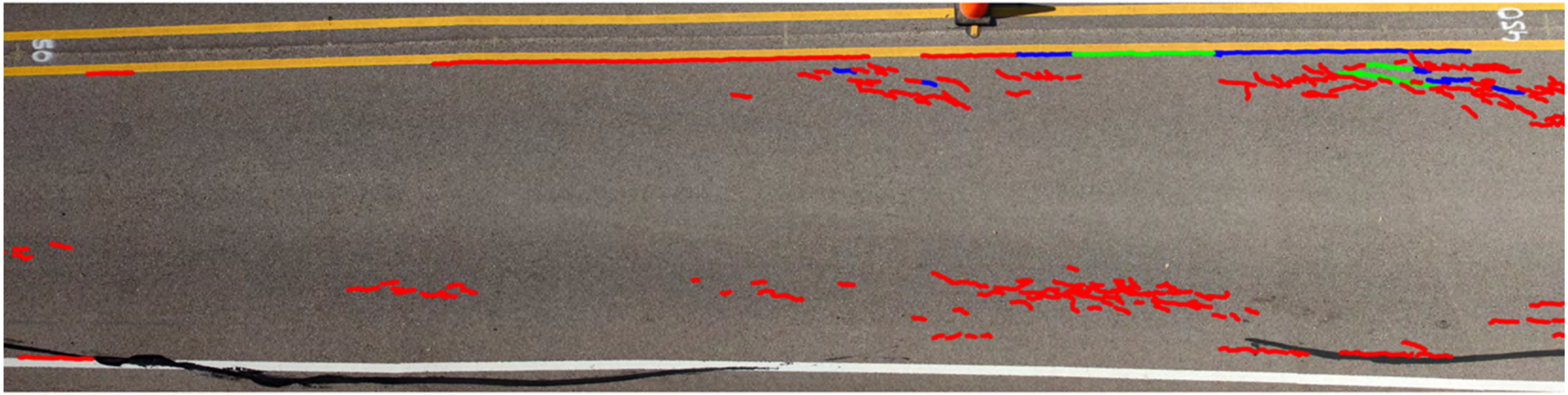
Section 2 /// Station 450-500

Manual Crack Map

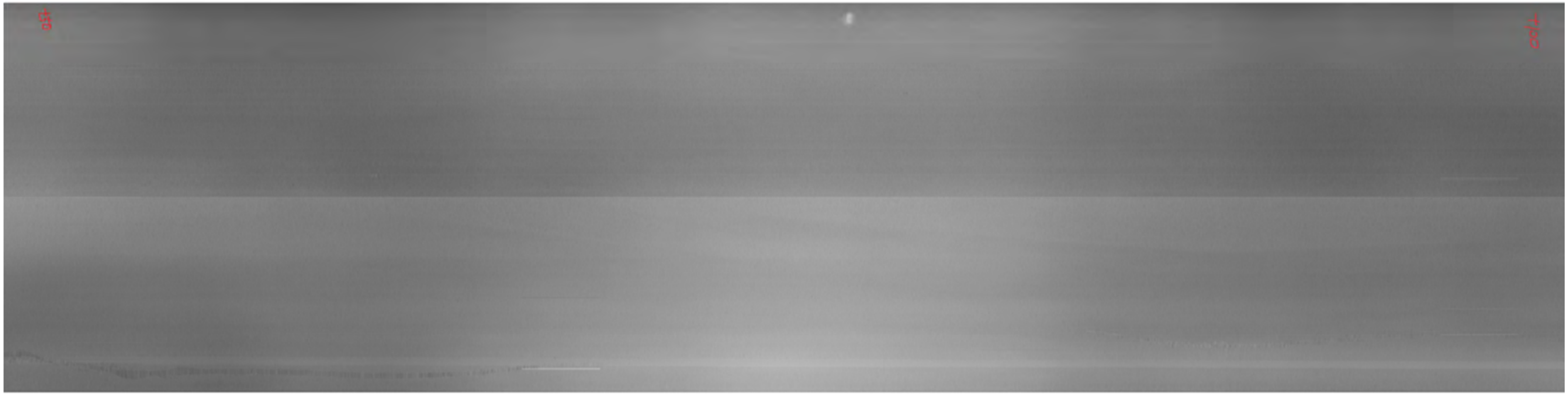


OSU (Fully Automated)

Section 4 /// Station 050-100



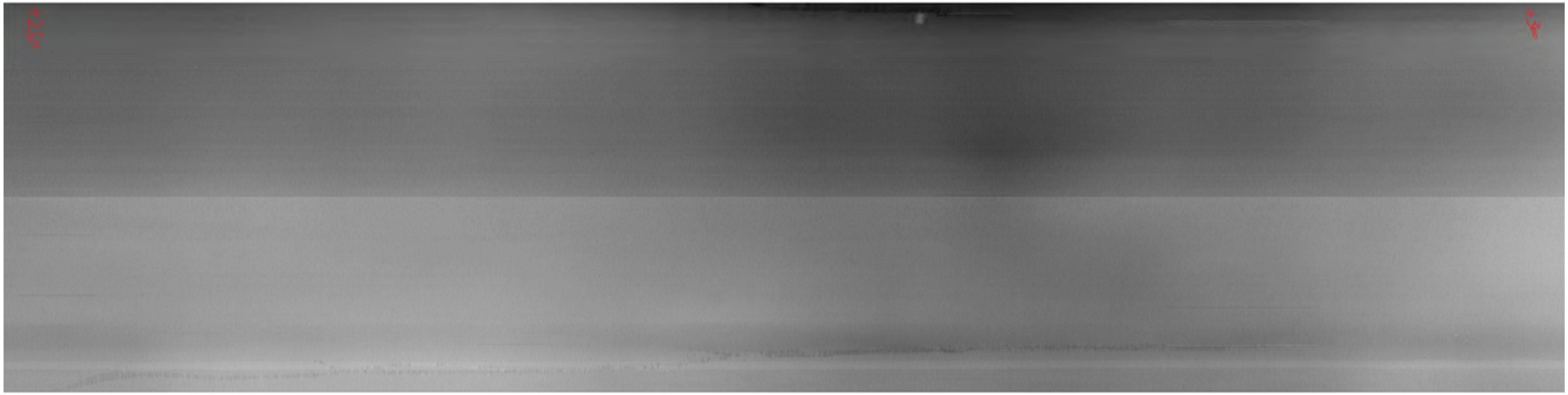
Manual Crack Map



OSU (Fully Automated)

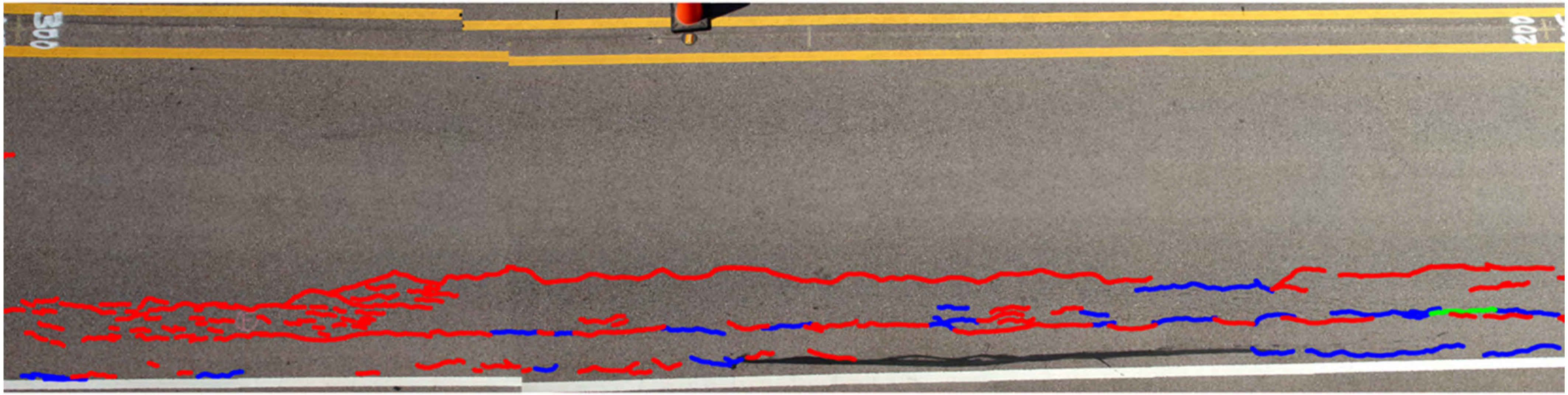
Section 4 /// Station 250-300

Manual Crack Map



OSU (Fully Automated)

Section 4 /// Station 300-350



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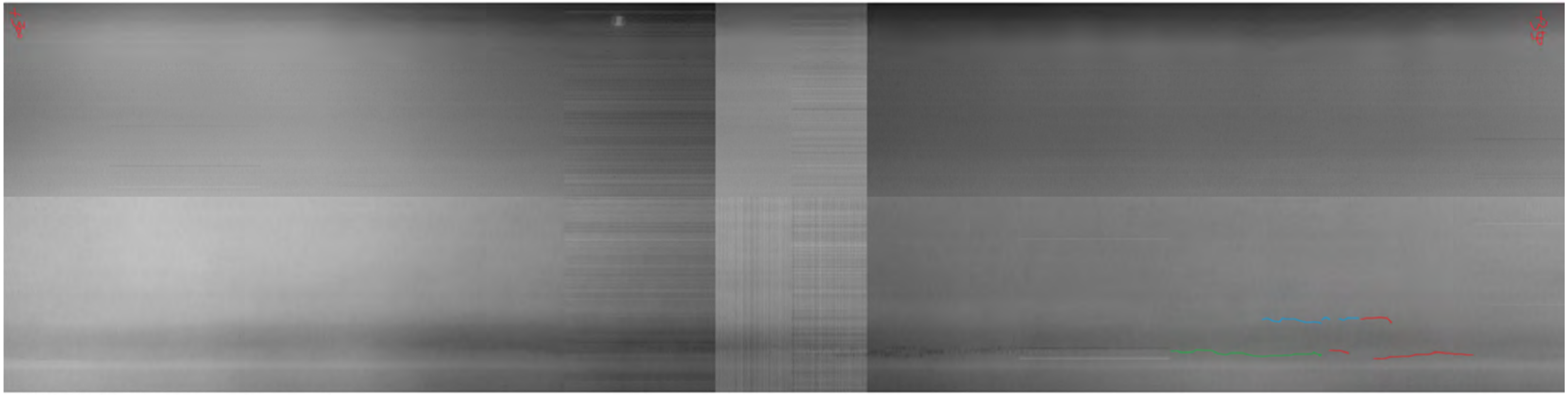


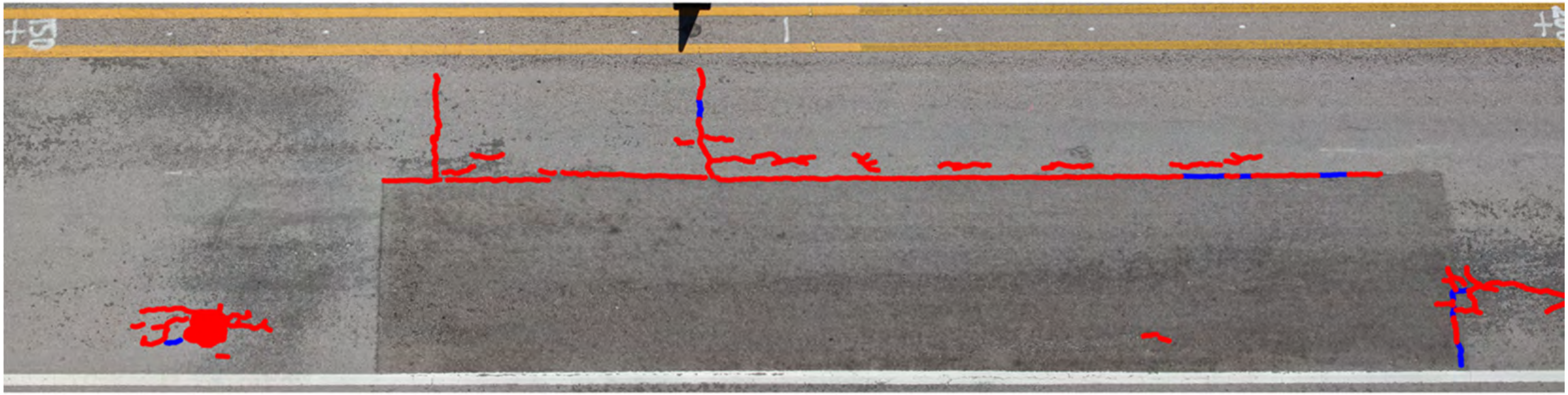
OSU (Fully Automated)

Section 6 /// Station 100-150

Manual Crack Map

OSU (Fully Automated)

Section 6 /// Station 150-200



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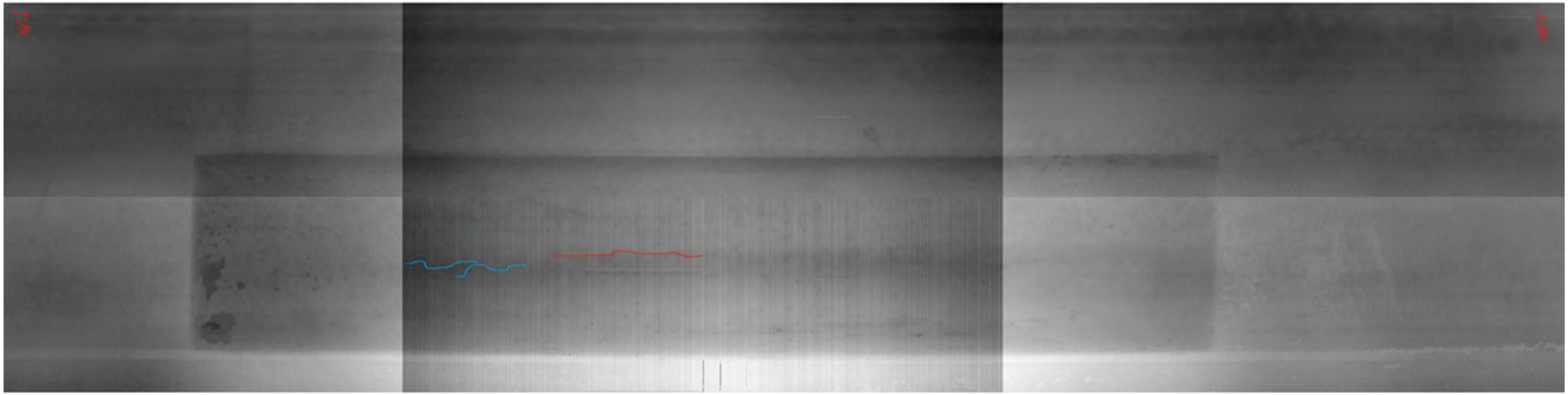
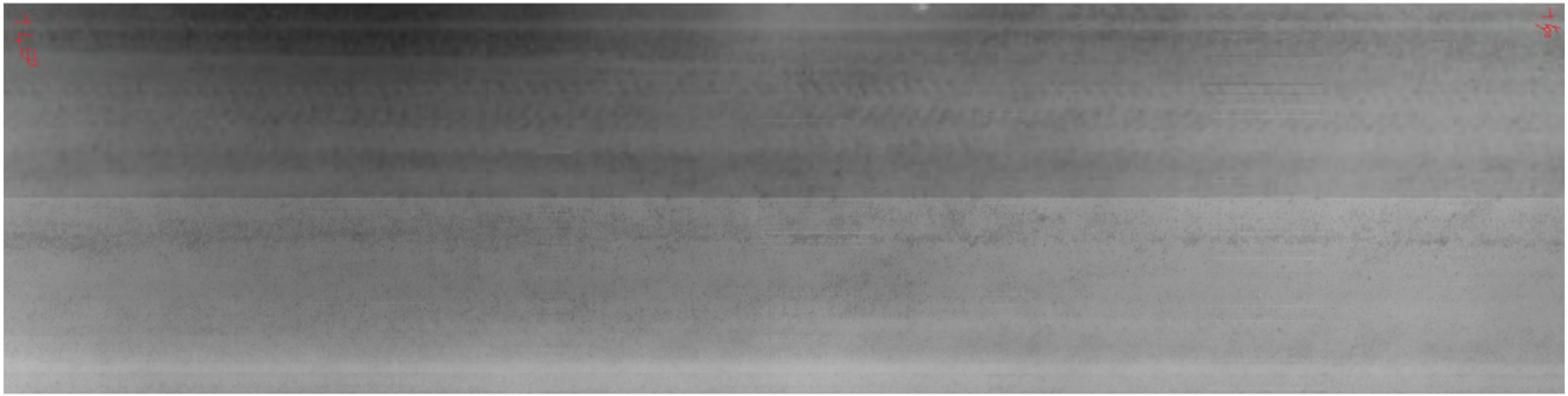


OSU (Fully Automated)

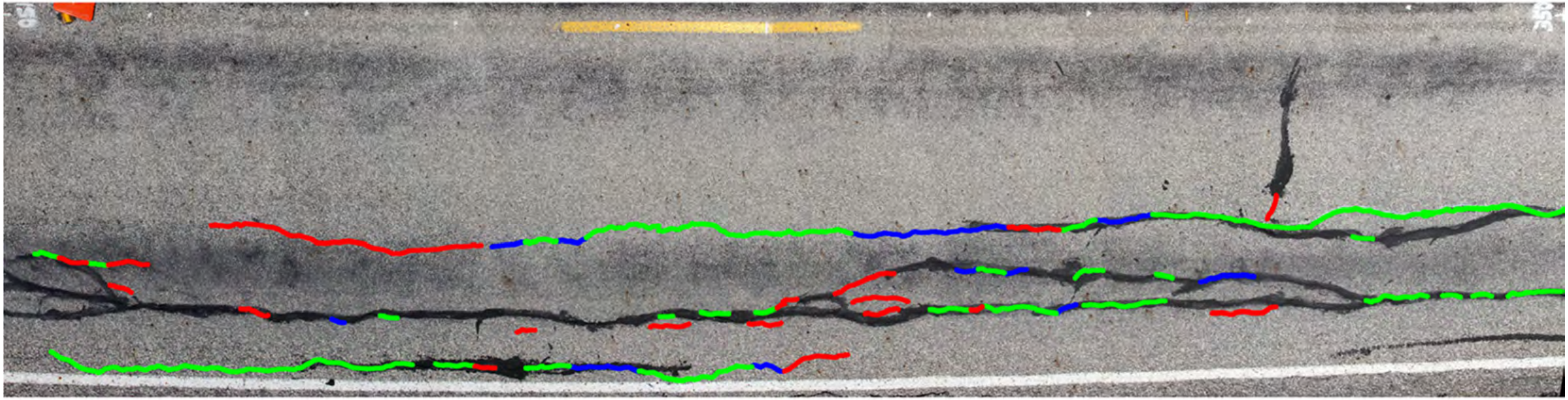
Section 6 /// Station 450-500

Manual Crack Map



OSU (Fully Automated)

Section 9 /// Station 150-200



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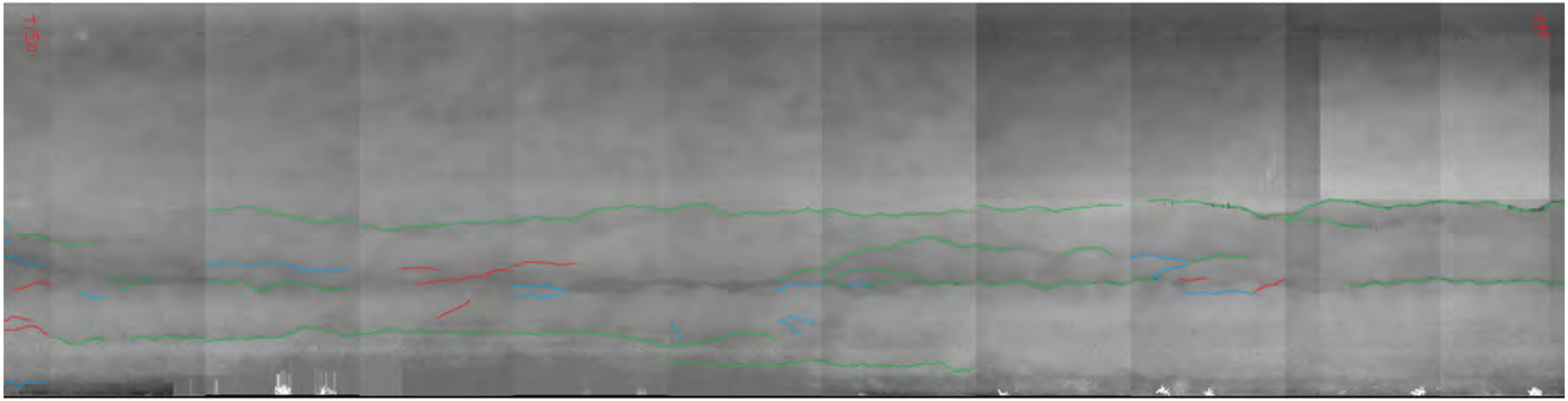
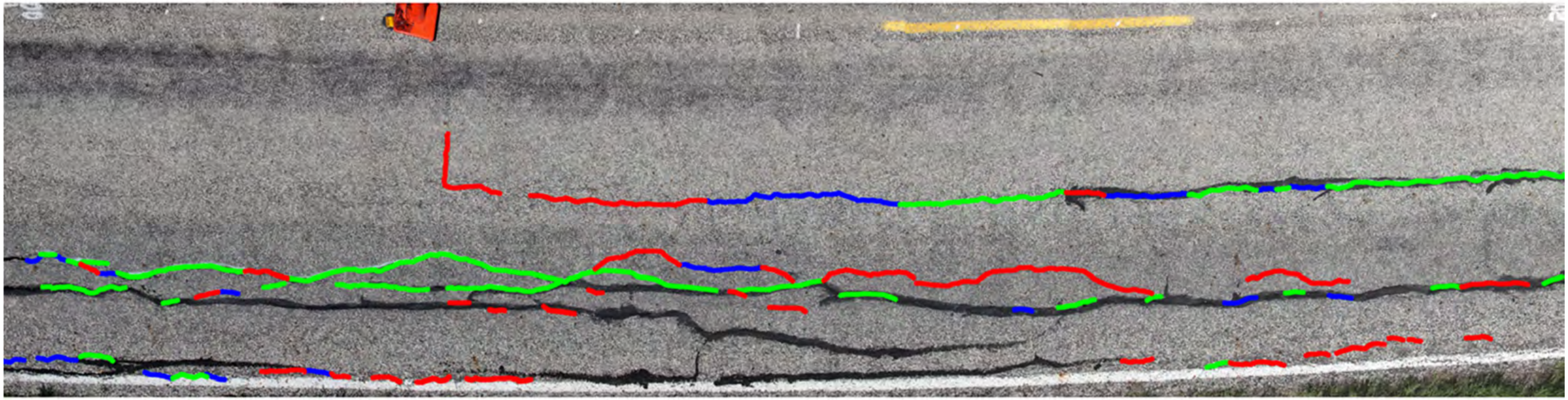


OSU (Fully Automated)

Section 9 /// Station 300-350



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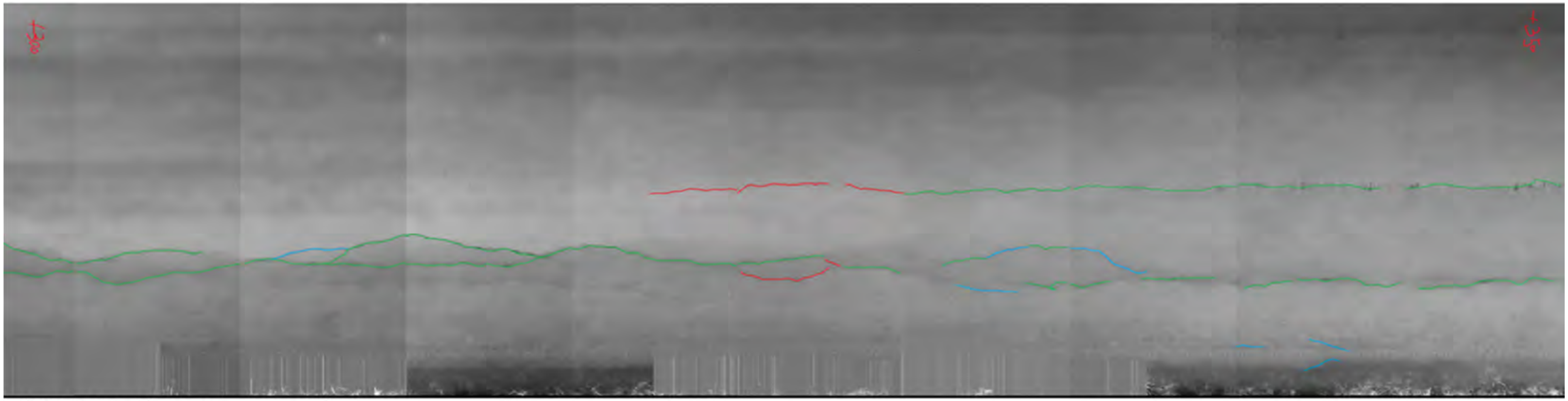
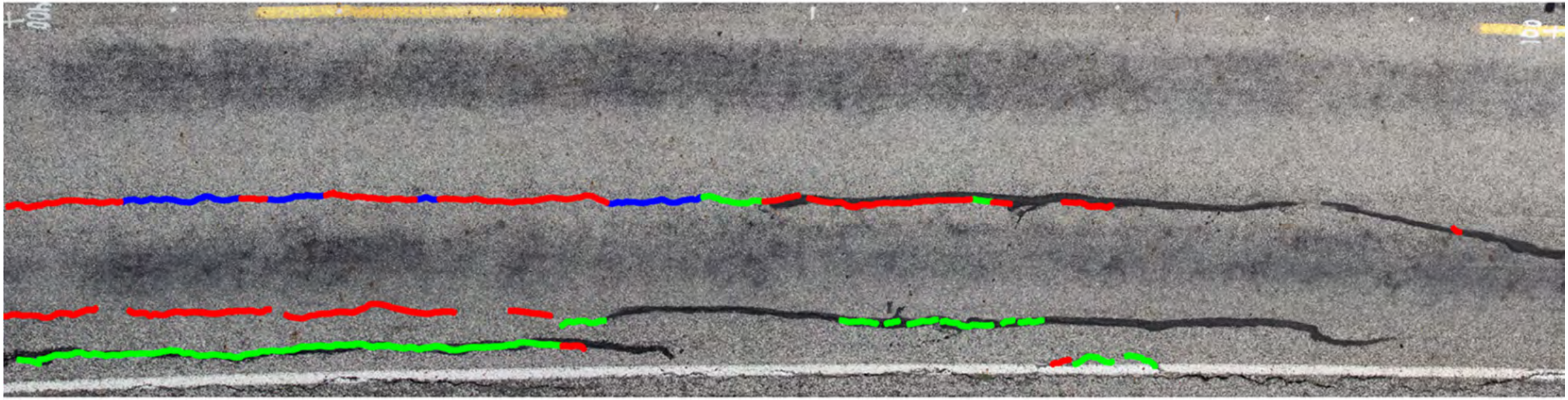


OSU (Fully Automated)

Section 9 /// Station 400-450



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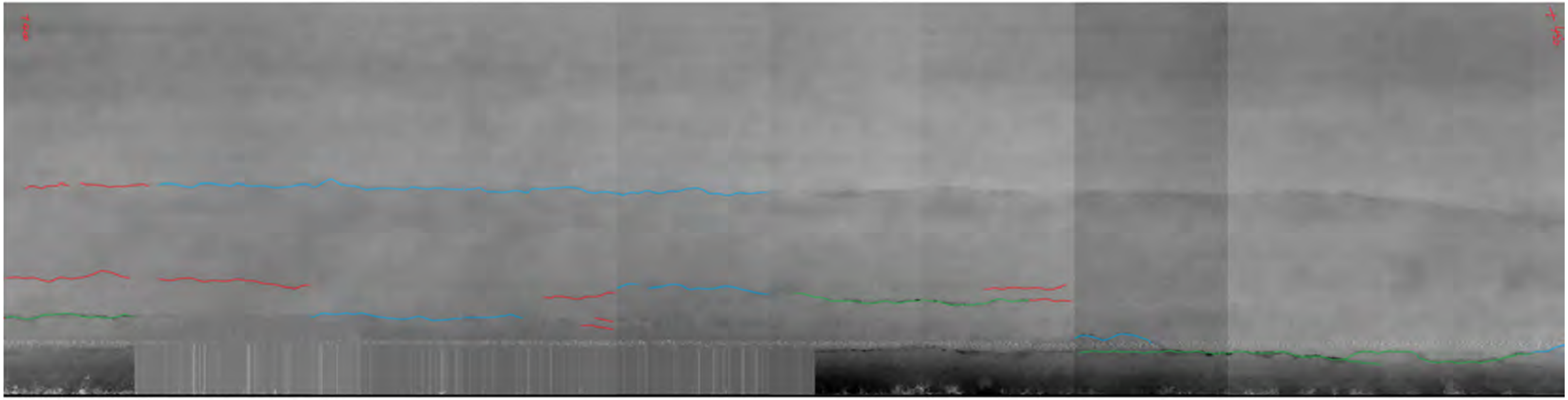
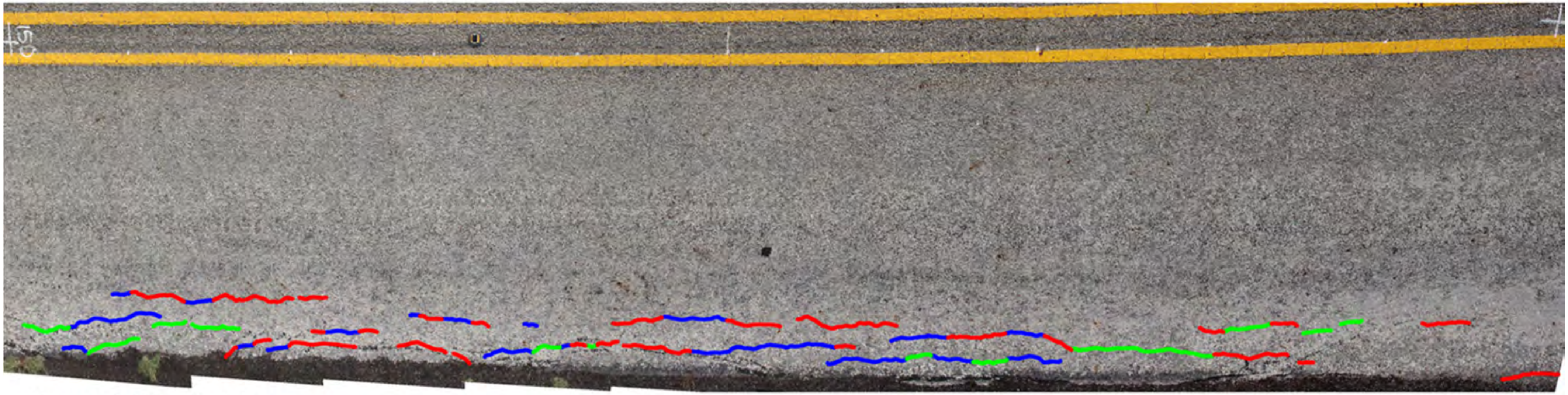


OSU (Fully Automated)

Section 10/// Station 150-200



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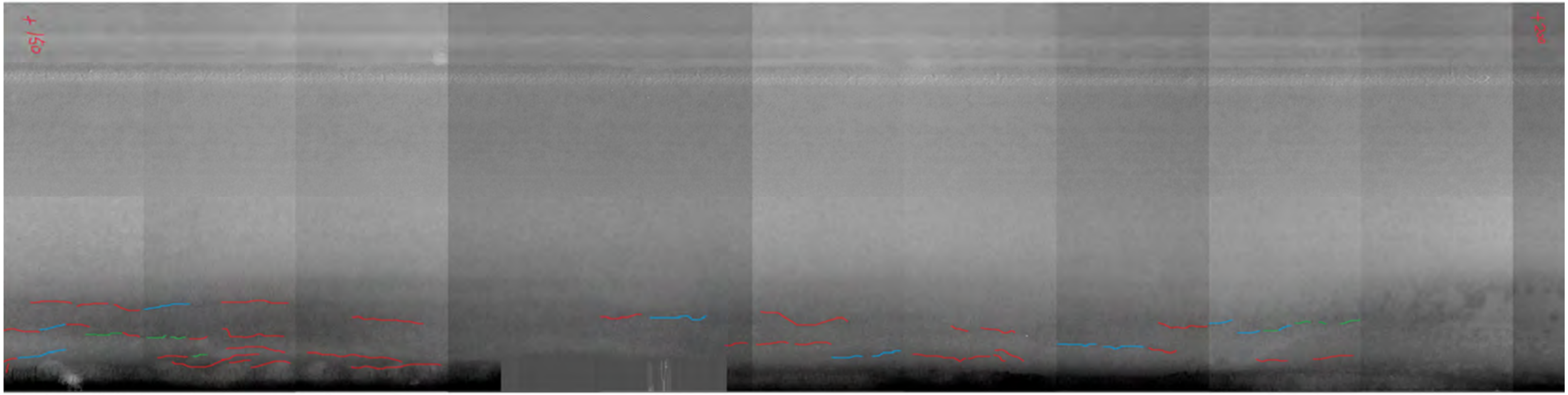
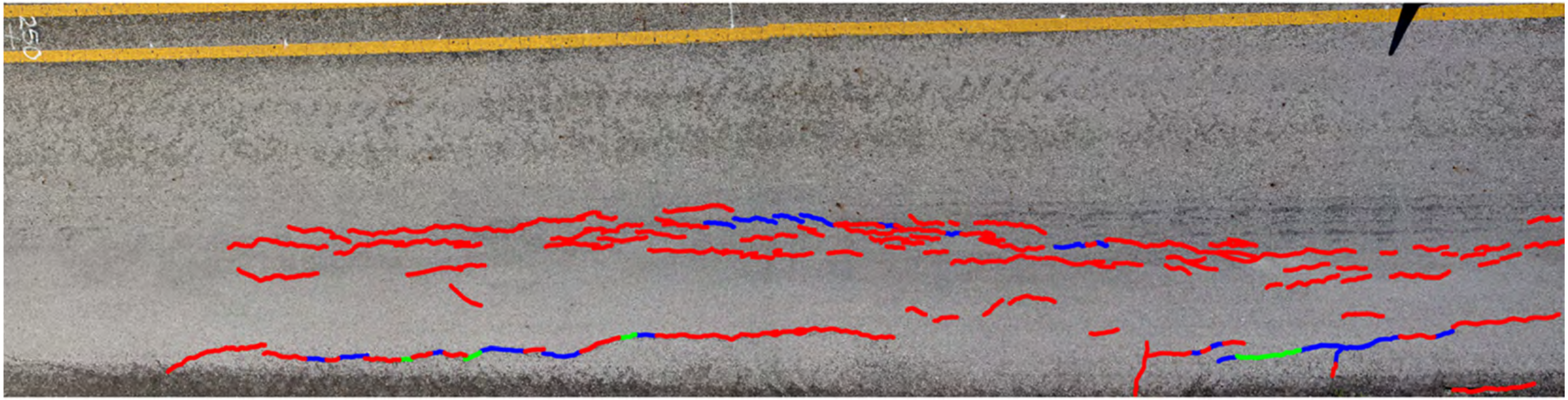


OSU (Fully Automated)

Section 10/// Station 250-300



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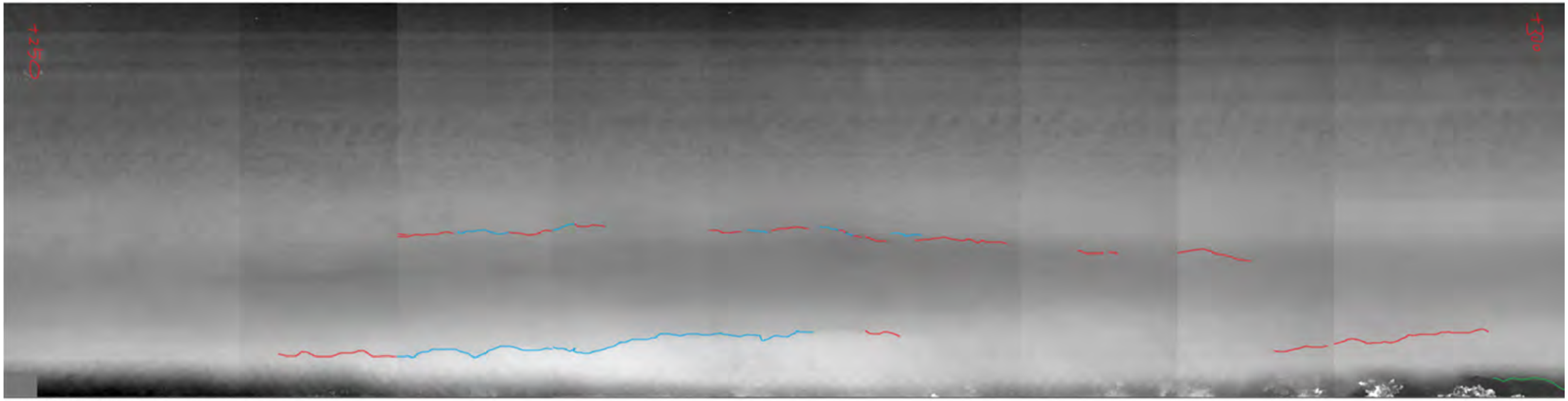

OSU (Fully Automated)

Section 10 /// Station 400-450

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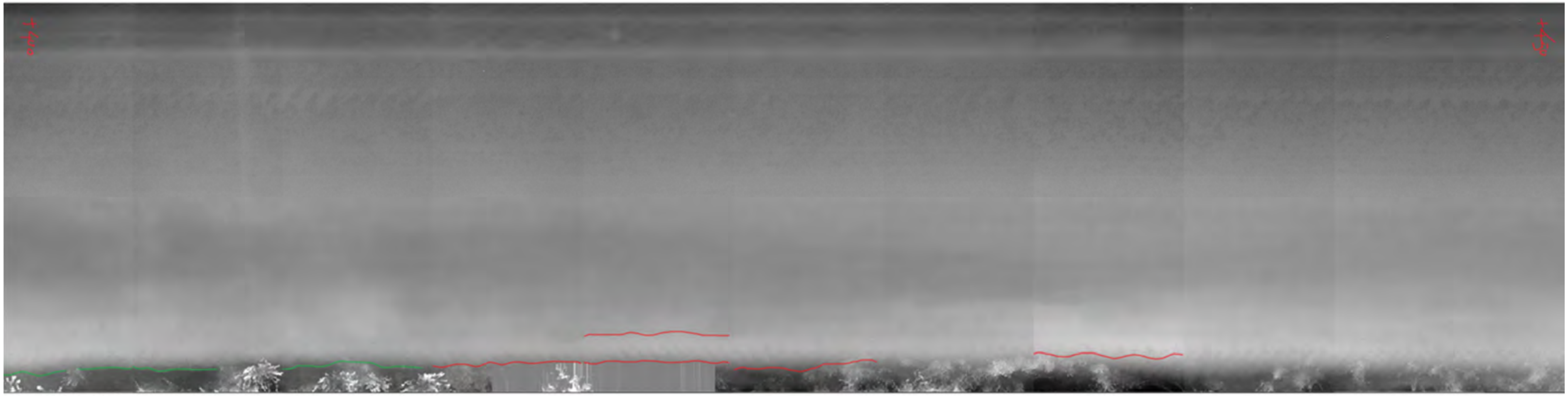
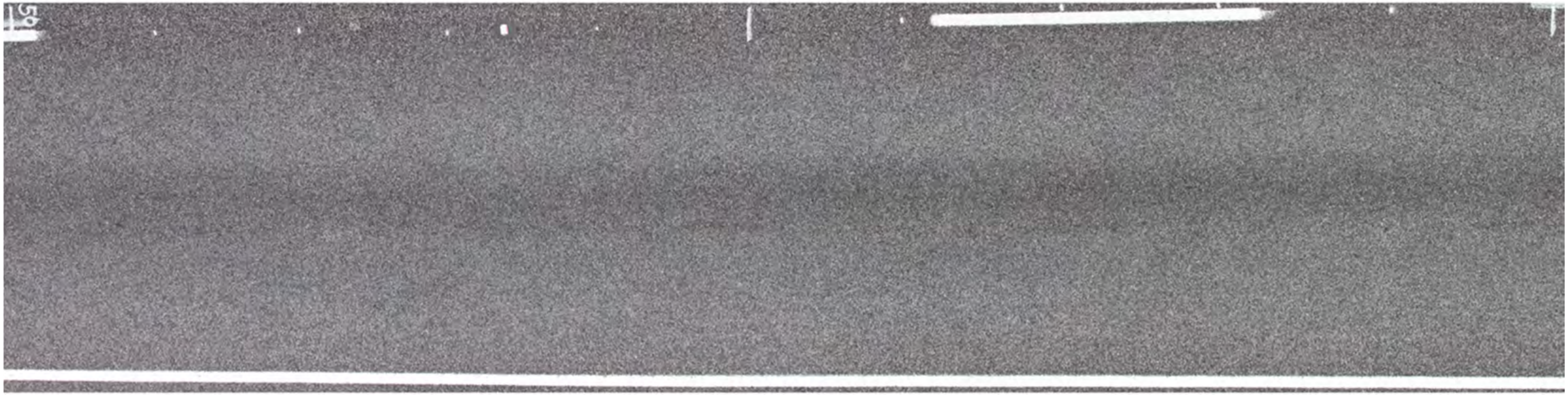


OSU (Fully Automated)

Section 11 /// Station 050-100



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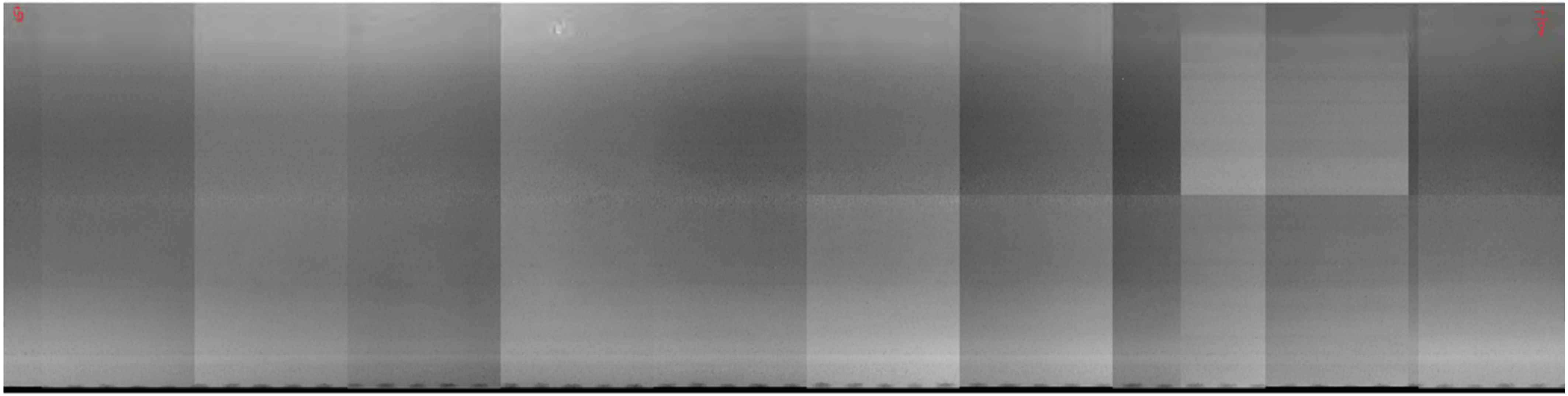
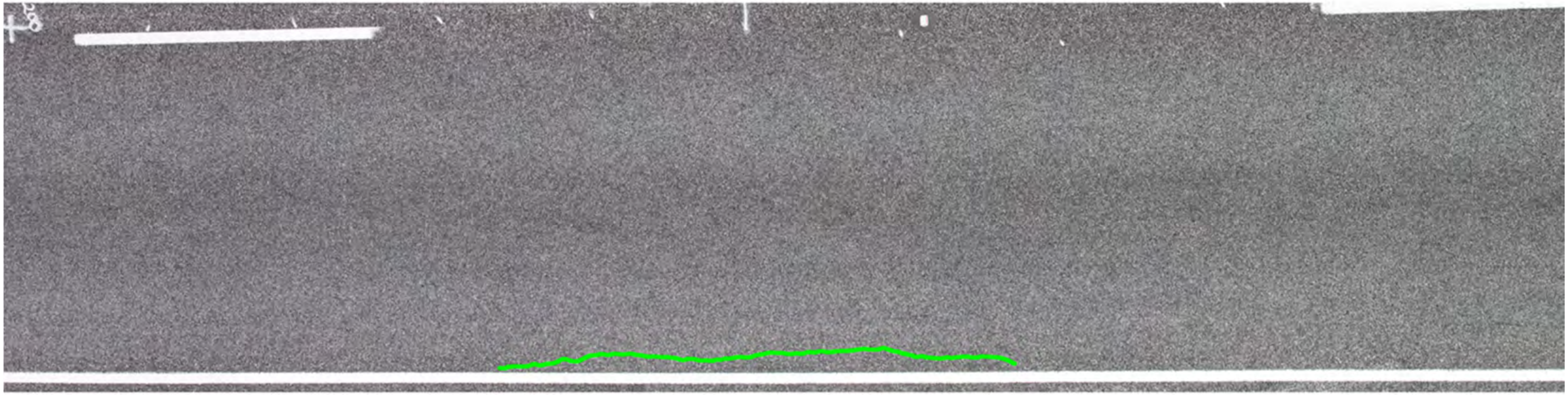


OSU (Fully Automated)

Section 11 /// Station 200-250



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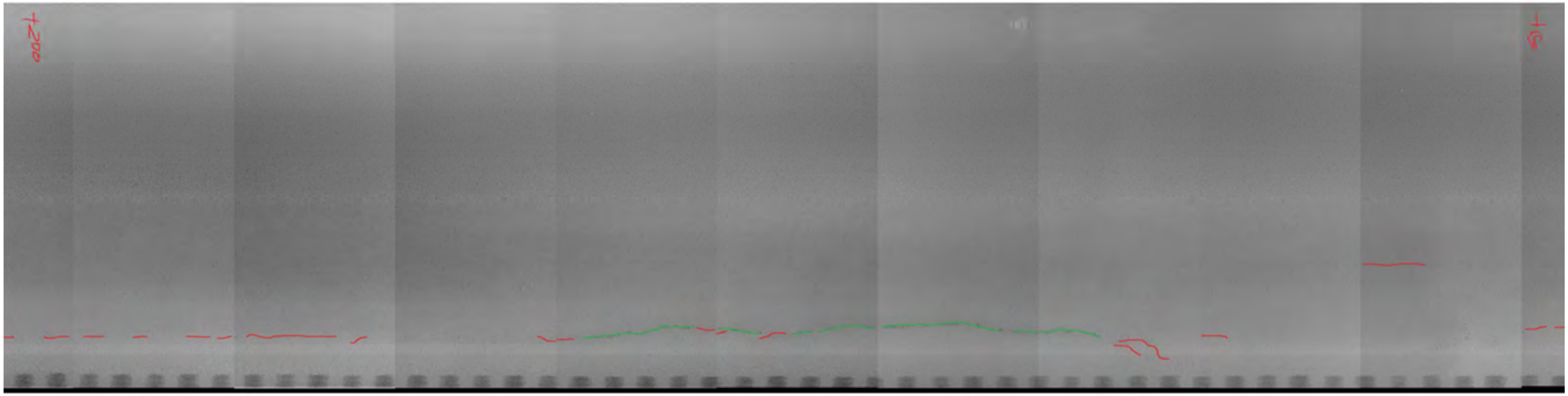
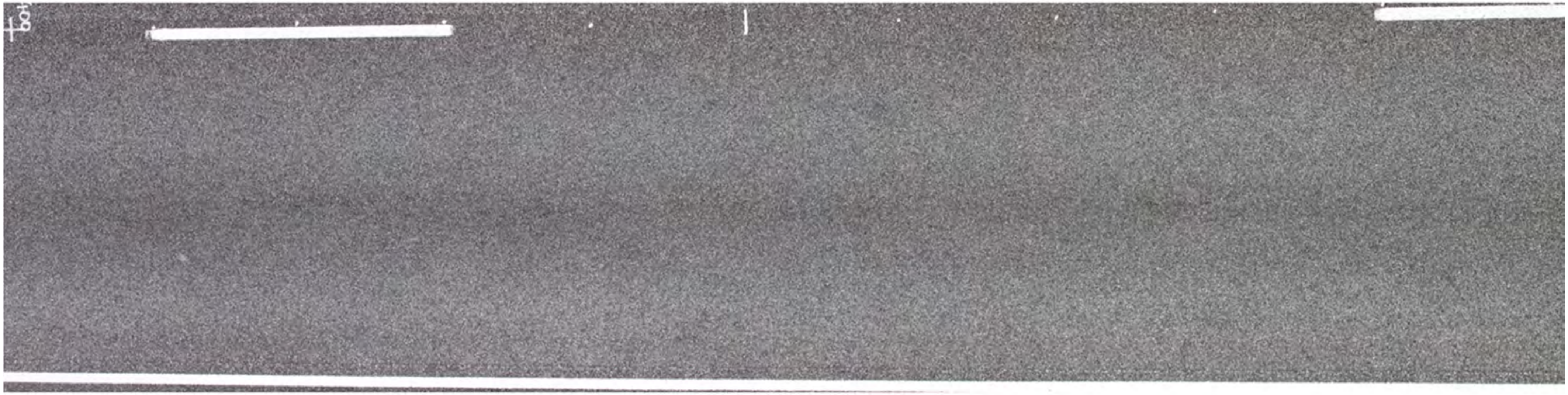


OSU (Fully Automated)

Section 11 /// Station 400-450



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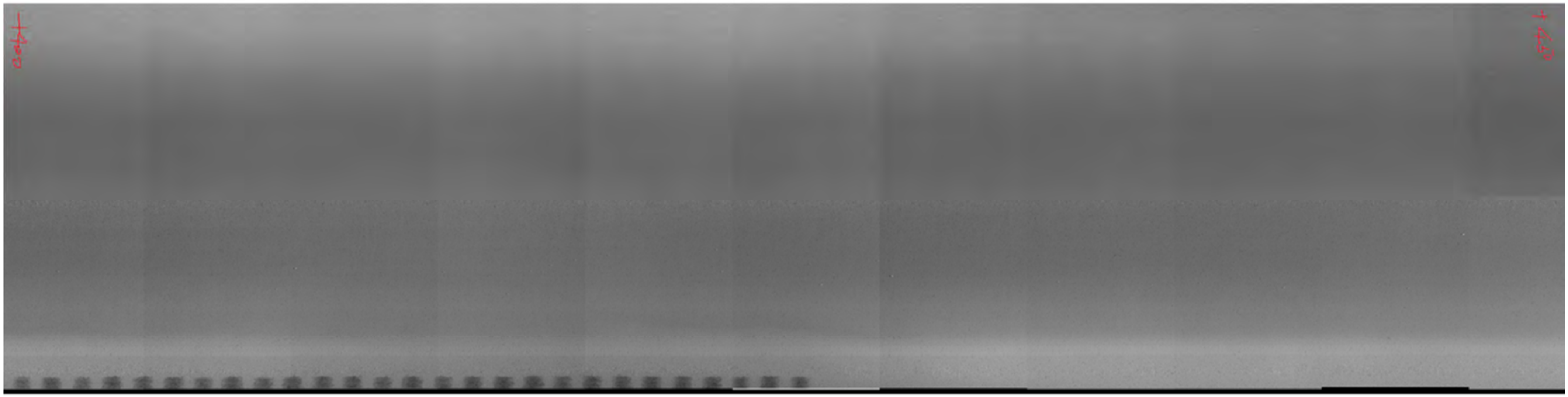
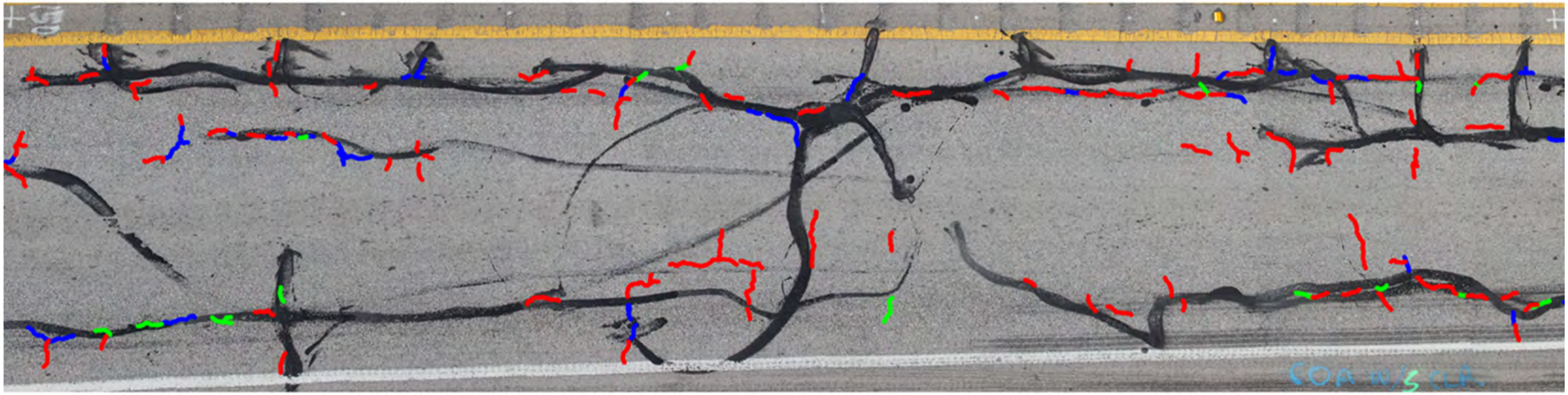


OSU (Fully Automated)

Section 12 /// Station 150-200



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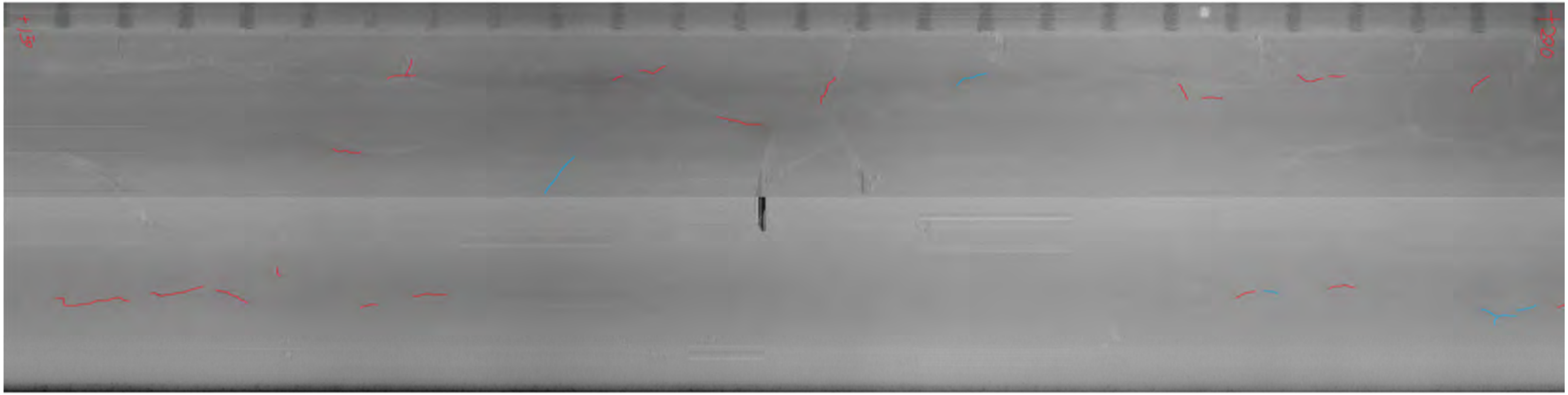


OSU (Fully Automated)

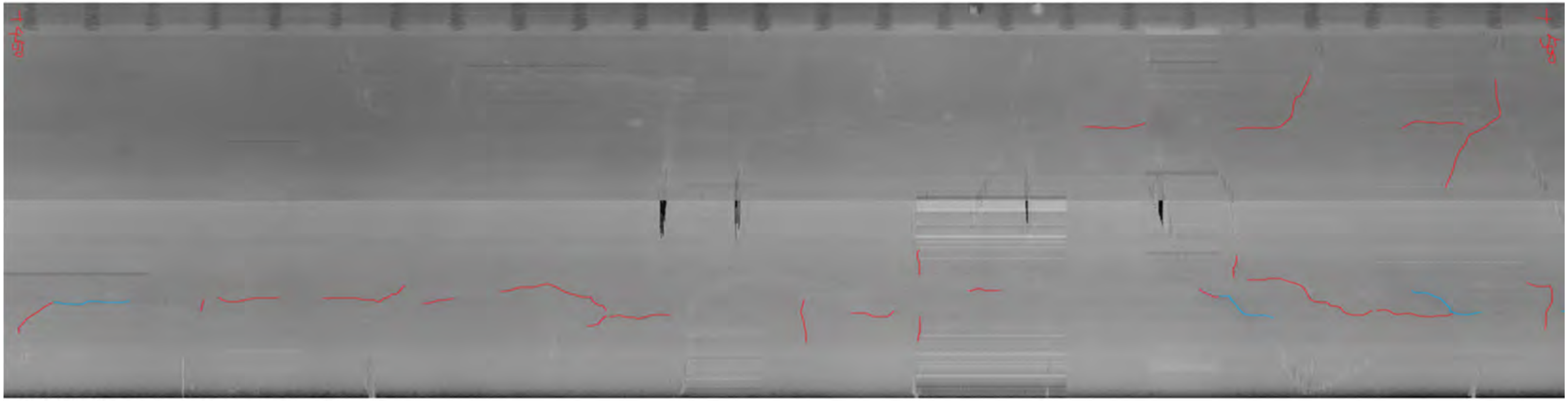
Section 12 /// Station 250-300

Manual Crack Map

OSU (Fully Automated)

Section 12 /// Station 450-500

Manual Crack Map



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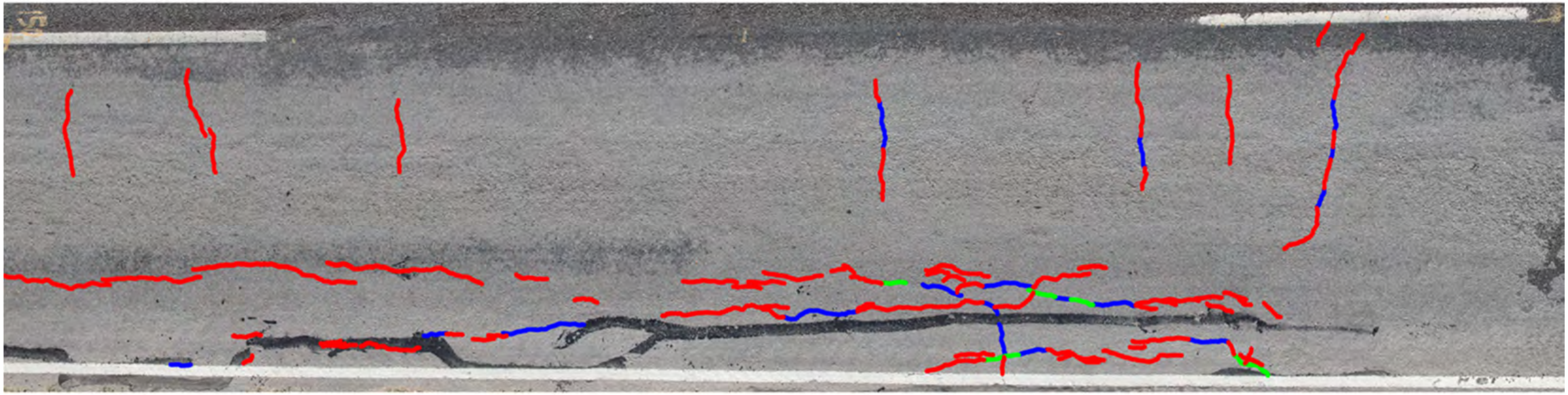
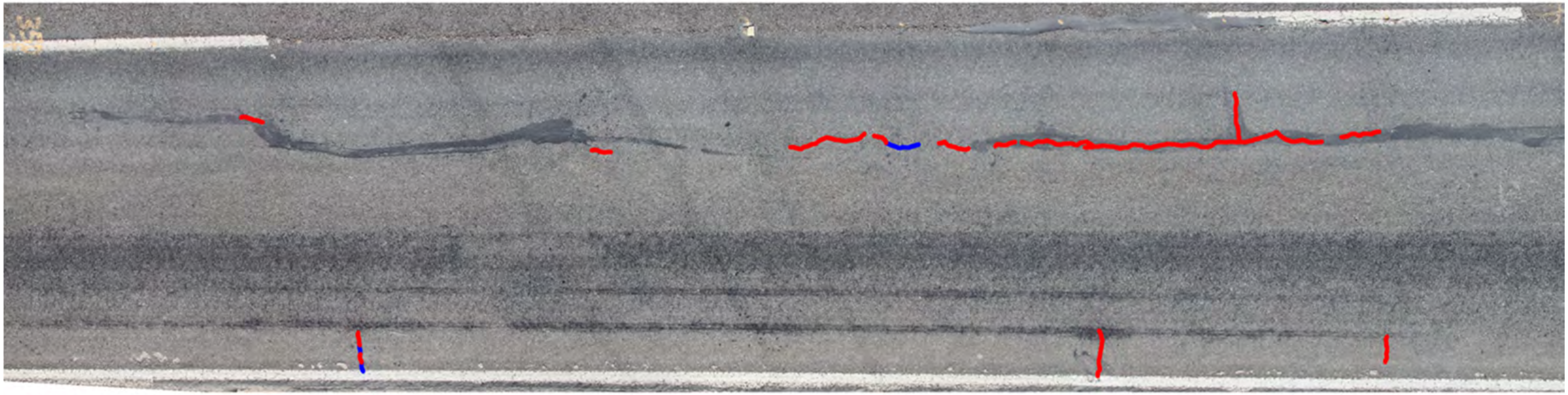
Section 13 /// Station 150-200



Manual Crack Map

OSU (Fully Automated)

Section 13 /// Station 350-400



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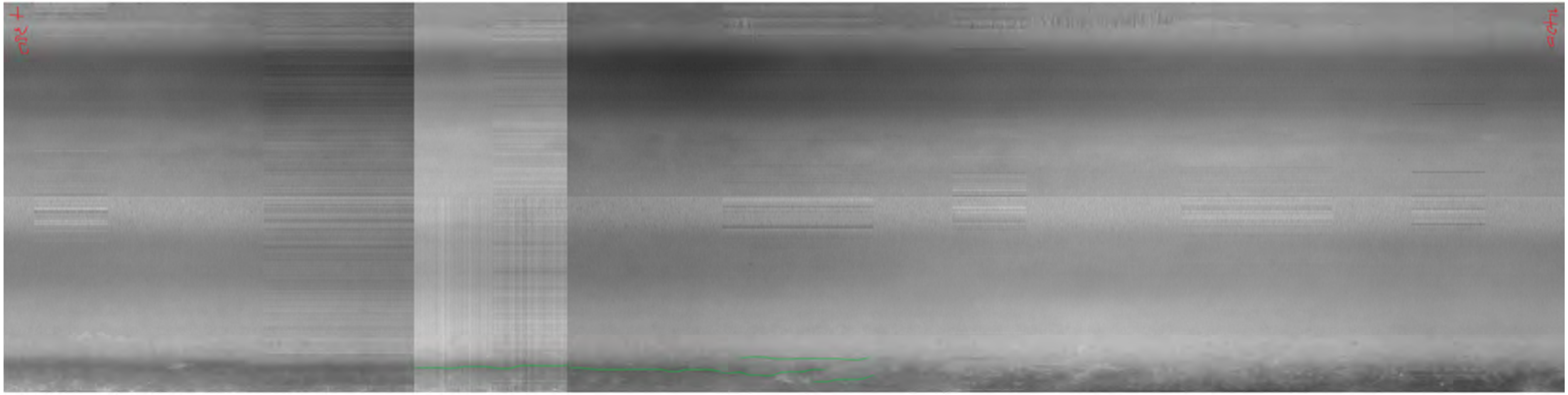
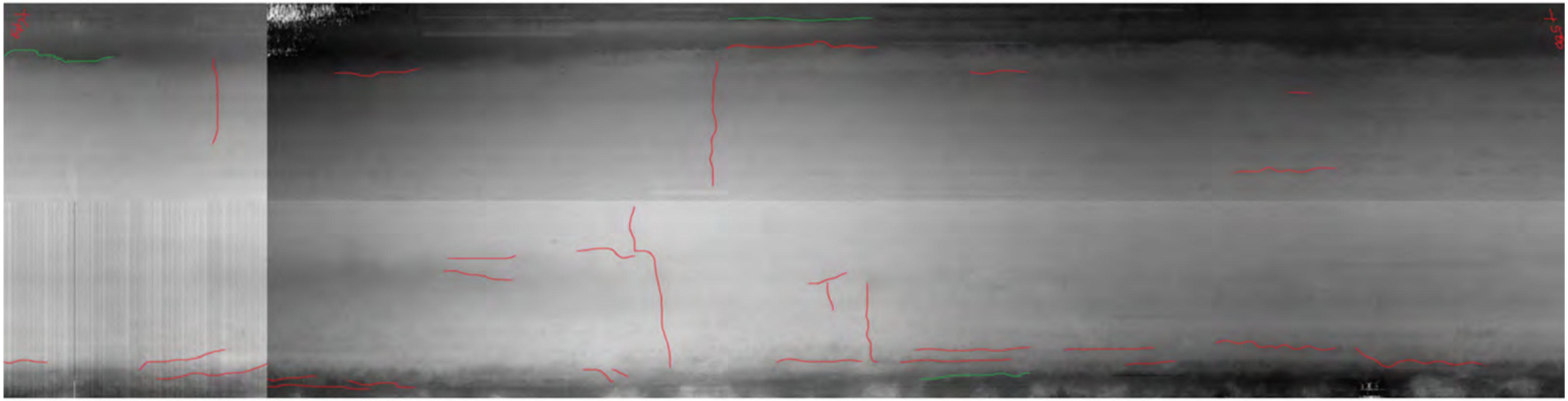


OSU (Fully Automated)

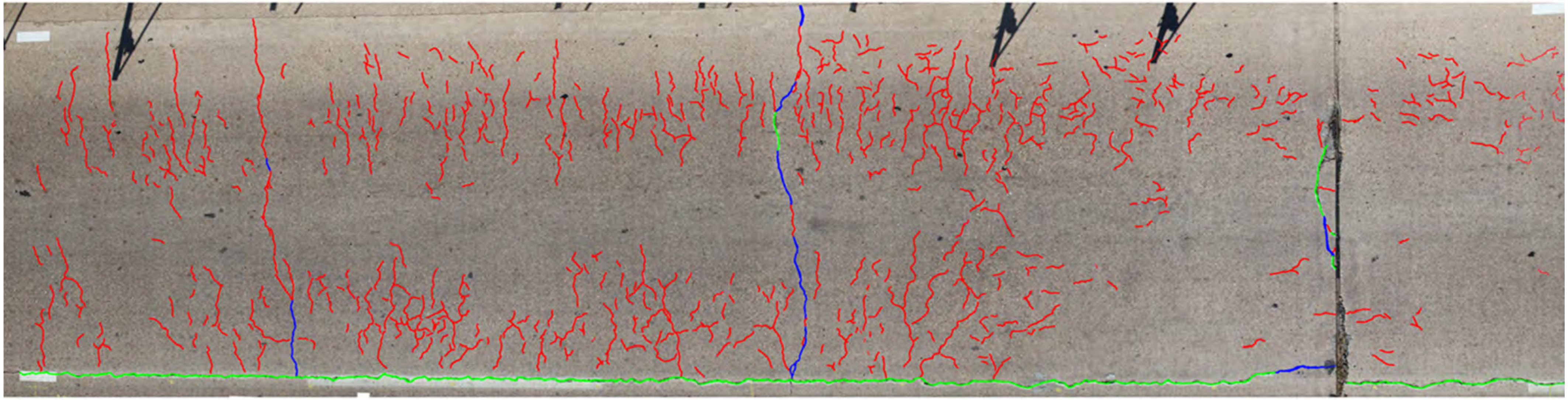
Section 13 /// Station 450-500

Manual Crack Map



OSU (Fully Automated)

Section 17 /// Station 050-100



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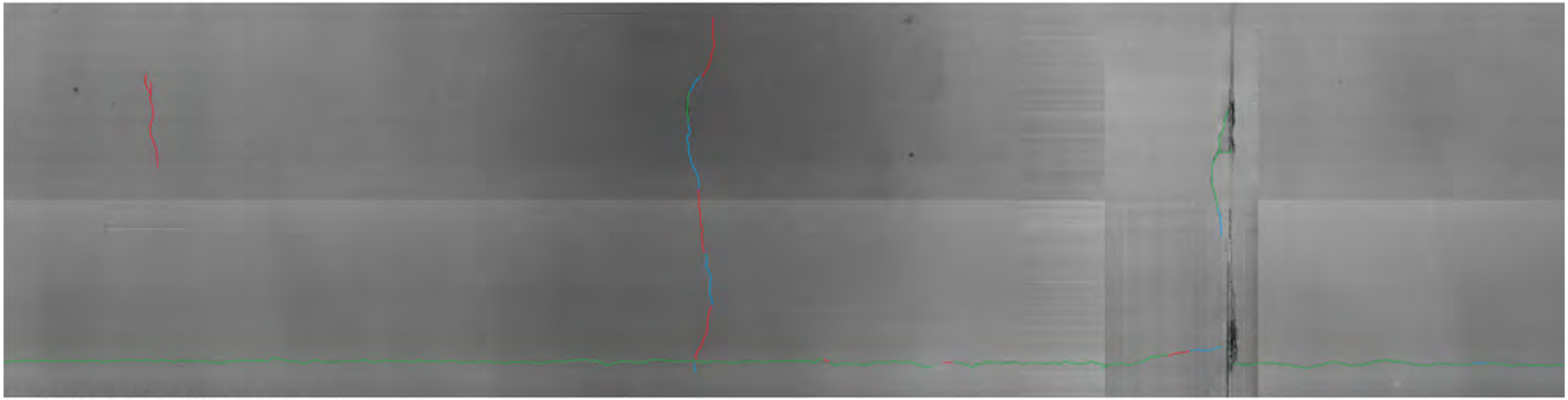
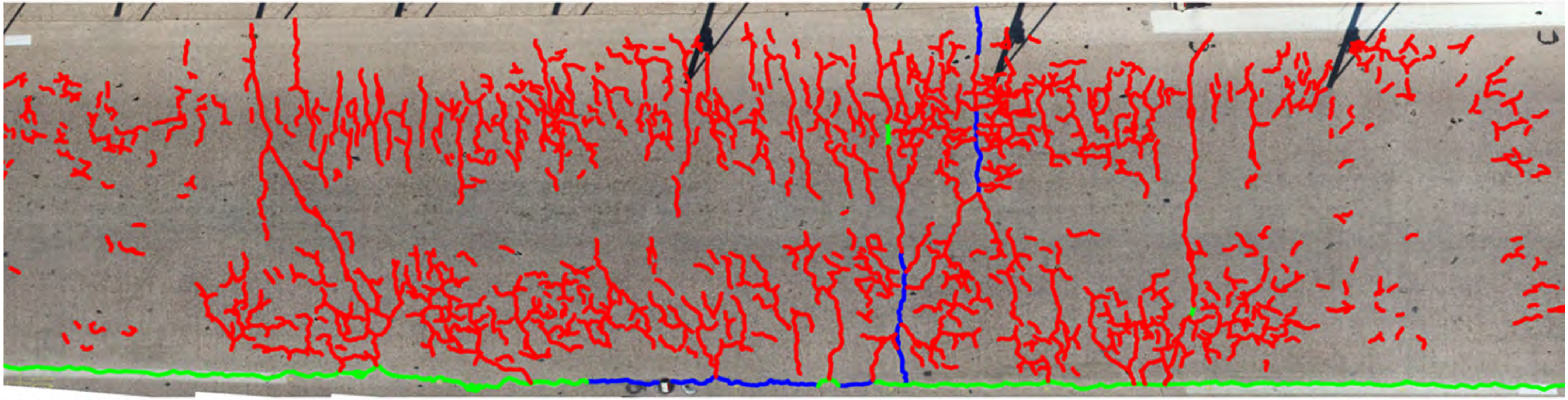


OSU (Fully Automated)

Section 17 /// Station 100-150



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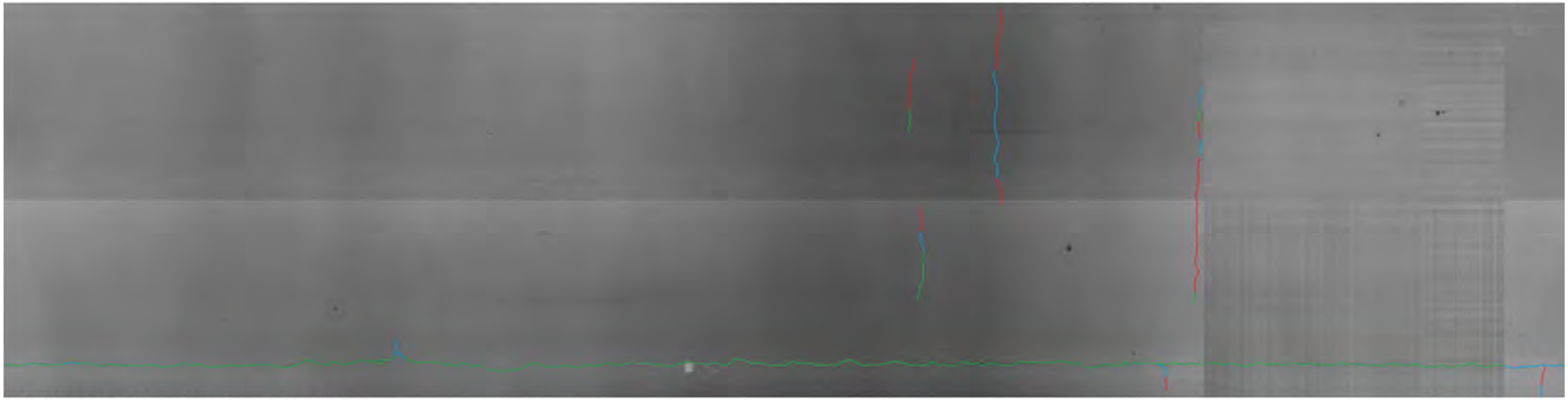
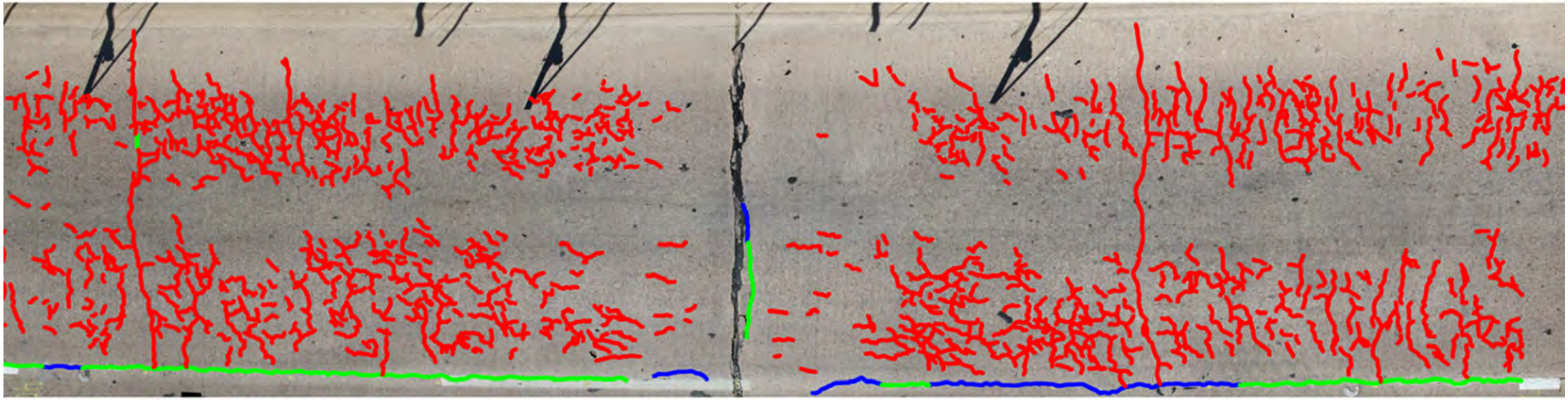


OSU (Fully Automated)

Section 17 /// Station 400-450



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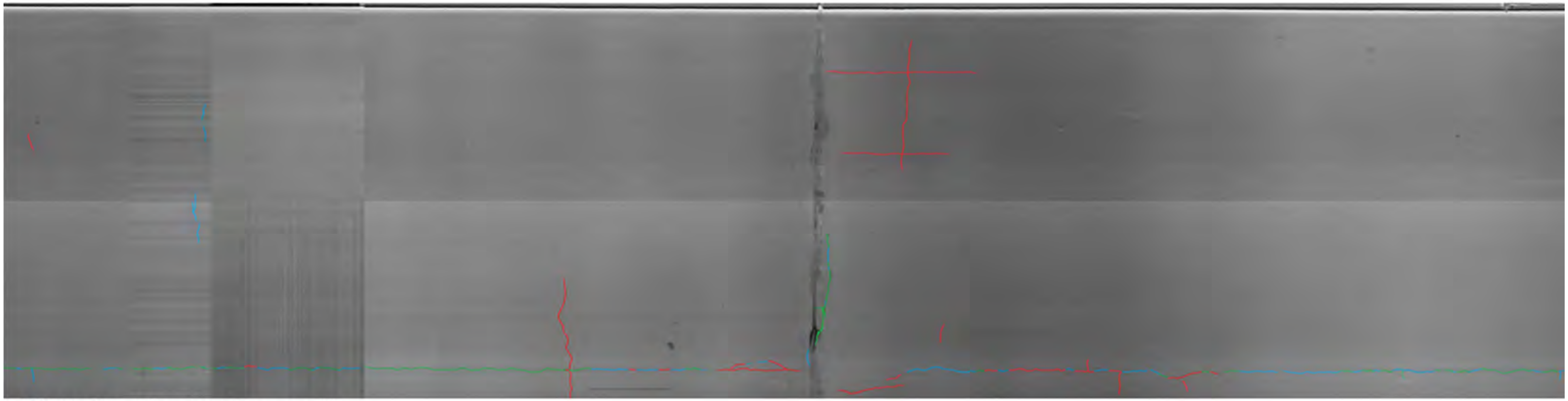
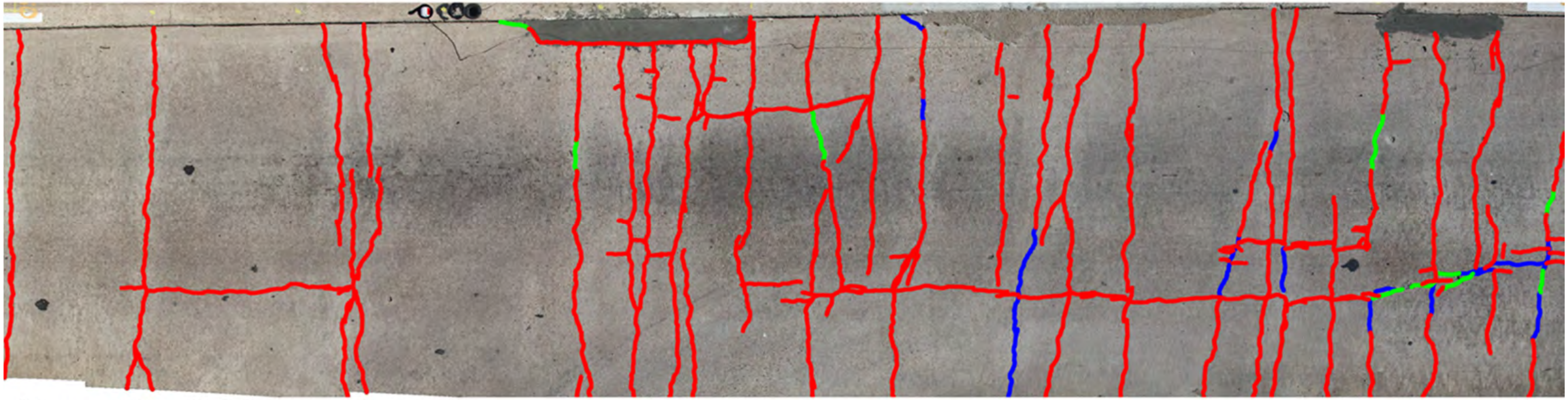


OSU (Fully Automated)

Section 19 /// Station 150-200



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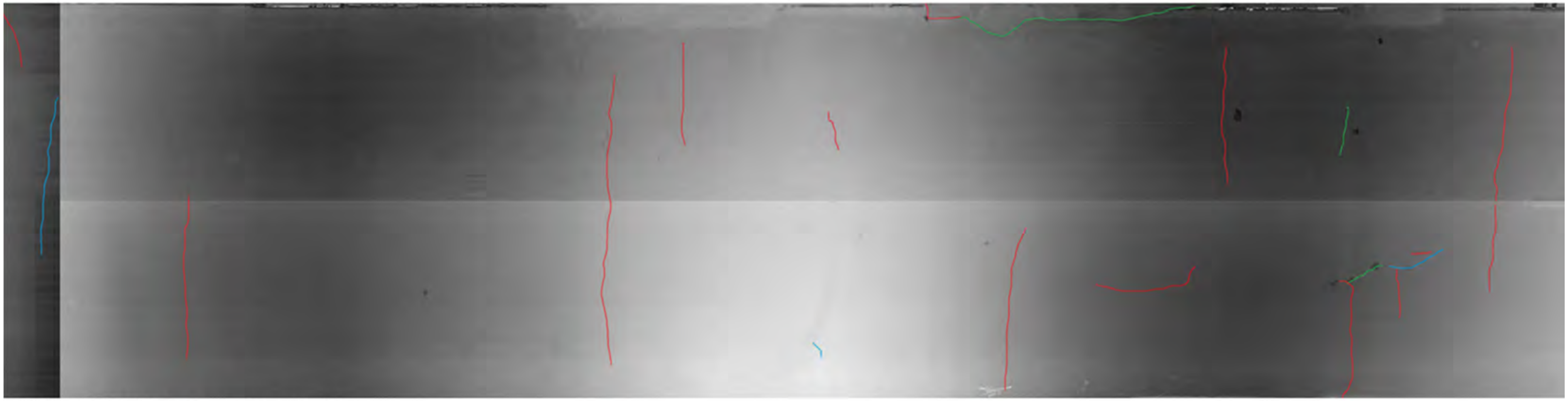
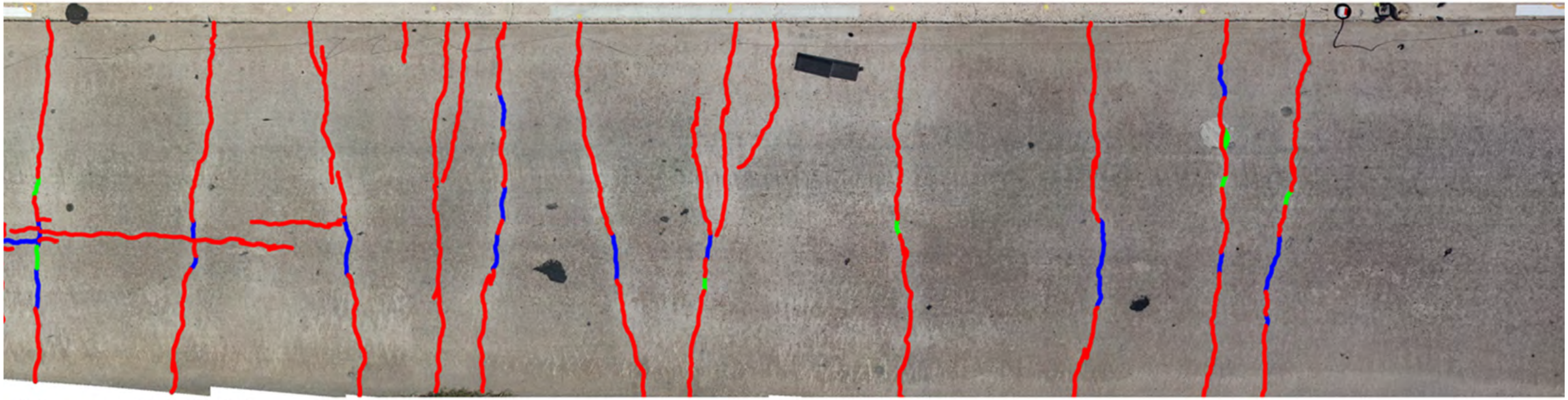


OSU (Fully Automated)

Section 19 /// Station 200-250



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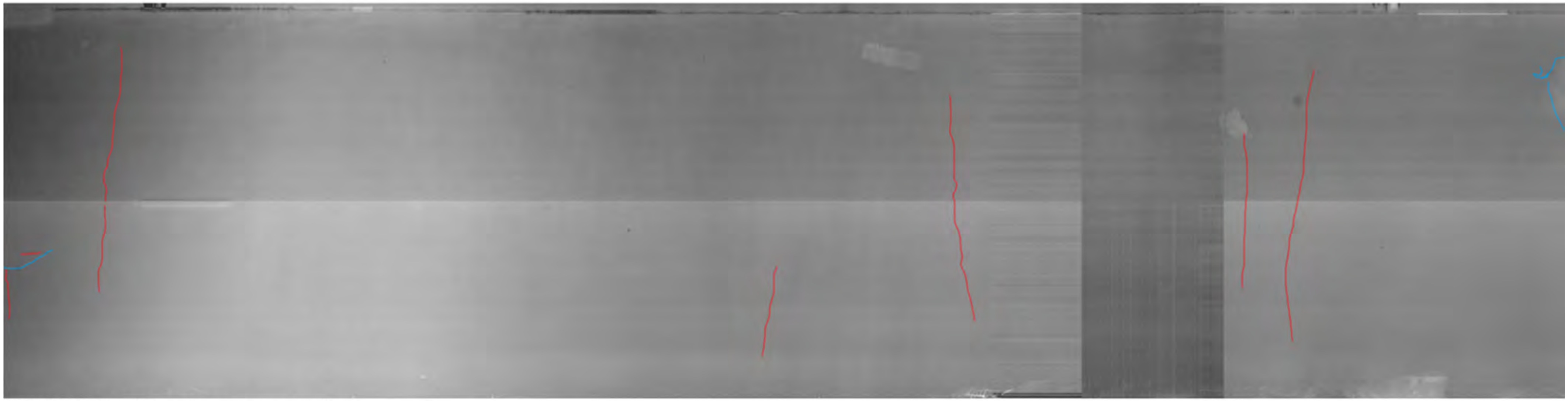
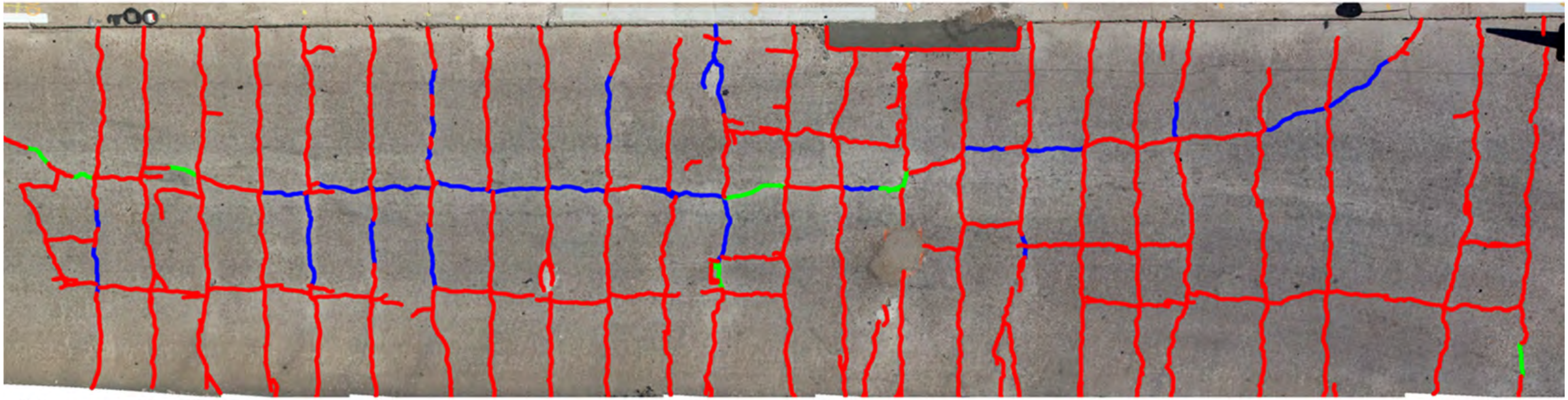
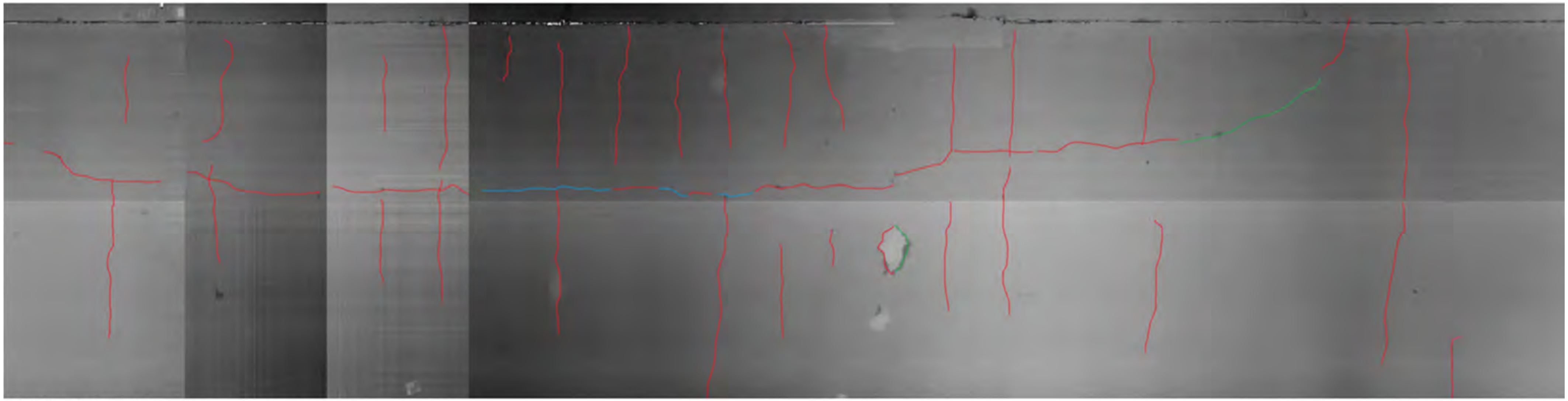


OSU (Fully Automated)

Section 19 /// Station 400-450



Manual Crack Map



OSU (Fully Automated)

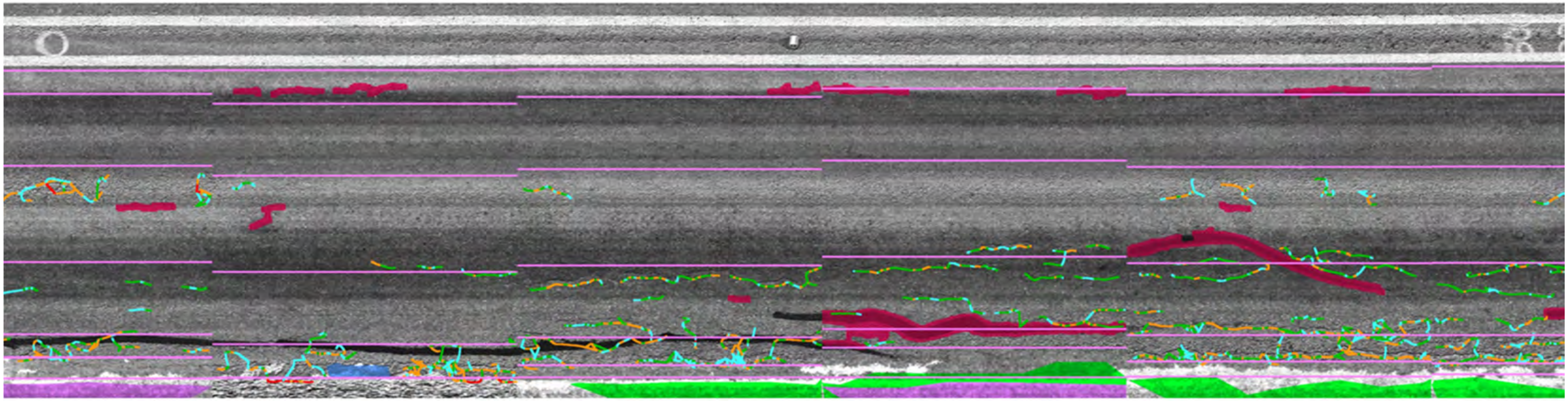
Appendix A.3

Crack Maps Comparison

Dynatest
fully automated

Section 2 /// Station 000-050

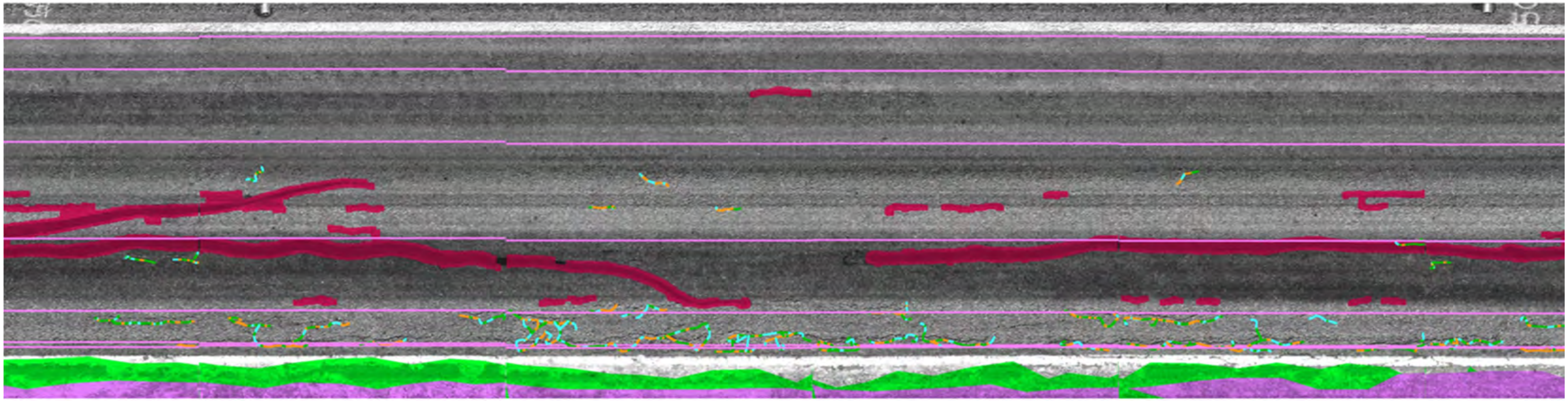
Manual Crack Map



Dynatest (Fully Automated)

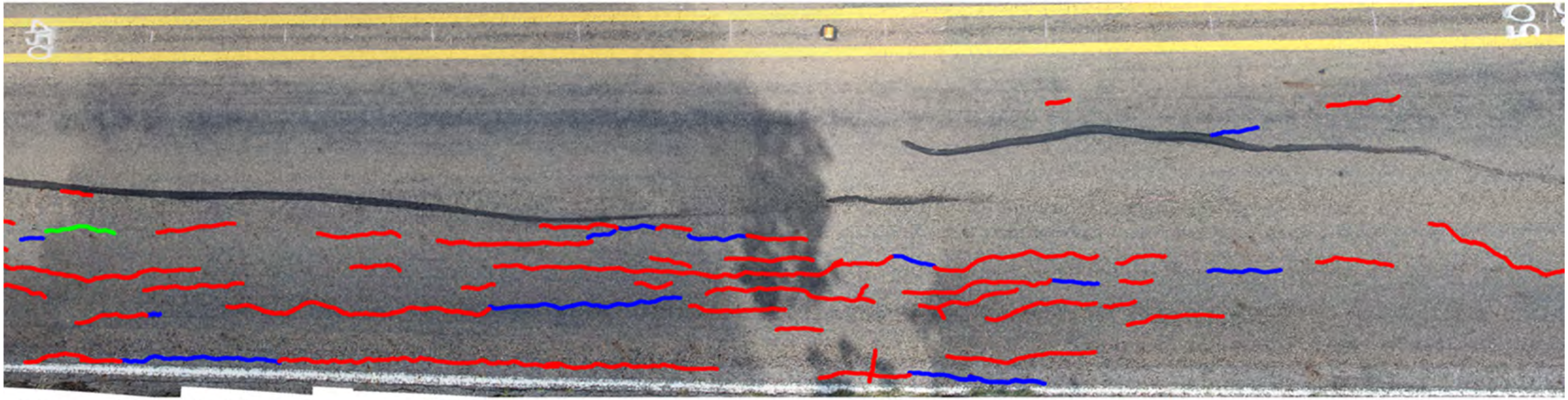
Section 2 /// Station 350-400

Manual Crack Map

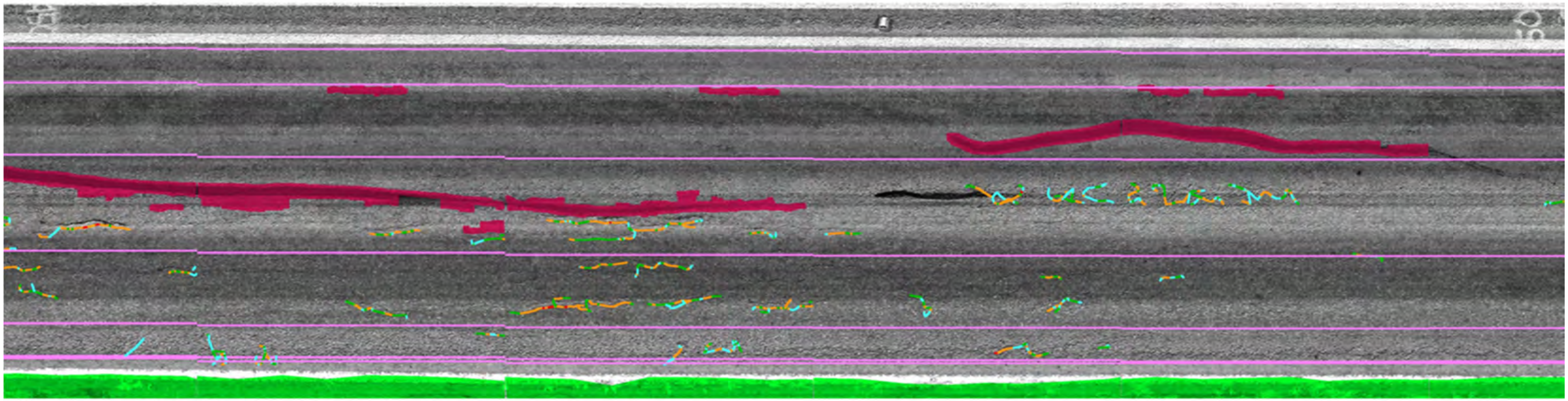


Dynatest (Fully Automated)

Section 2 /// Station 450-500

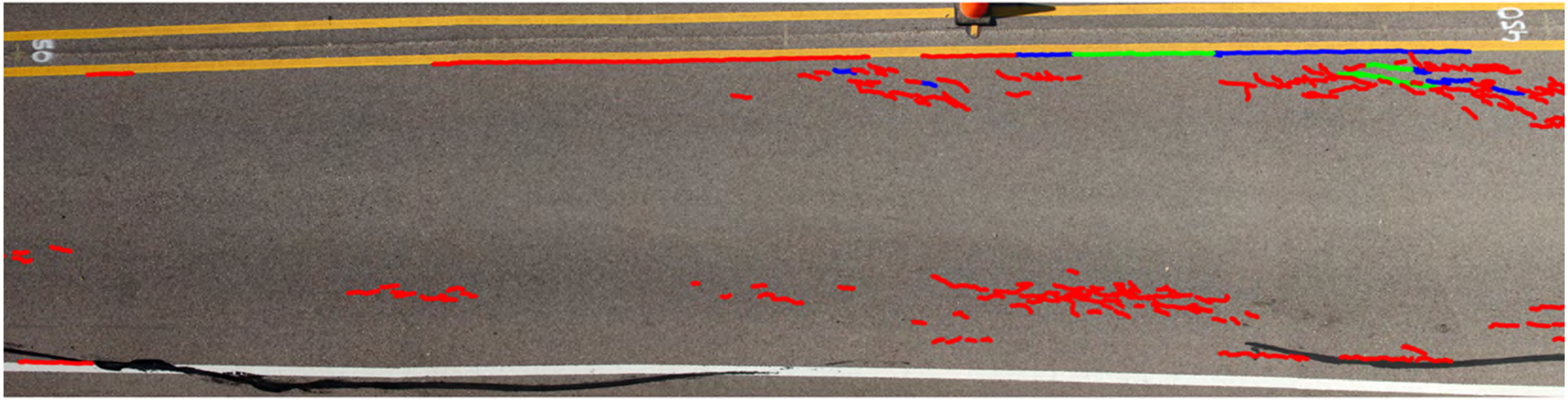


Manual Crack Map

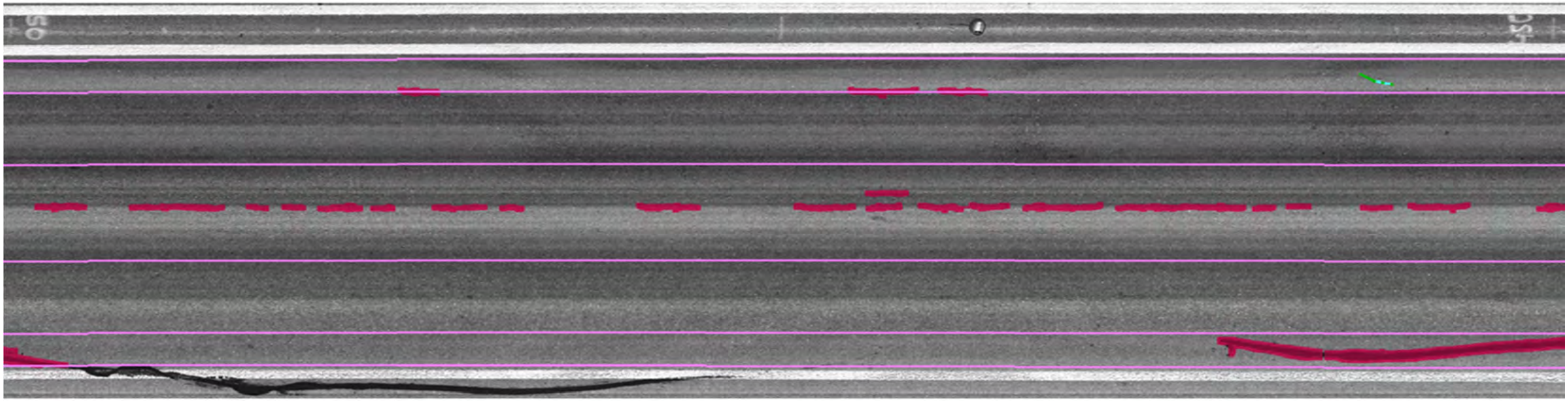


Dynatest (Fully Automated)

Section 4 /// Station 050-100



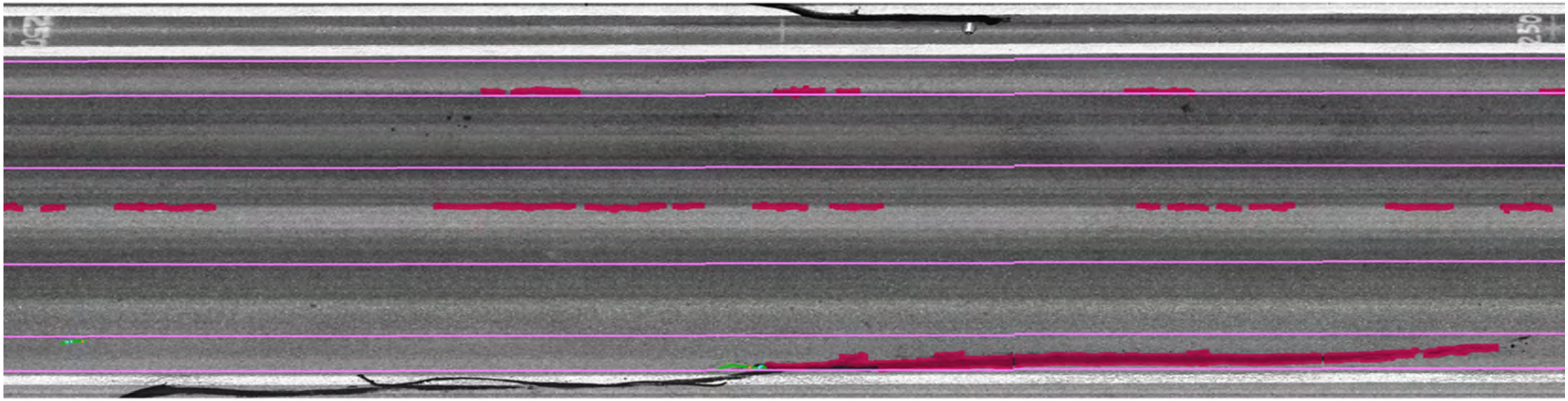
Manual Crack Map



Dynatest (Fully Automated)

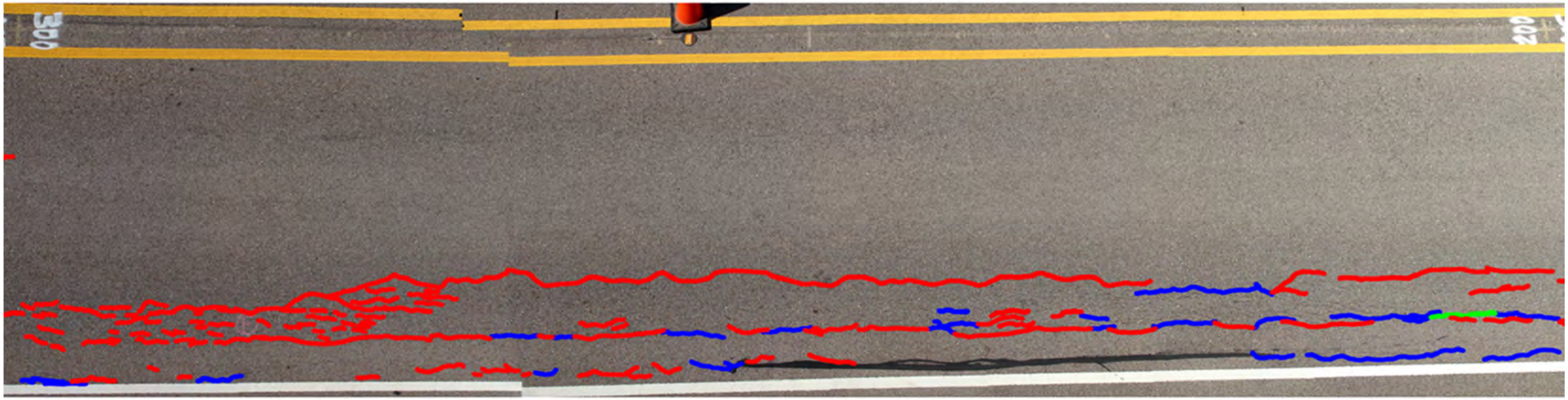
Section 4 /// Station 250-300

Manual Crack Map

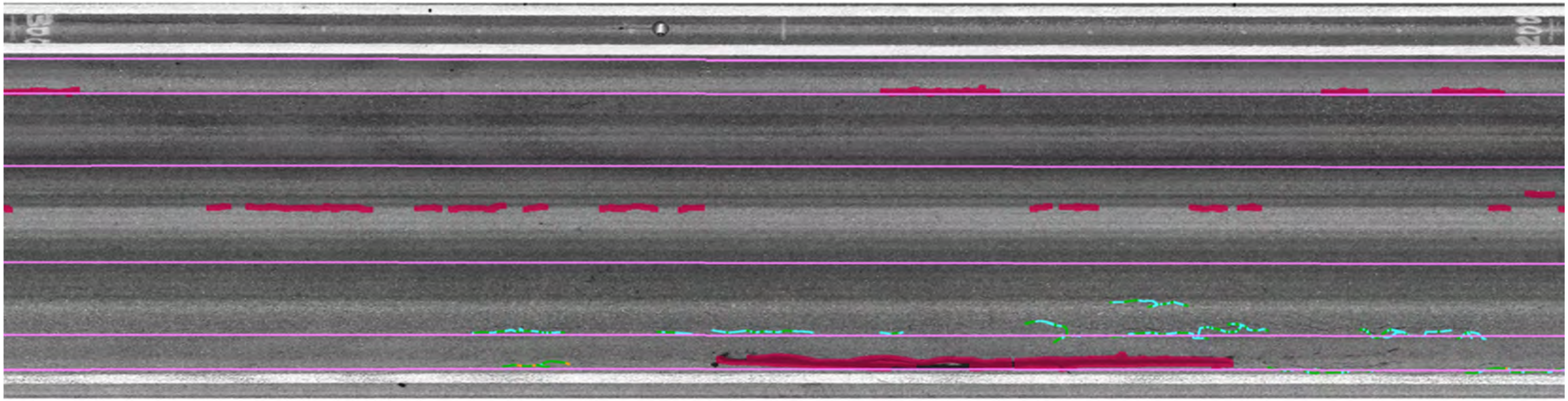


Dynatest (Fully Automated)

Section 4 /// Station 300-350



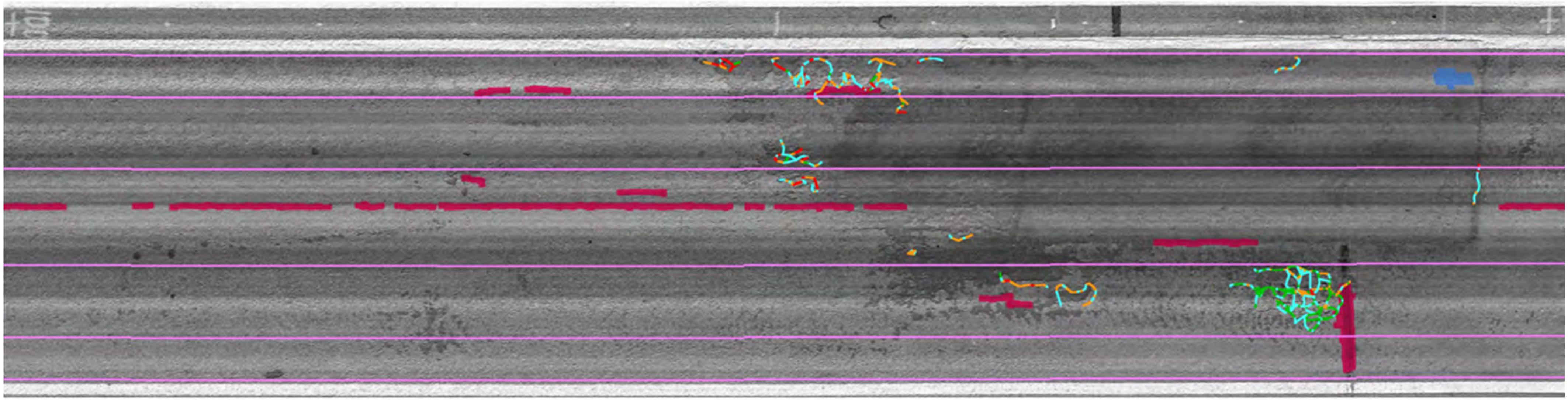
Manual Crack Map



Dynatest (Fully Automated)

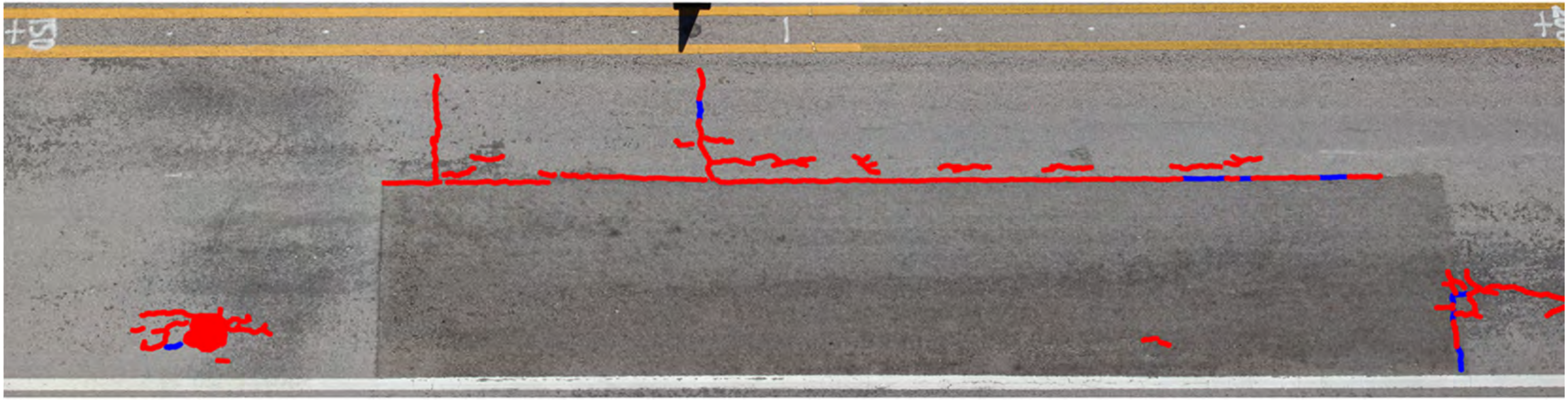
Section 6 /// Station 100-150

Manual Crack Map

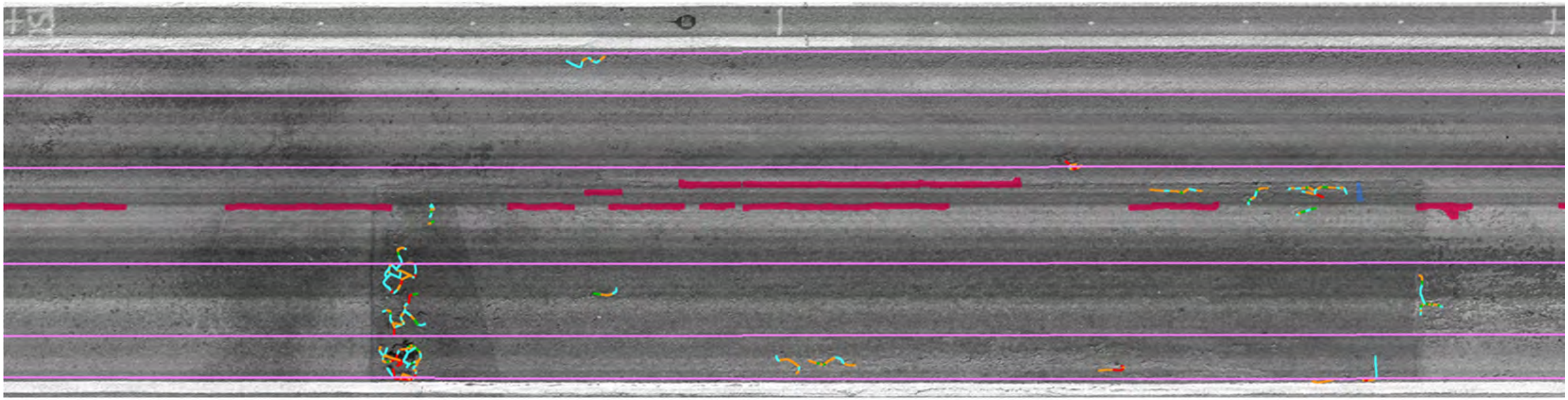


Dynatest (Fully Automated)

Section 6 /// Station 150-200



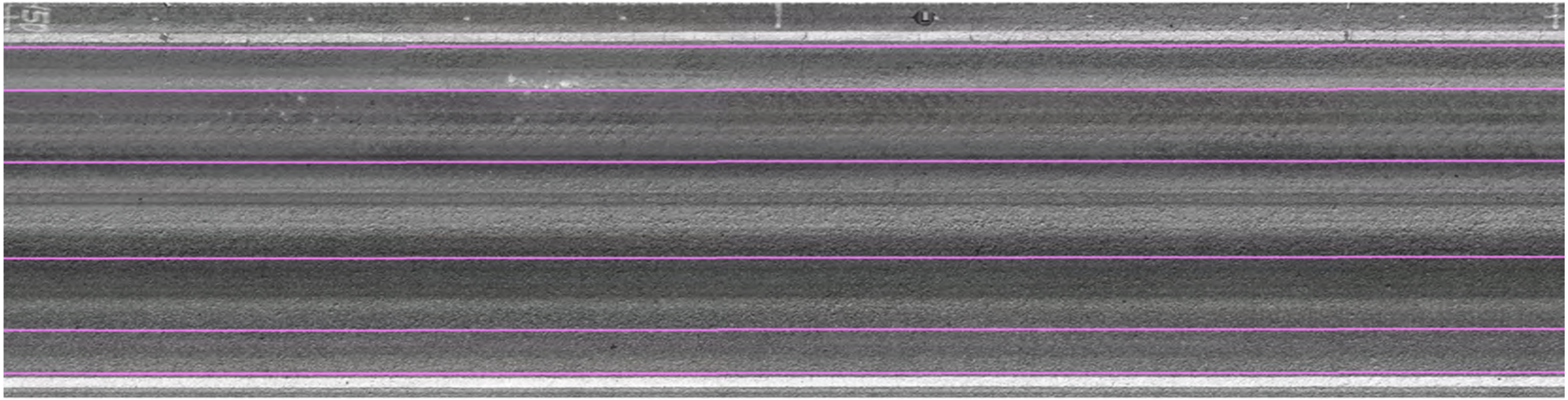
Manual Crack Map



Dynatest (Fully Automated)

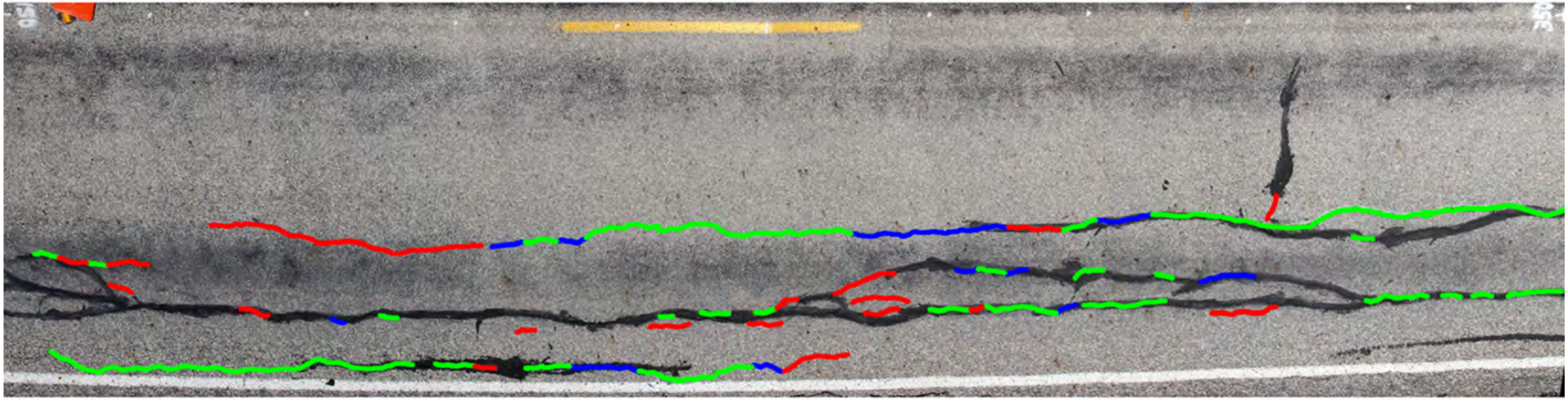
Section 6 /// Station 450-500

Manual Crack Map

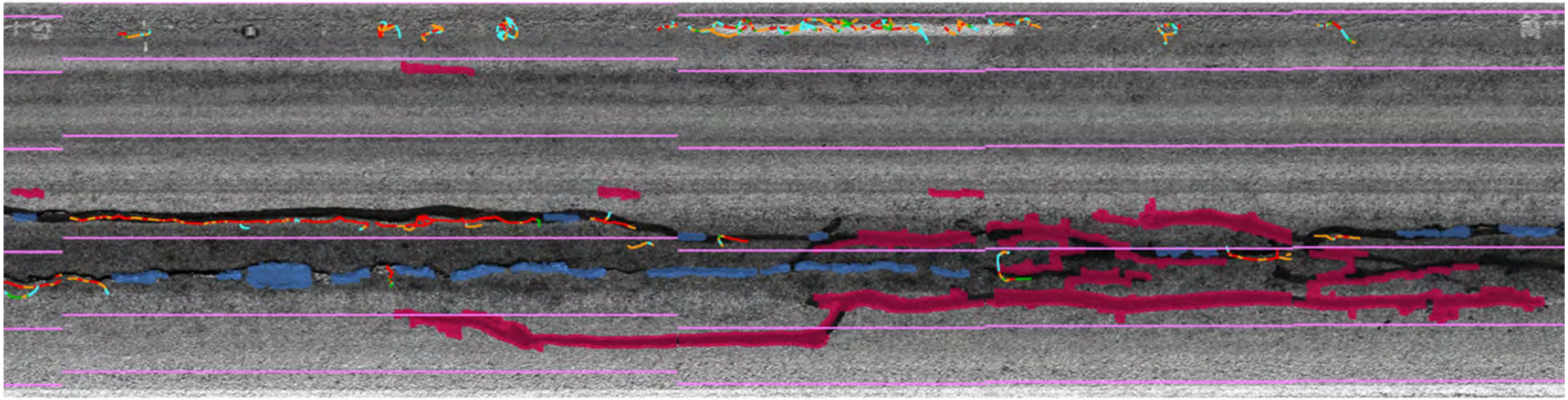


Dynatest (Fully Automated)

Section 9 /// Station 150-200

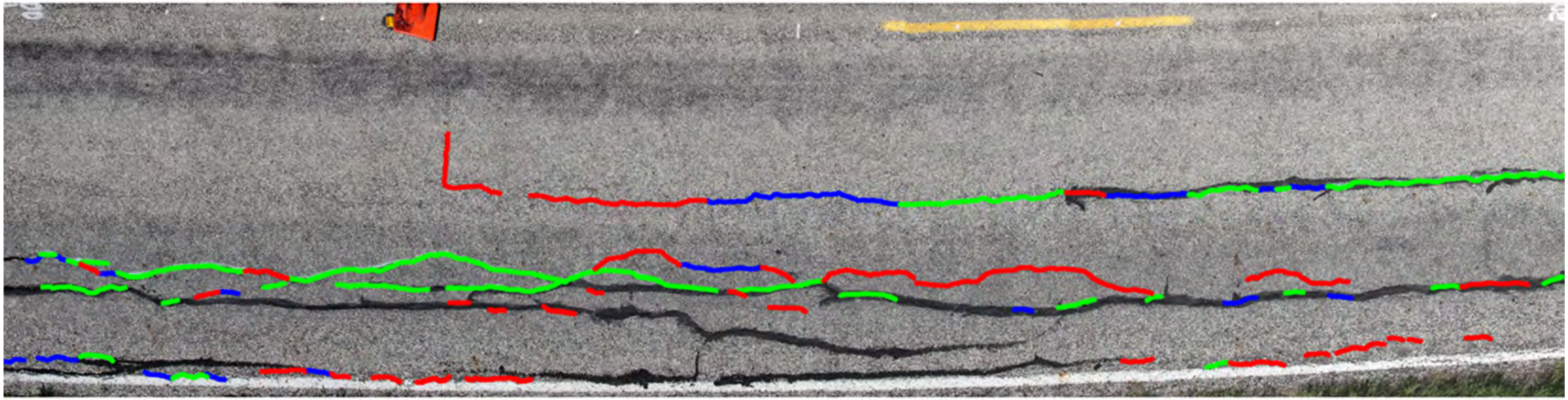


Manual Crack Map



Dynatest (Fully Automated)

Section 9 /// Station 300-350



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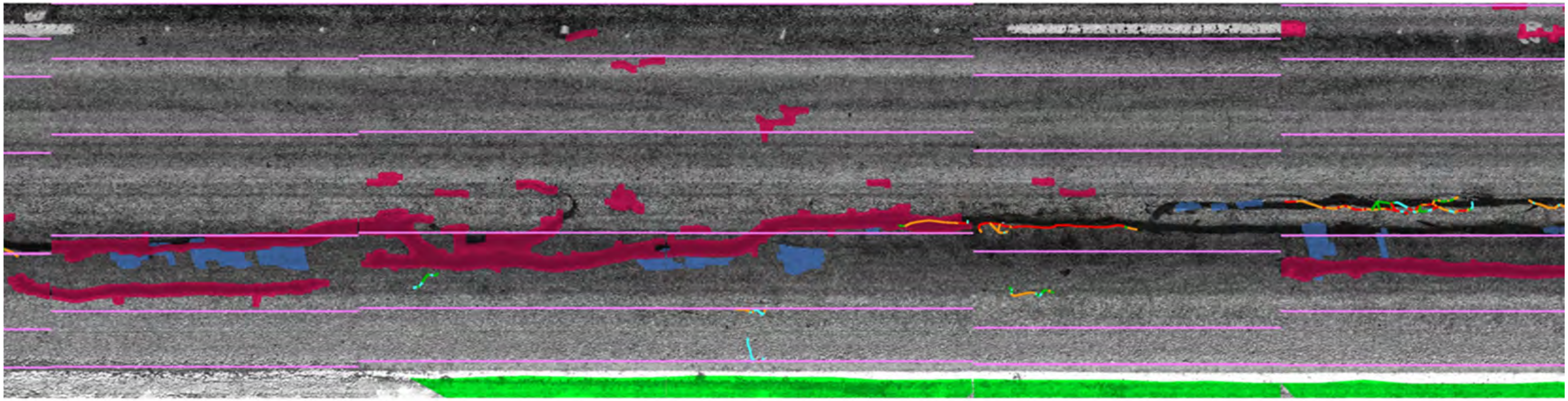
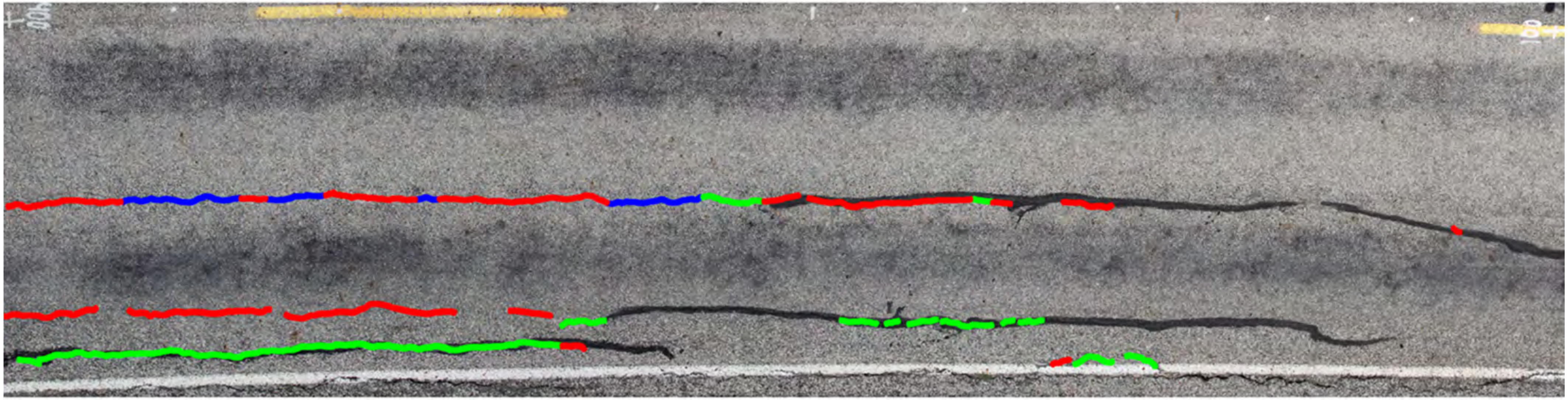
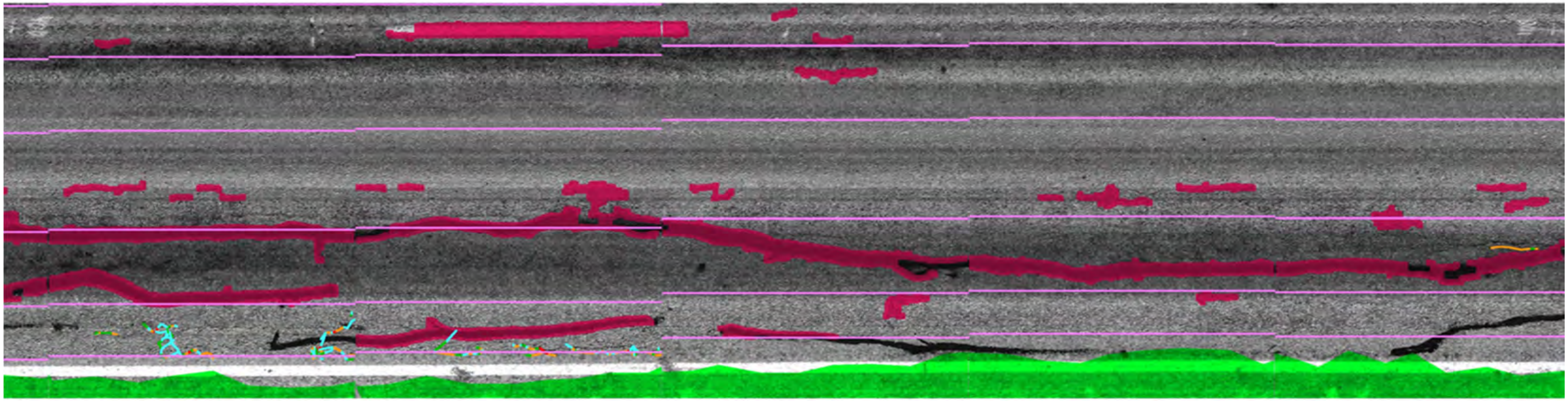


Dynatest (Fully Automated)

Section 9 /// Station 400-450

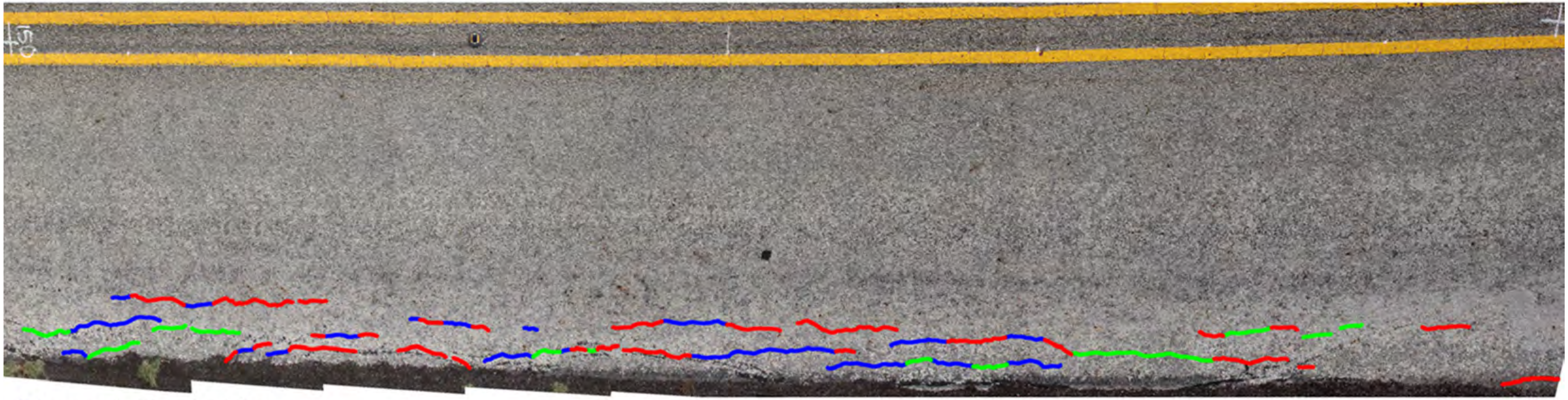


Manual Crack Map

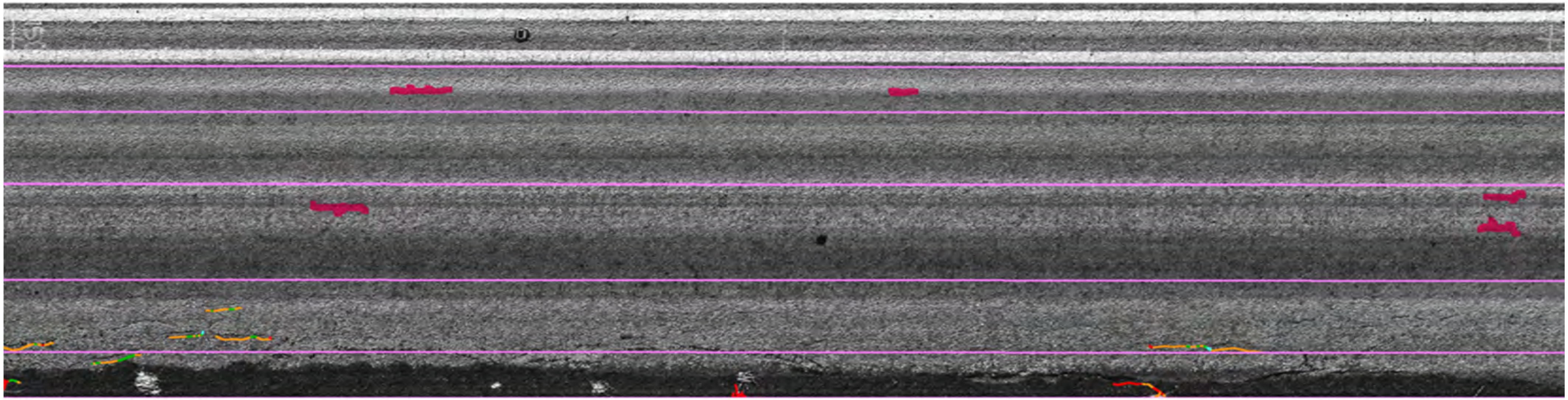


Dynatest (Fully Automated)

Section 10/// Station 150-200

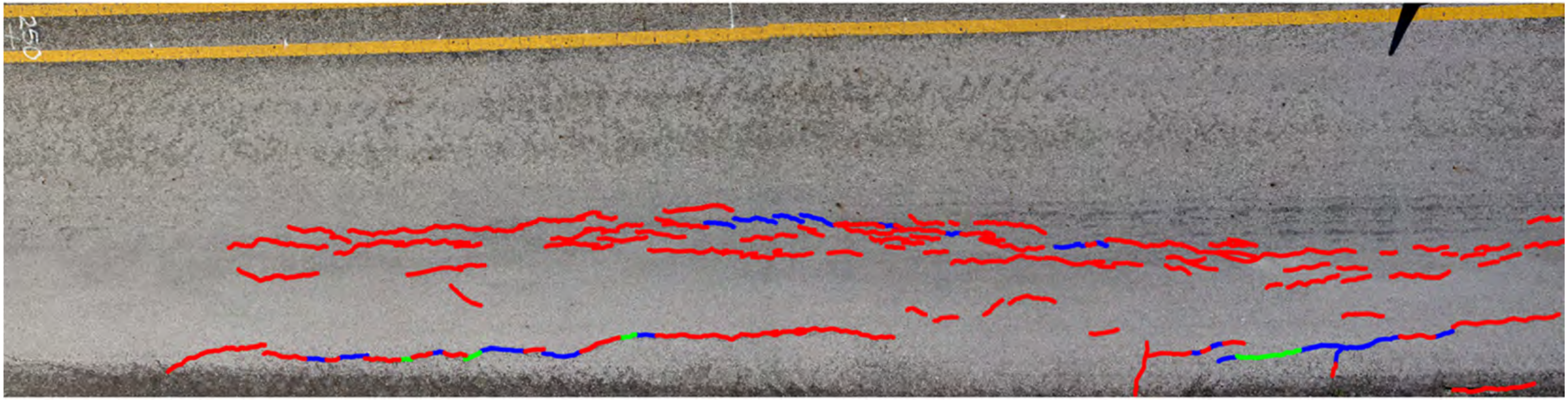


Manual Crack Map

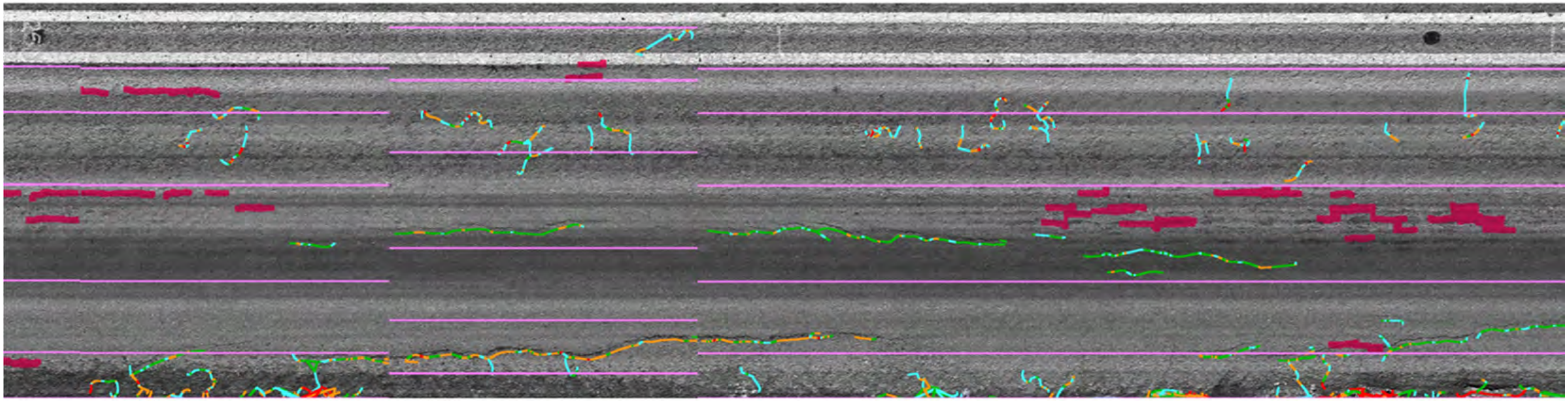


Dynatest (Fully Automated)

Section 10/// Station 250-300



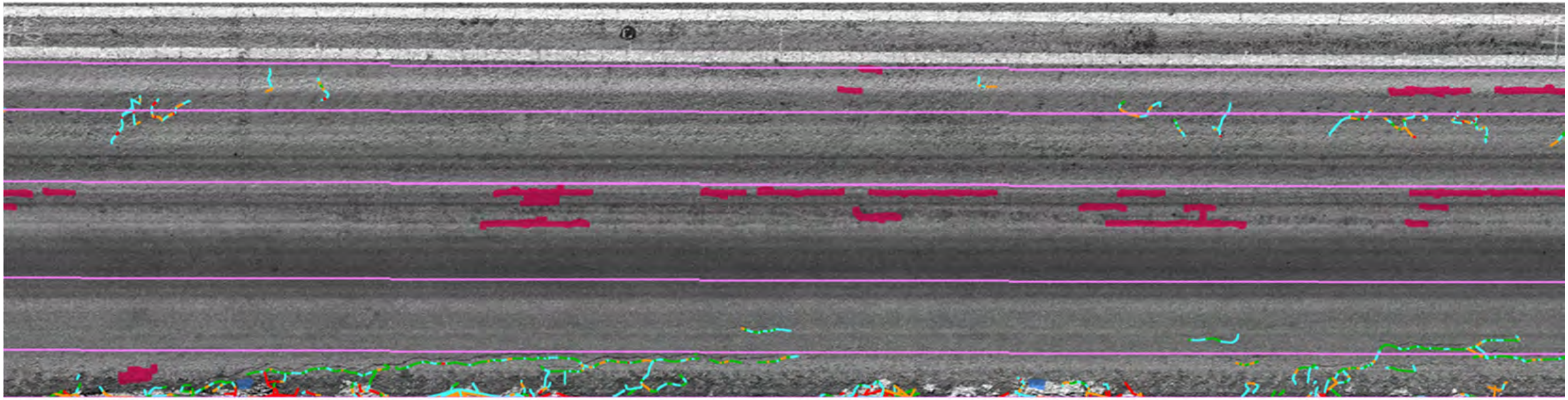
Manual Crack Map



Dynatest (Fully Automated)

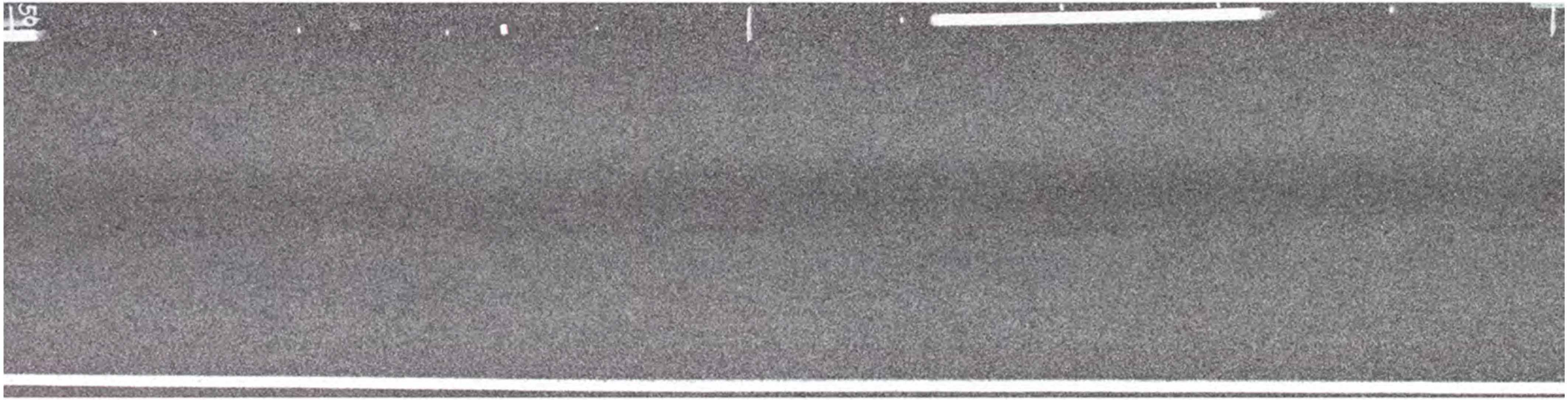
Section 10 /// Station 400-450

Manual Crack Map

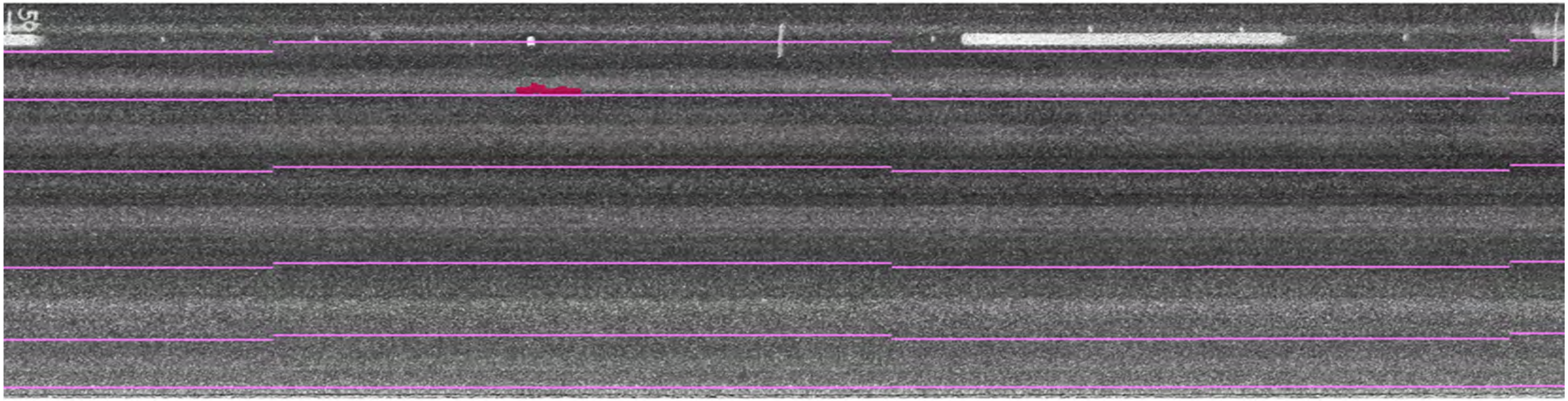


Dynatest (Fully Automated)

Section 11 /// Station 050-100

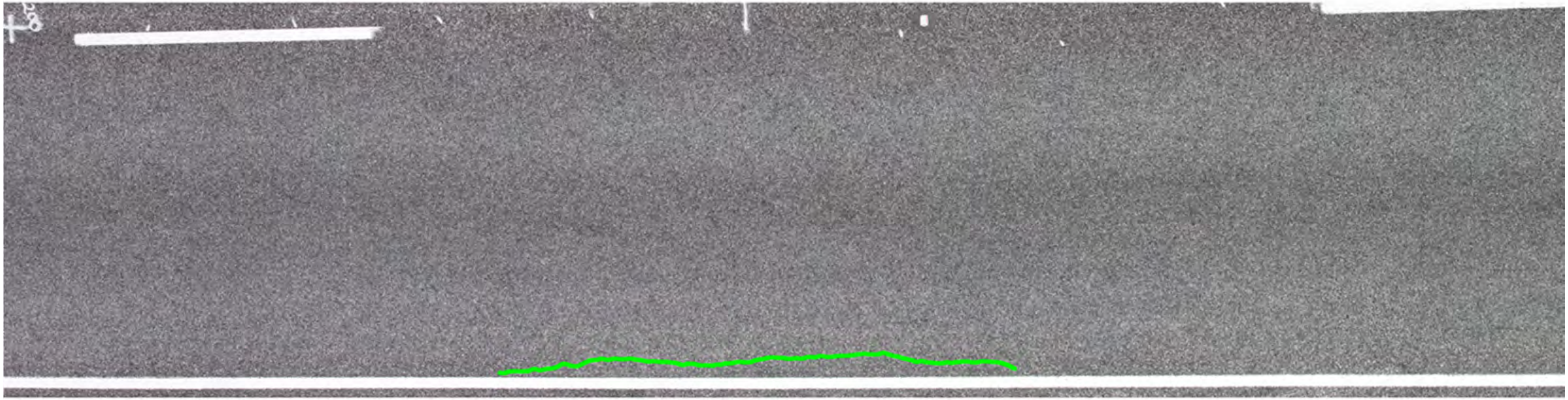


Manual Crack Map

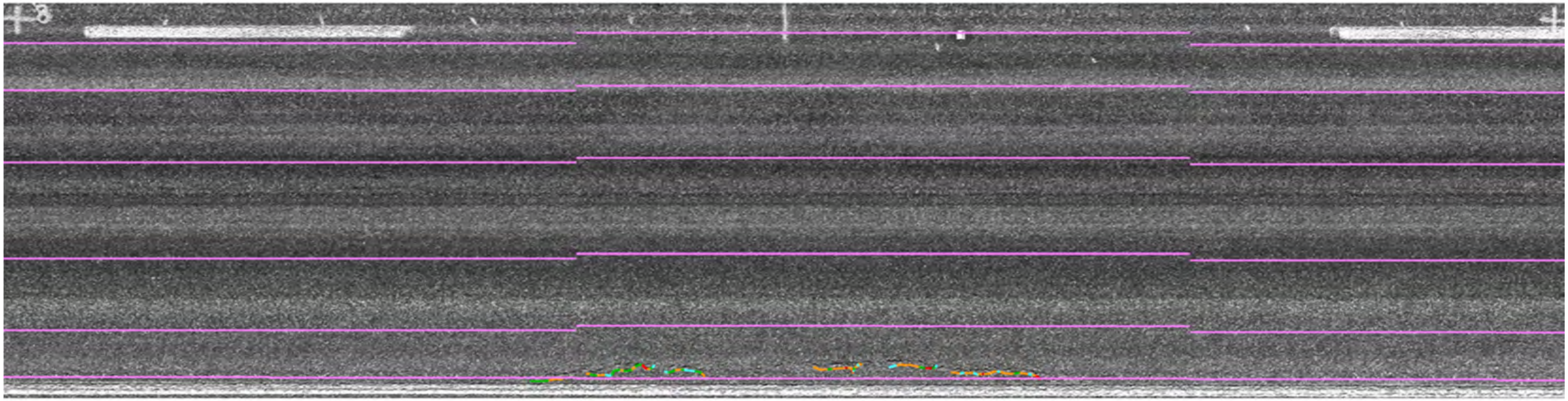


Dynatest (Fully Automated)

Section 11 /// Station 200-250

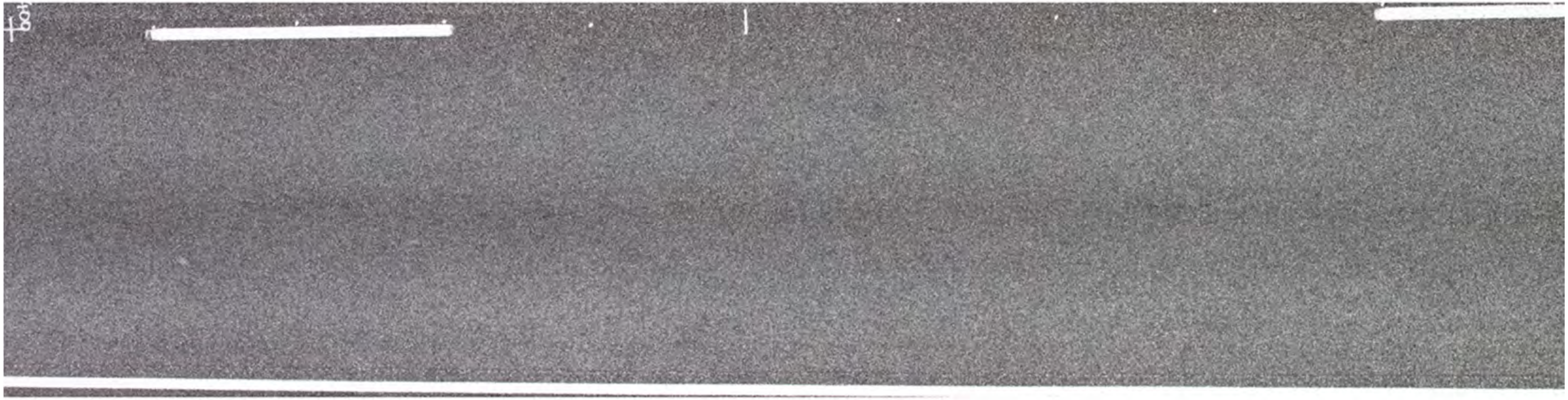


Manual Crack Map



Dynatest (Fully Automated)

Section 11 /// Station 400-450



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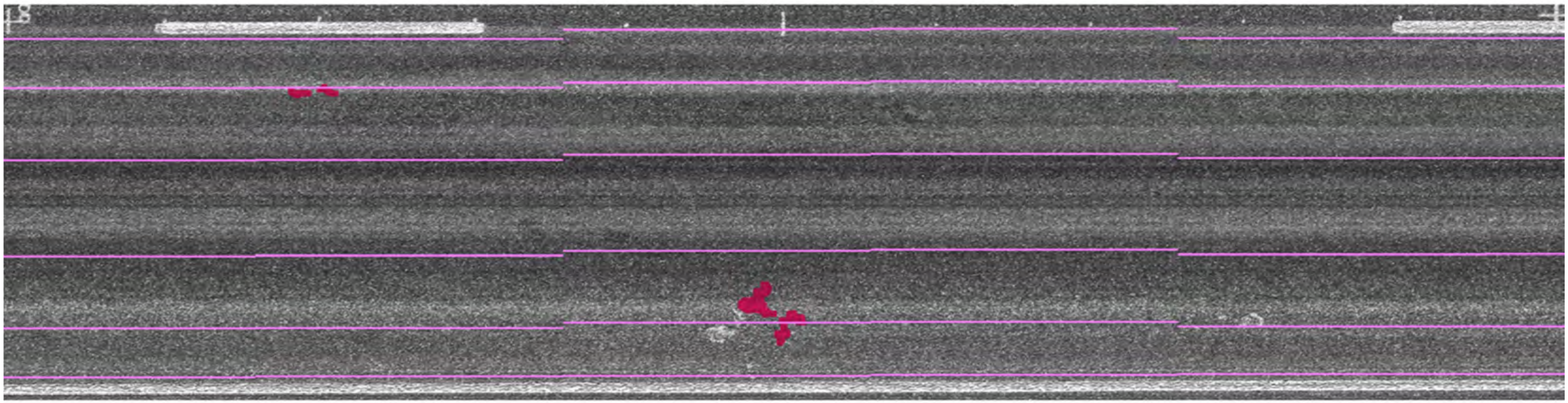
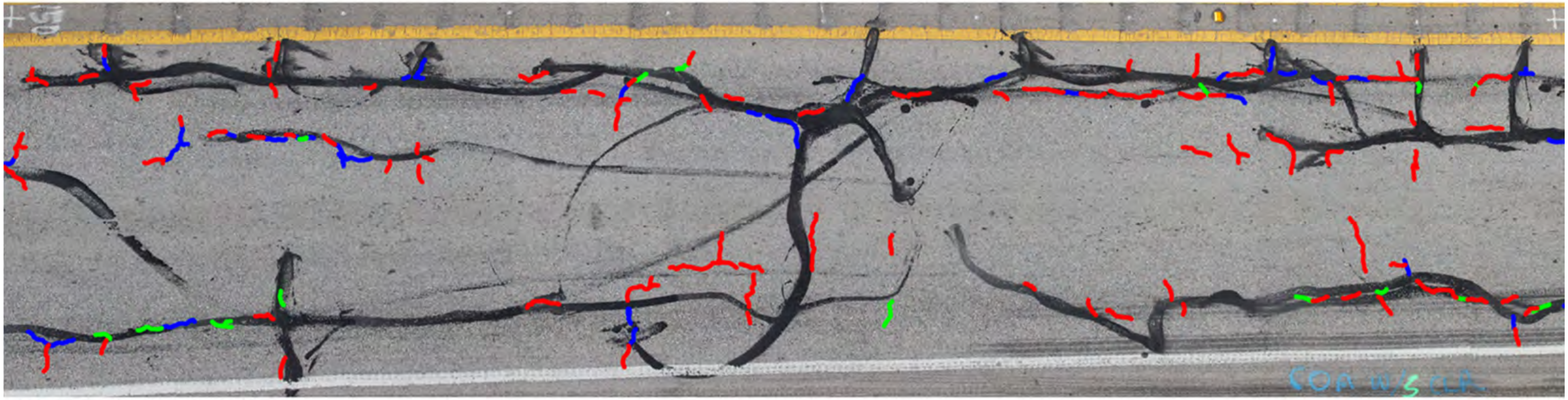
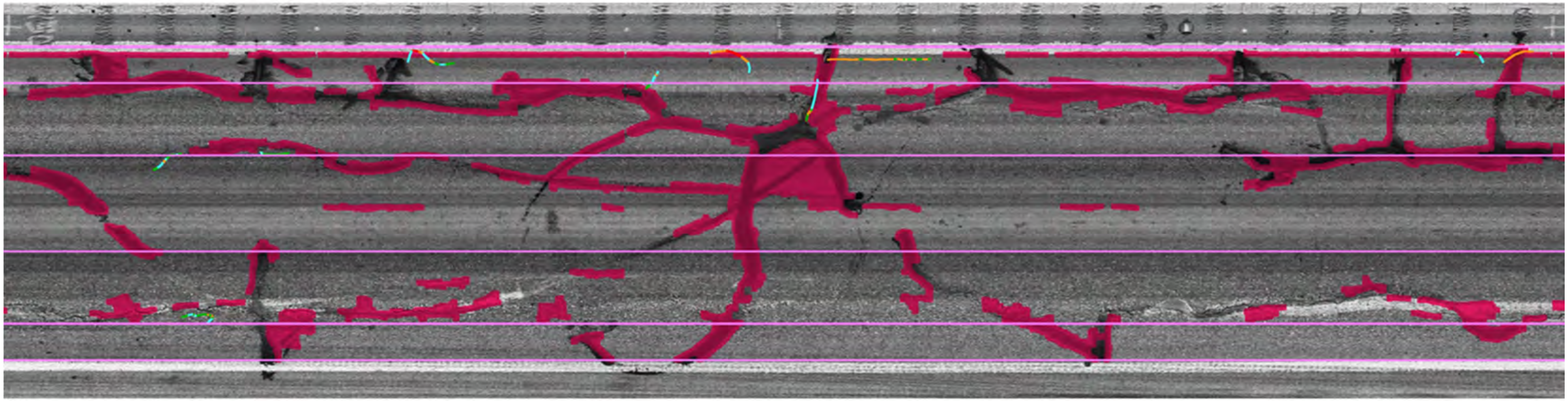


Dynatest (Fully Automated)

Section 12 /// Station 150-200



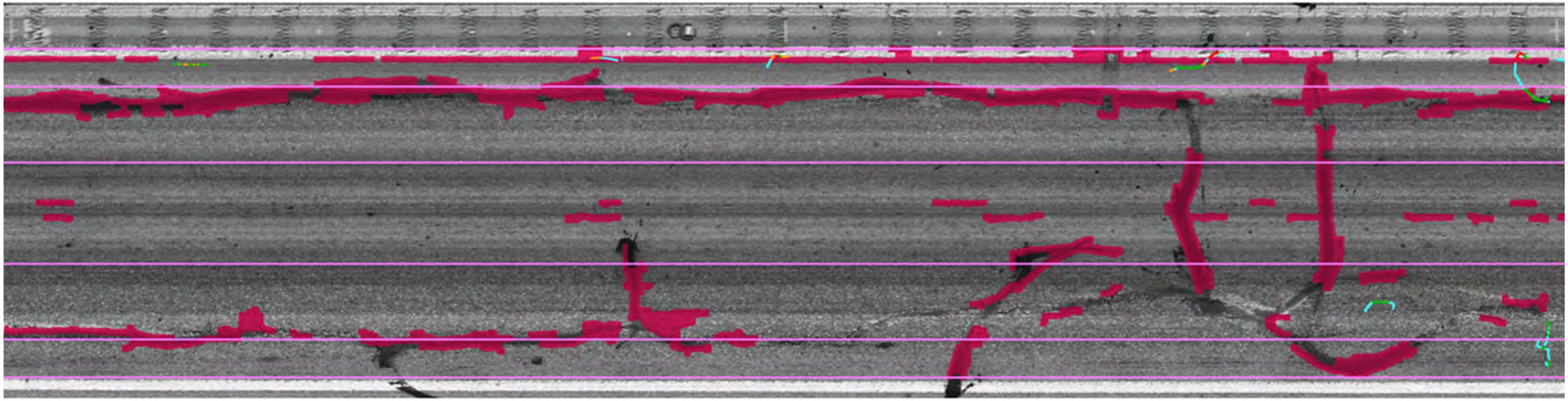
Manual Crack Map



Dynatest (Fully Automated)

Section 12 /// Station 250-300

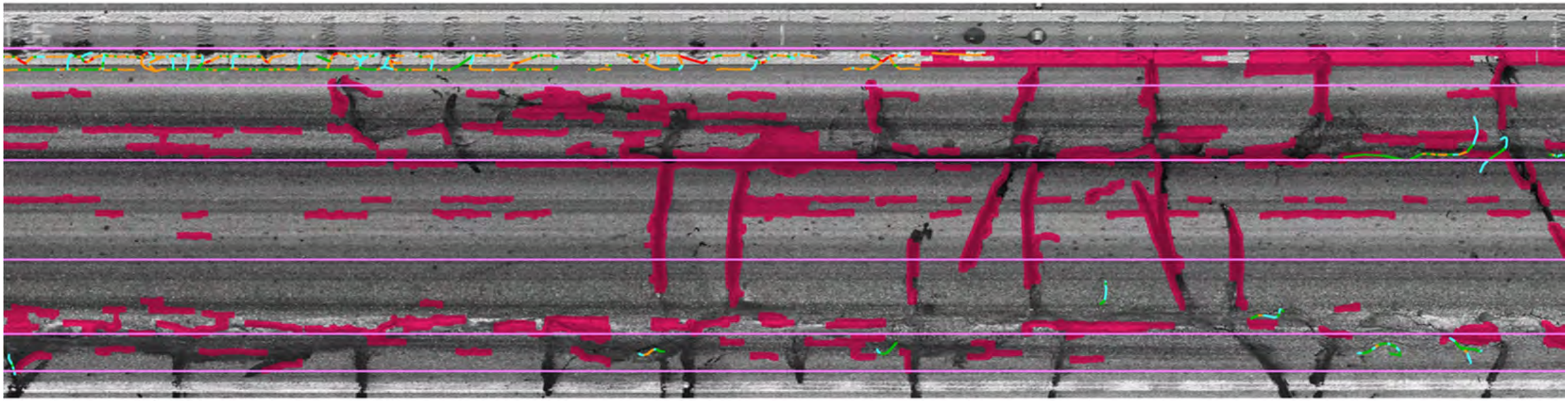
Manual Crack Map



Dynatest (Fully Automated)

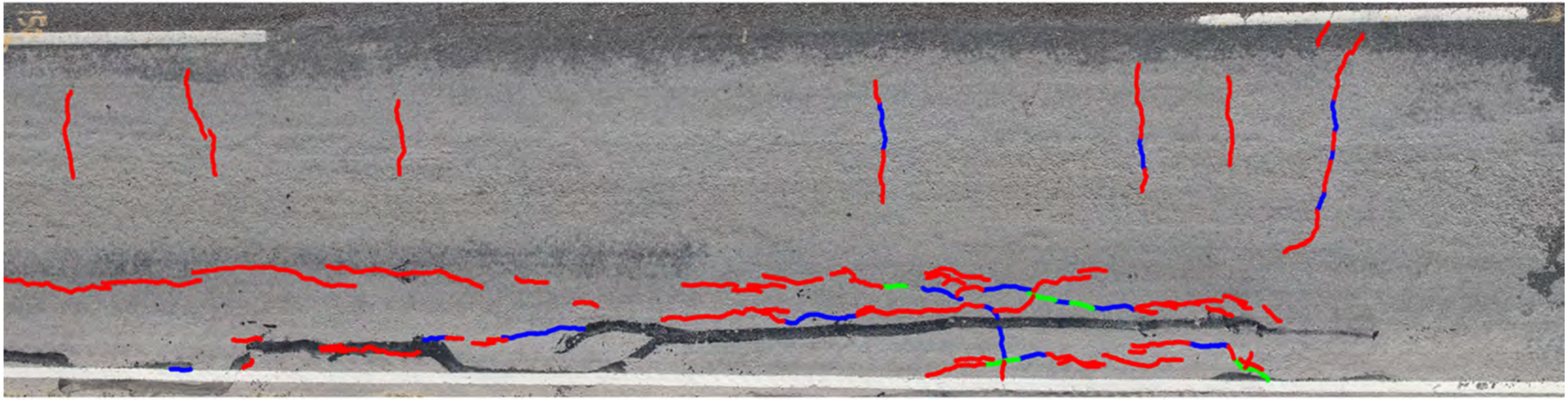
Section 12 /// Station 450-500

Manual Crack Map

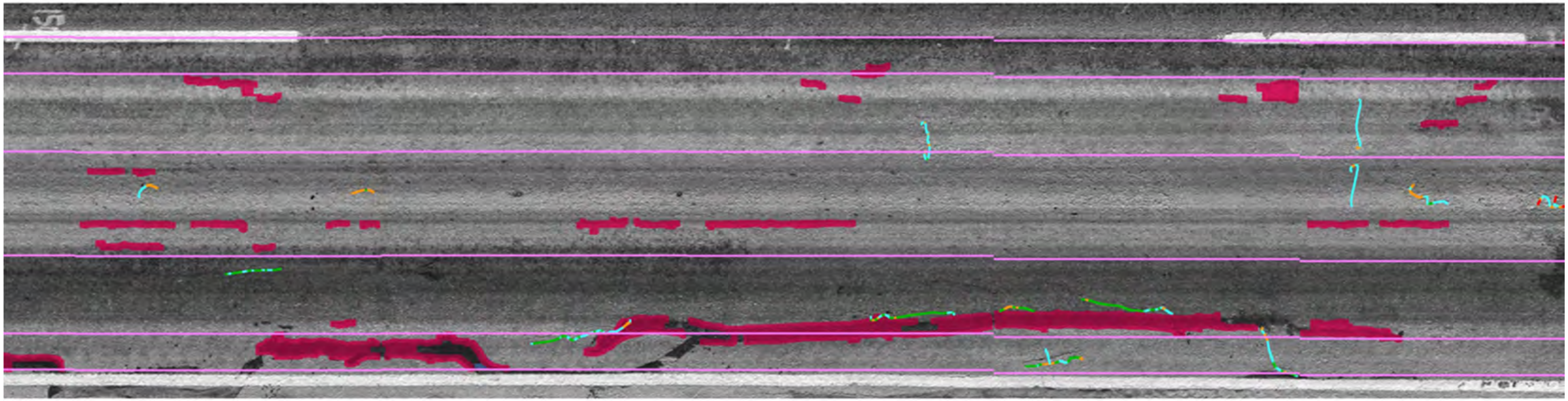


Dynatest (Fully Automated)

Section 13 /// Station 150-200

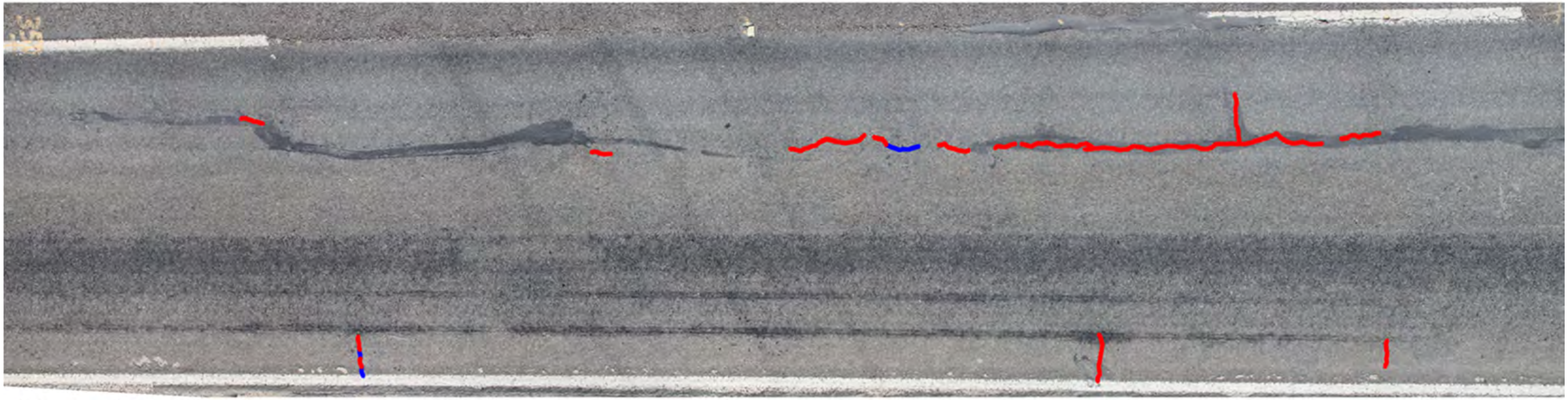


Manual Crack Map

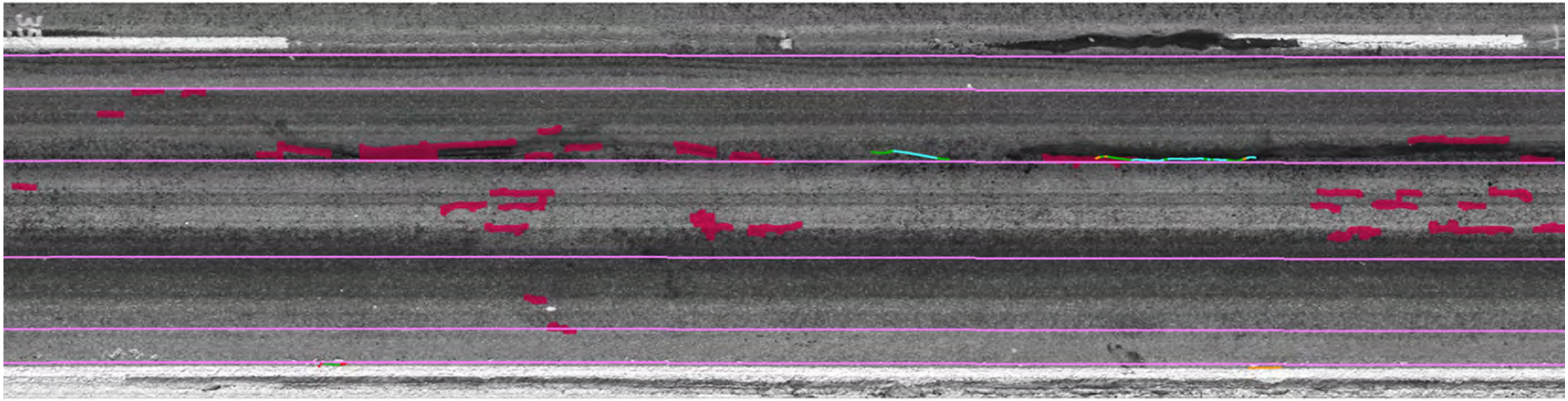


Dynatest (Fully Automated)

Section 13 /// Station 350-400

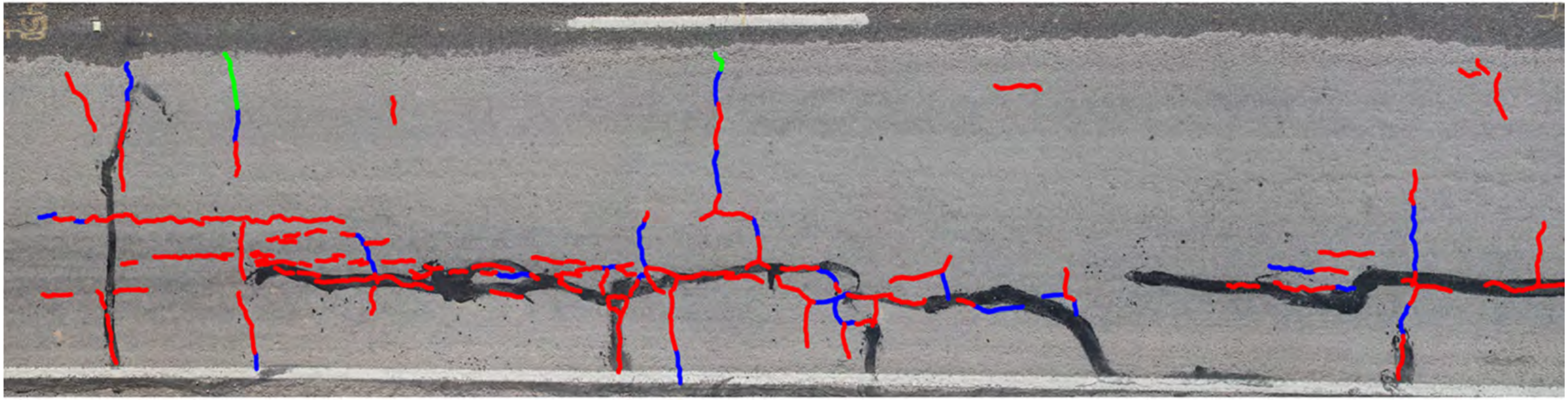


Manual Crack Map

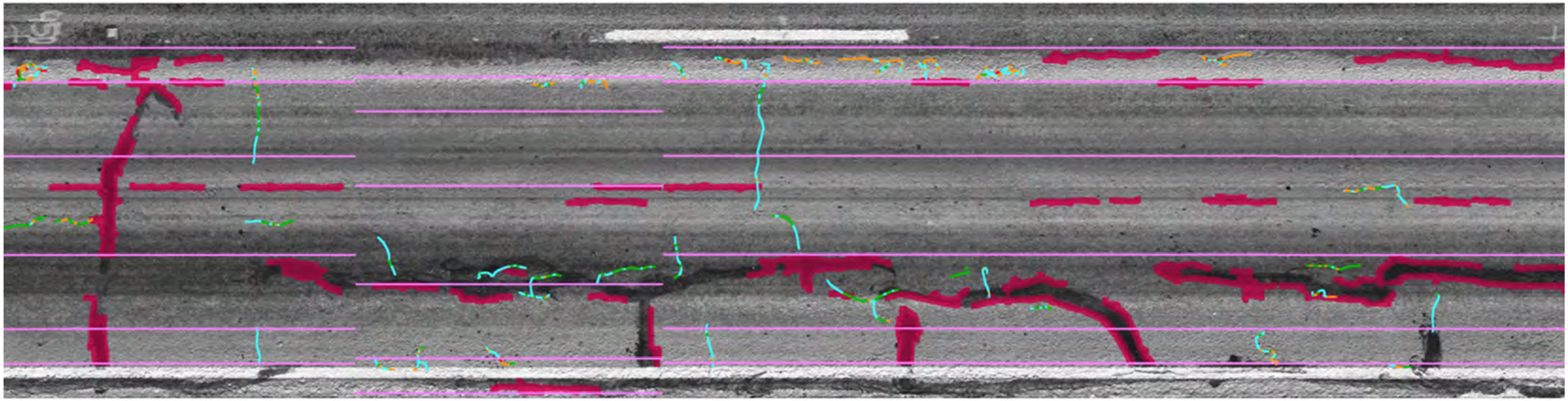


Dynatest (Fully Automated)

Section 13 /// Station 450-500

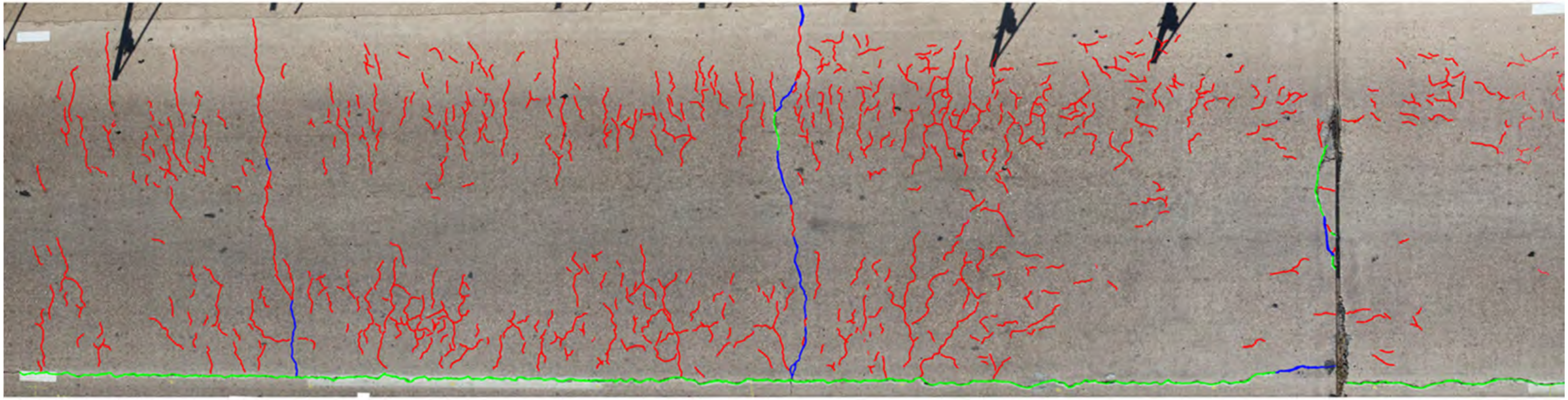


Manual Crack Map

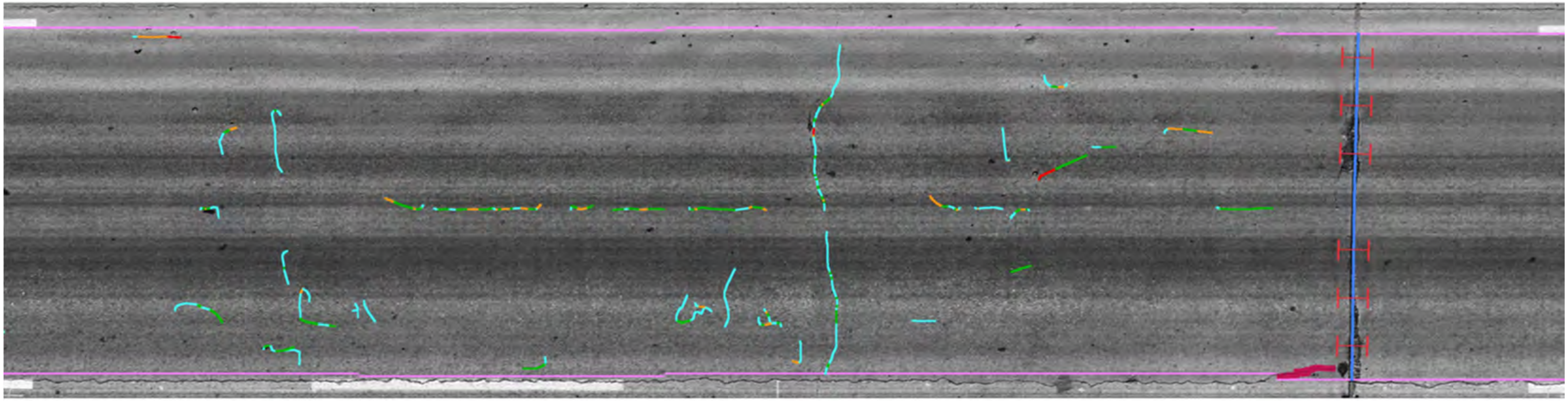


Dynatest (Fully Automated)

Section 17 /// Station 050-100

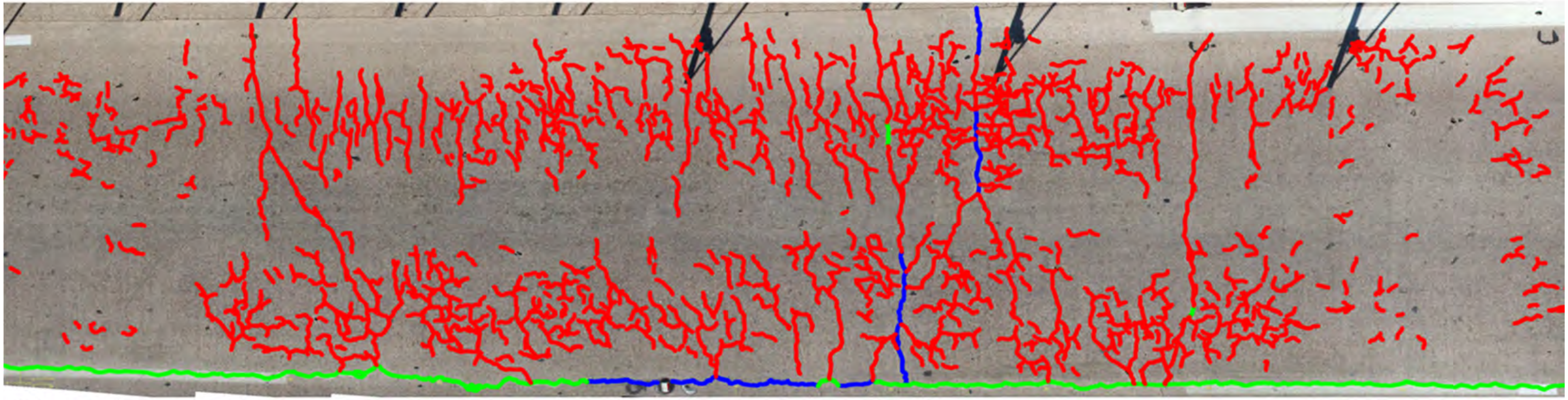


Manual Crack Map

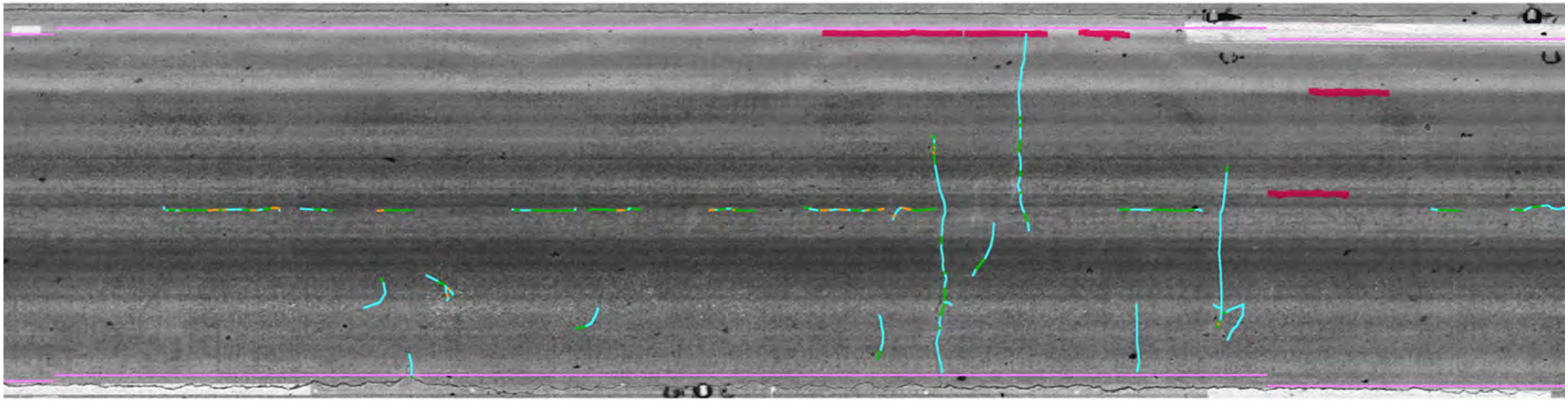


Dynatest (Fully Automated)

Section 17 /// Station 100-150

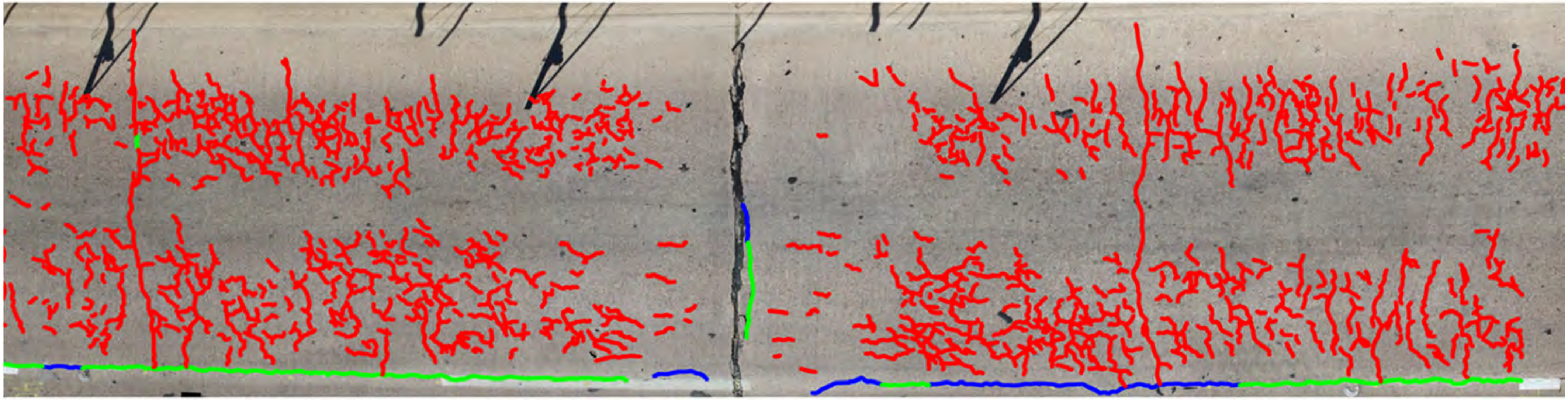


Manual Crack Map

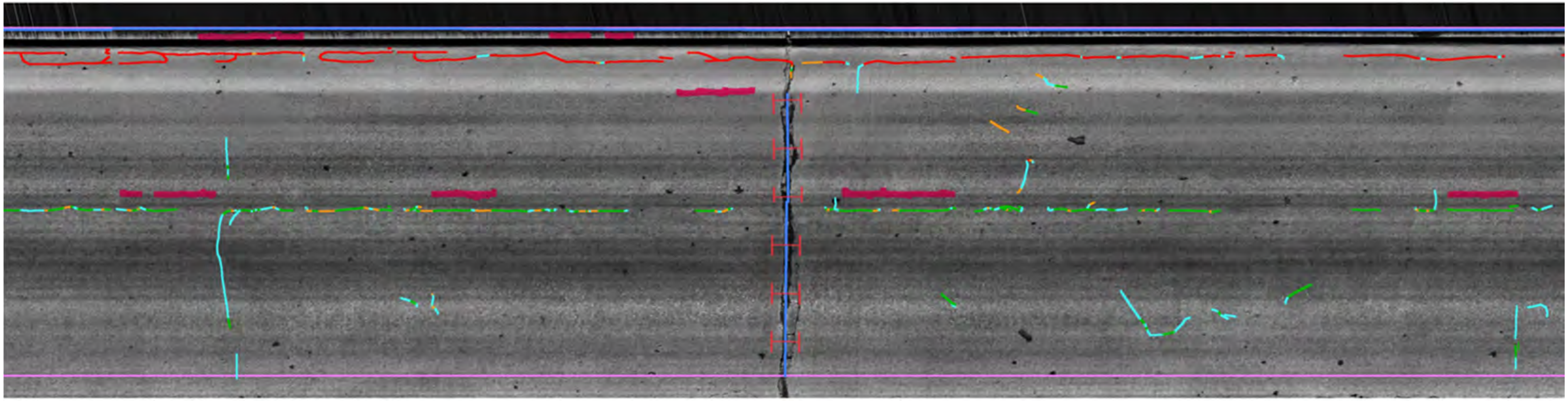


Dynatest (Fully Automated)

Section 17 /// Station 400-450

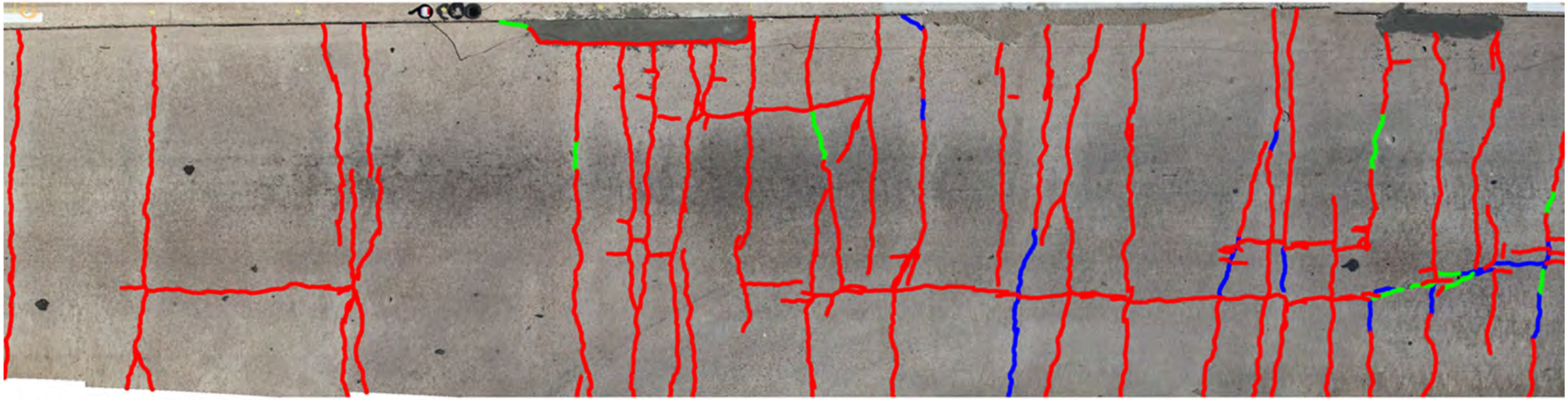


Manual Crack Map

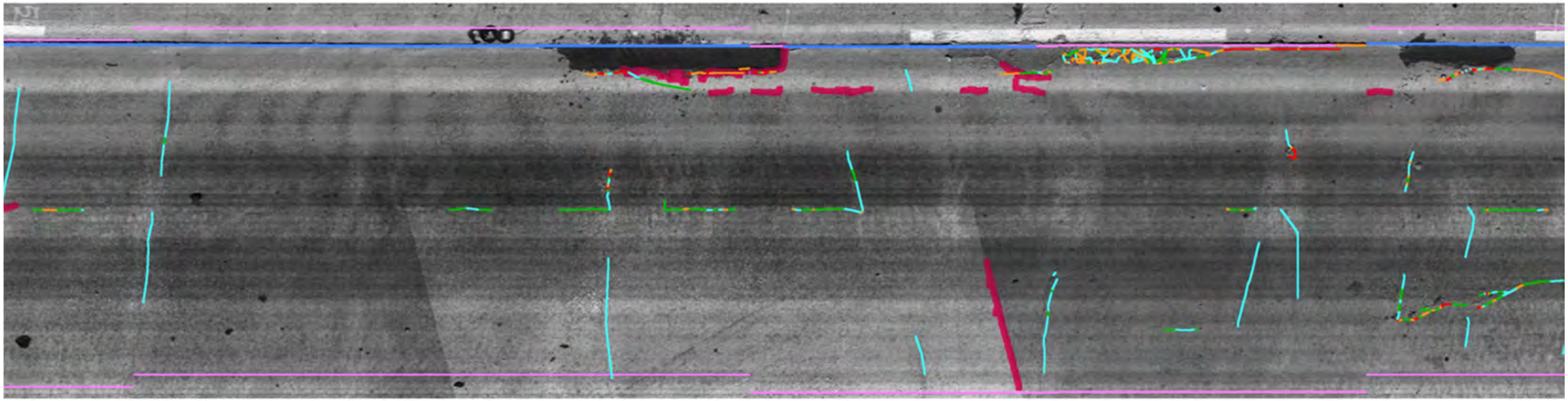


Dynatest (Fully Automated)

Section 19 /// Station 150-200



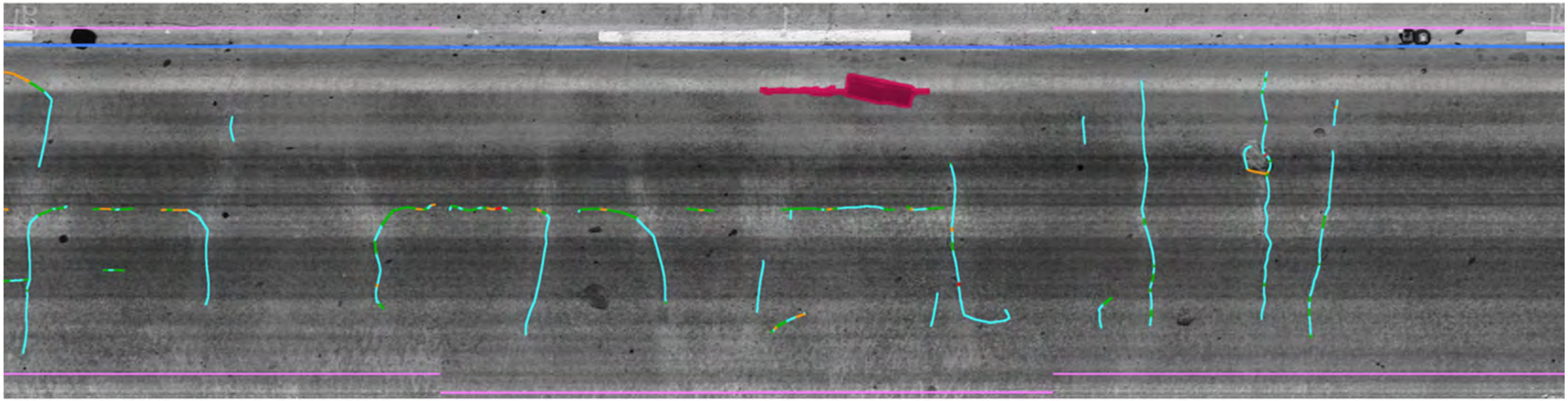
Manual Crack Map



Dynatest (Fully Automated)

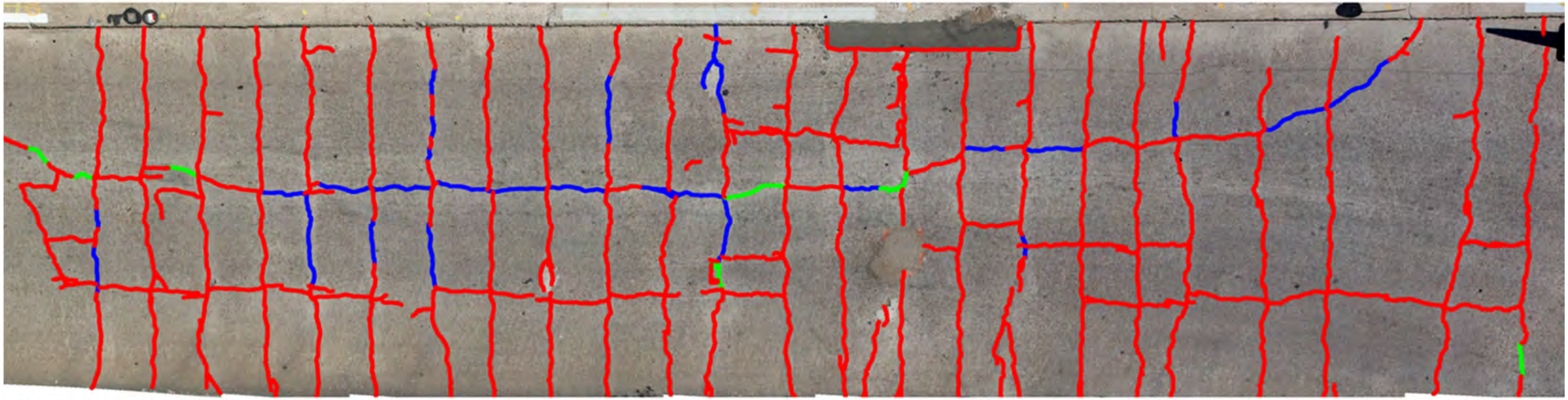
Section 19 /// Station 200-250

Manual Crack Map

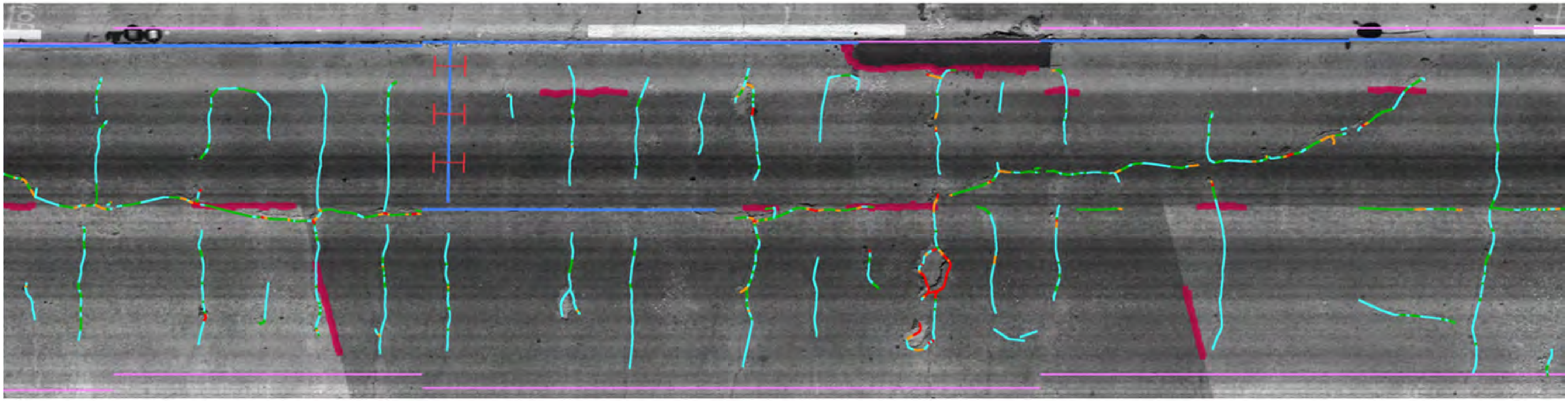


Dynatest (Fully Automated)

Section 19 /// Station 400-450



Manual Crack Map



Dynatest (Fully Automated)

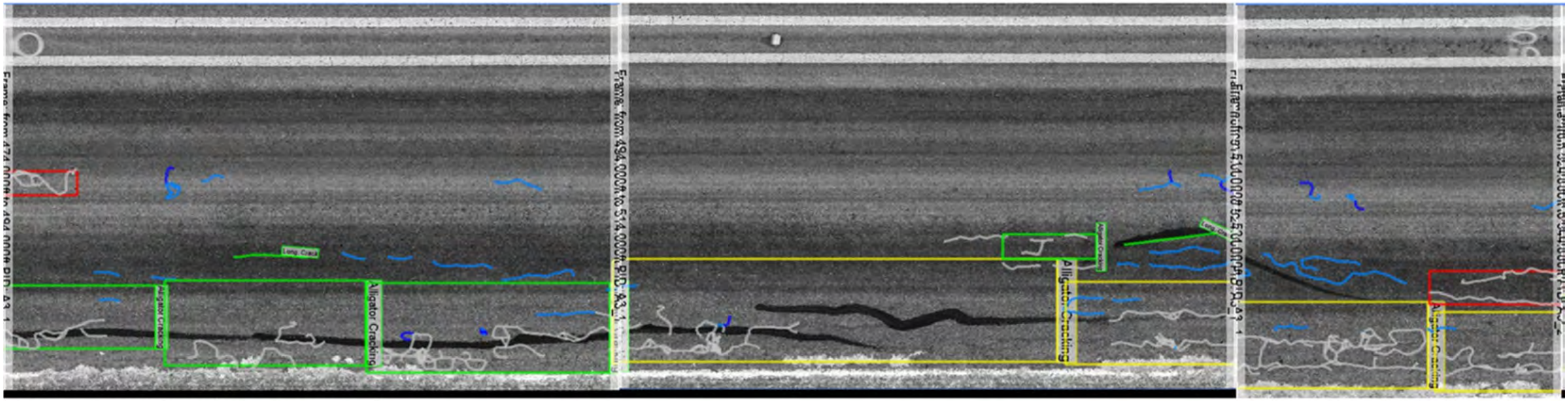
Appendix A.4

Crack Maps Comparison

Dynatest
semi automated

Section 2 /// Station 000-050

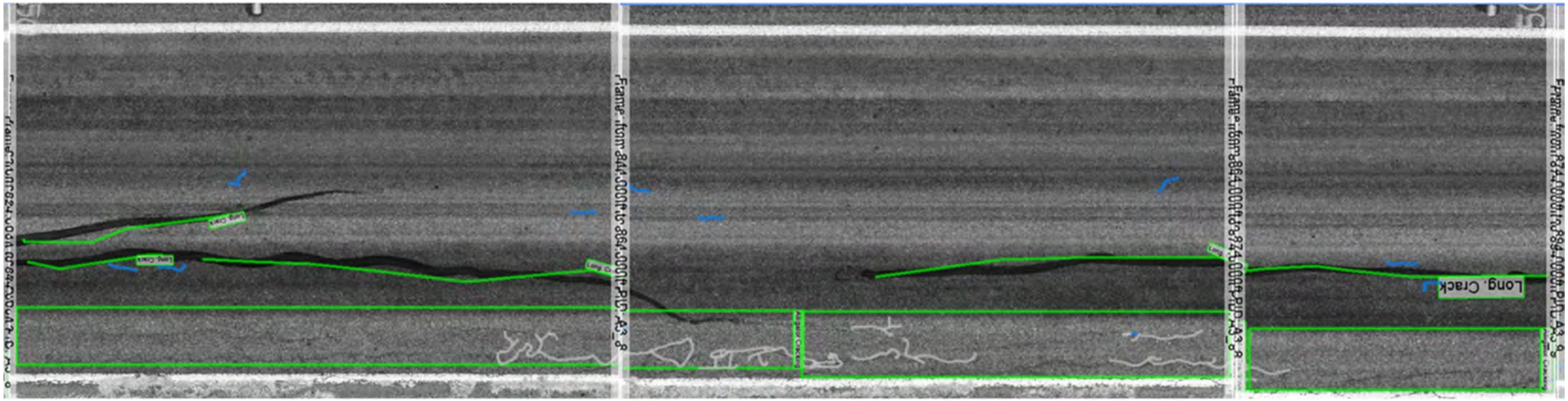
Manual Crack Map



Dynatest (Semi Automated)

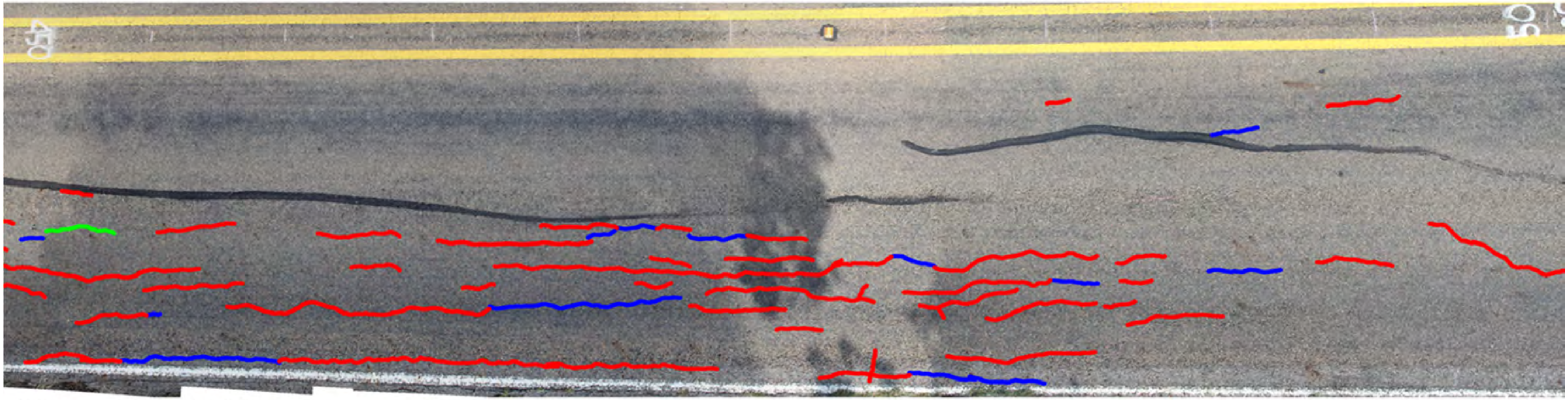
Section 2 /// Station 350-400

Manual Crack Map

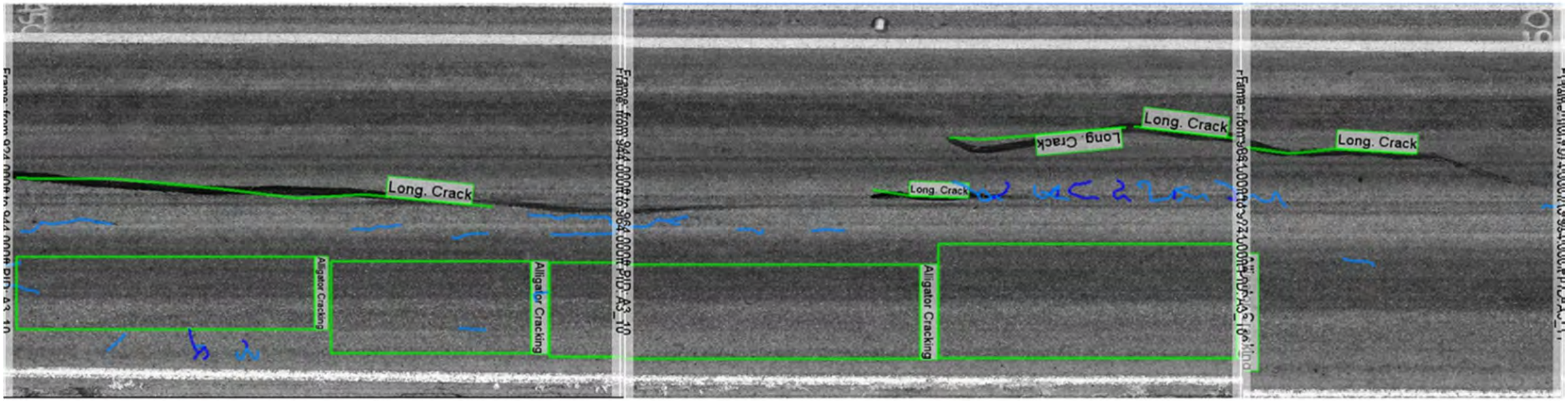


Dynatest (Semi Automated)

Section 2 /// Station 450-500

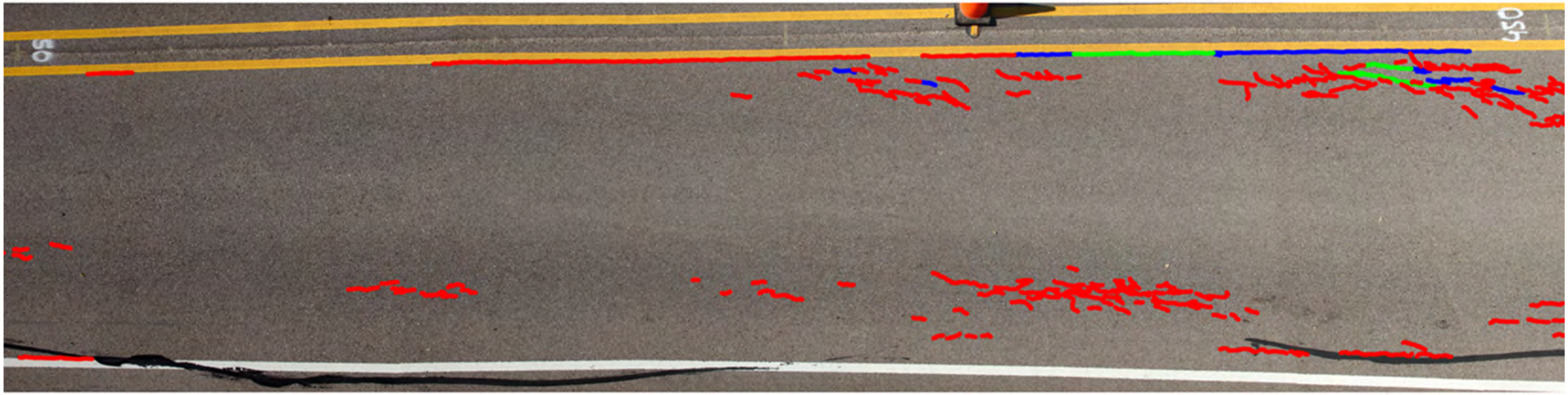


Manual Crack Map

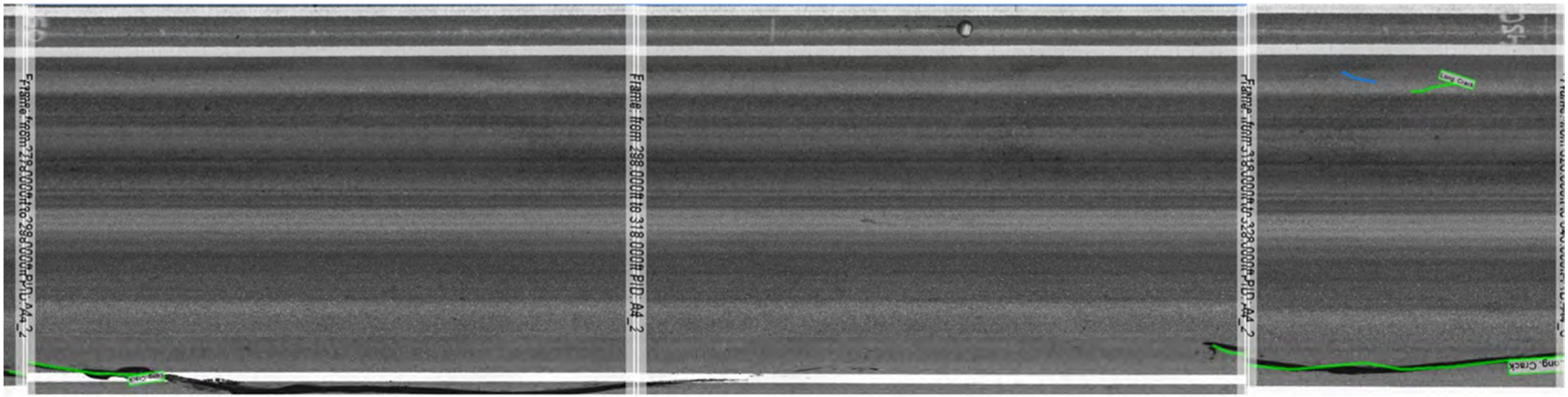


Dynatest (Semi Automated)

Section 4 /// Station 050-100



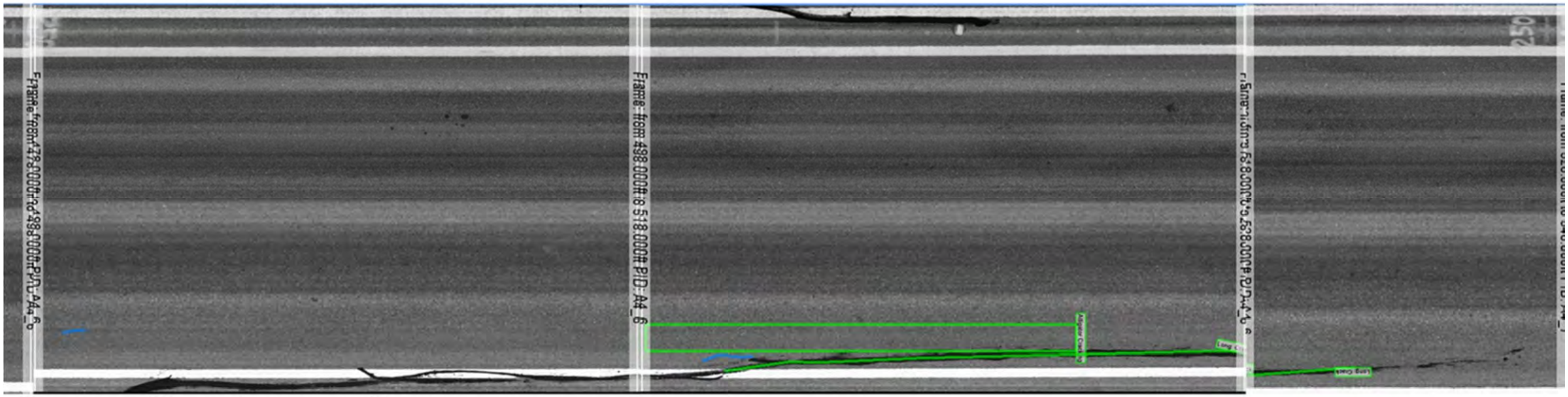
Manual Crack Map



Dynatest (Semi Automated)

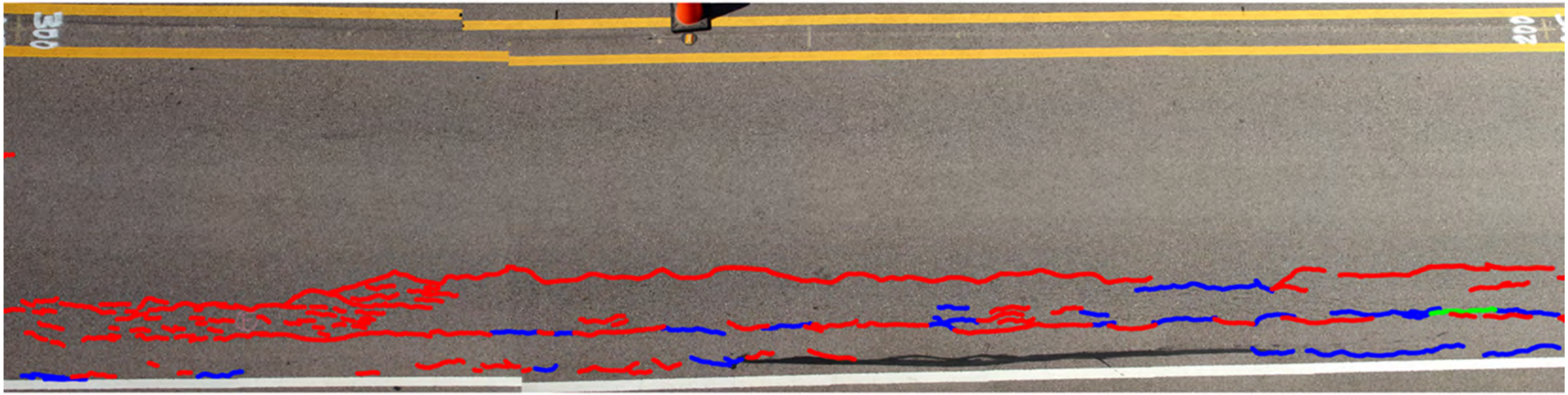
Section 4 /// Station 250-300

Manual Crack Map

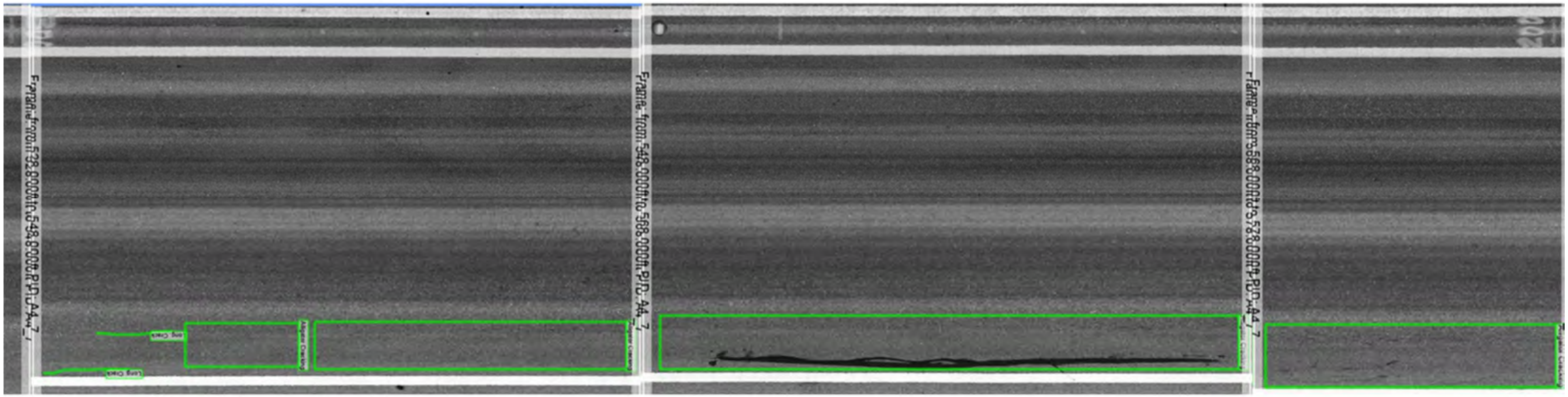


Dynatest (Semi Automated)

Section 4 /// Station 300-350



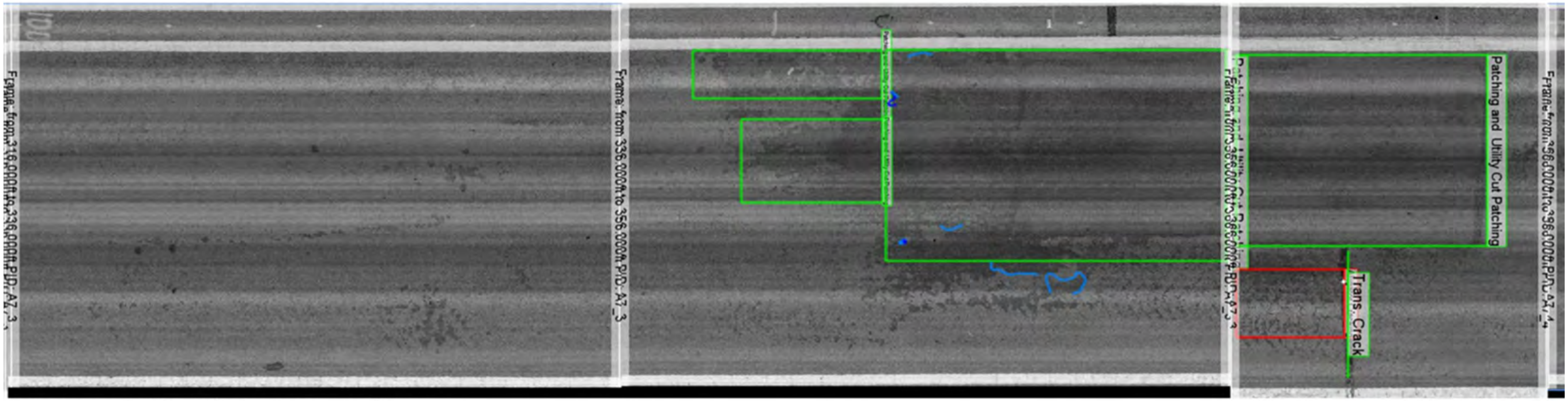
Manual Crack Map



Dynatest (Semi Automated)

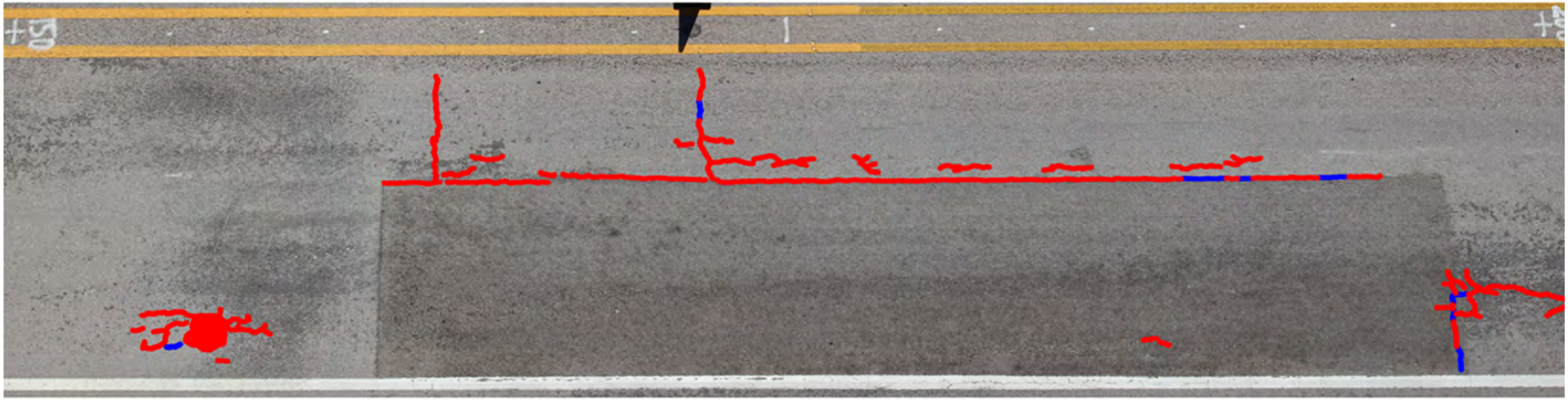
Section 6 /// Station 100-150

Manual Crack Map

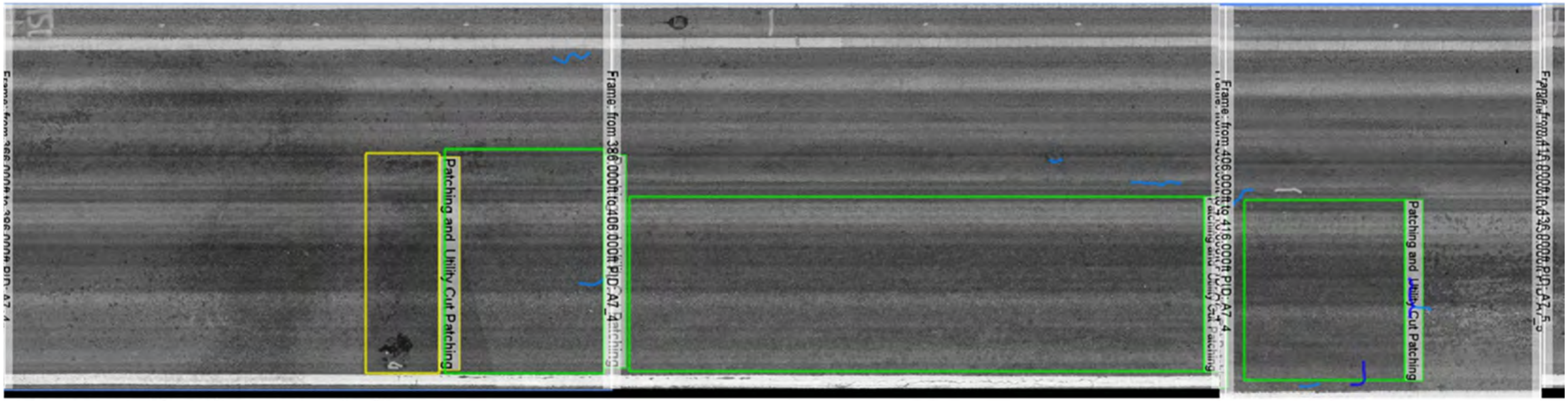


Dynatest (Semi Automated)

Section 6 /// Station 150-200



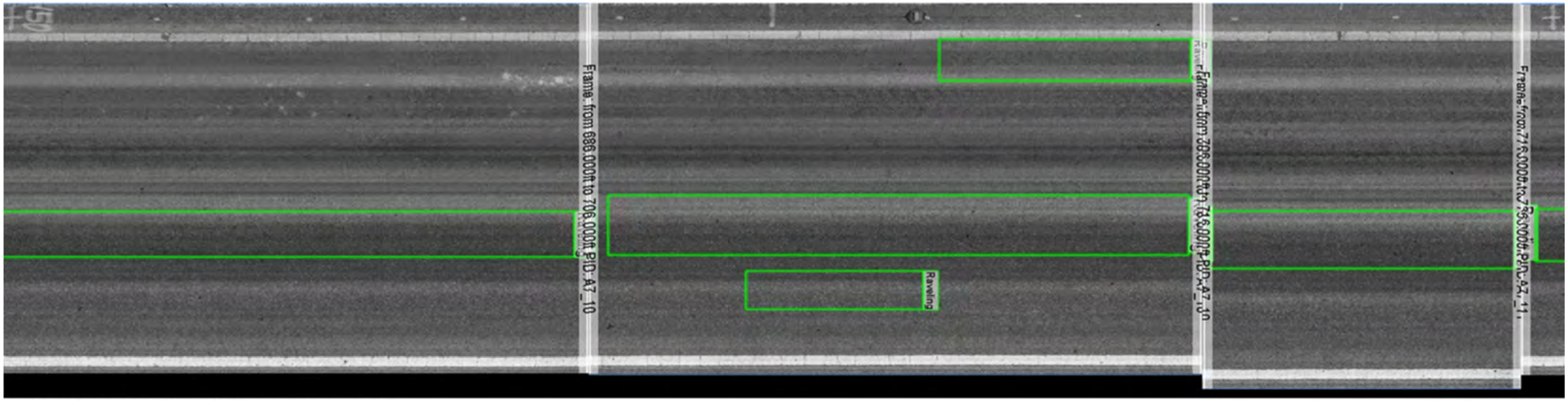
Manual Crack Map



Dynatest (Semi Automated)

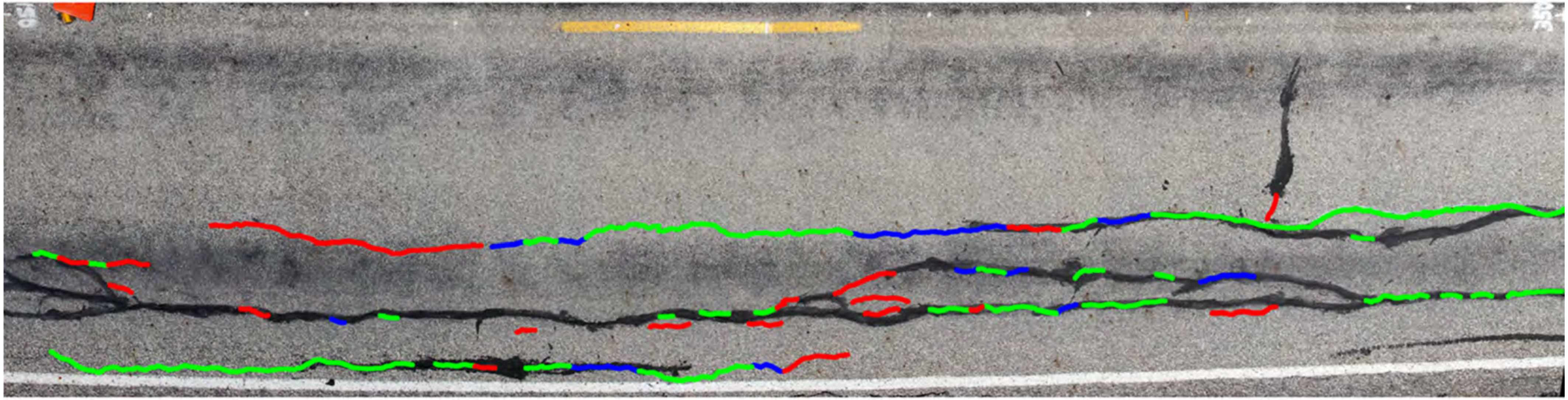
Section 6 /// Station 450-500

Manual Crack Map

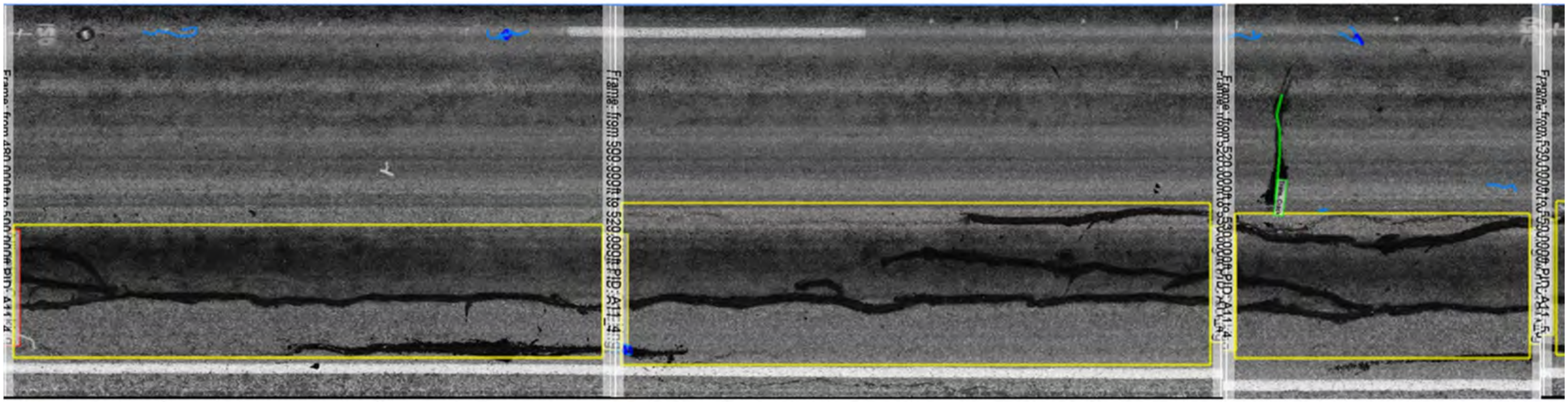


Dynatest (Semi Automated)

Section 9 /// Station 150-200

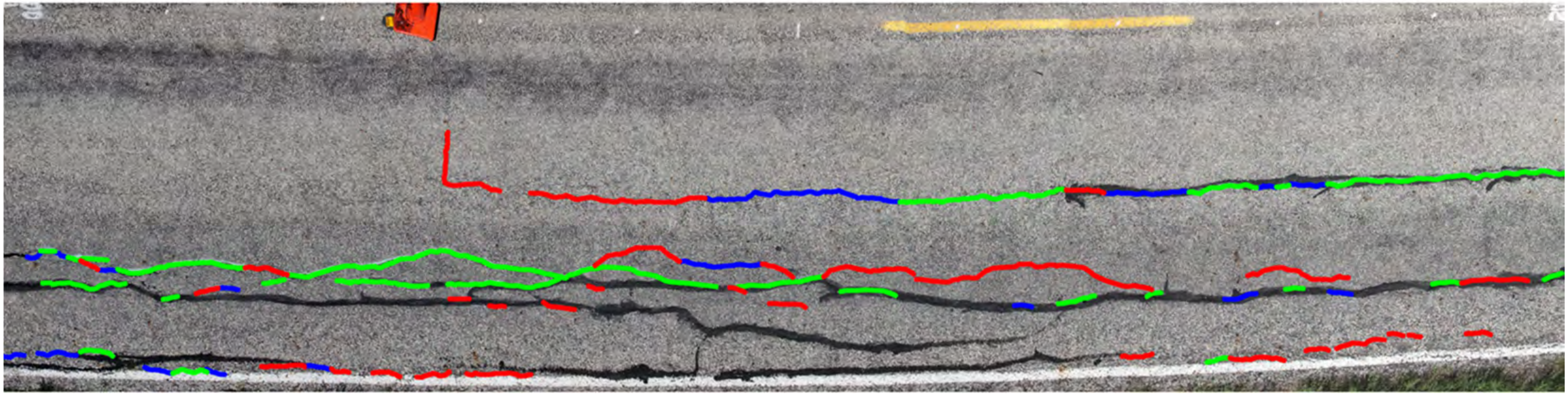


Manual Crack Map



Dynatest (Semi Automated)

Section 9 /// Station 300-350



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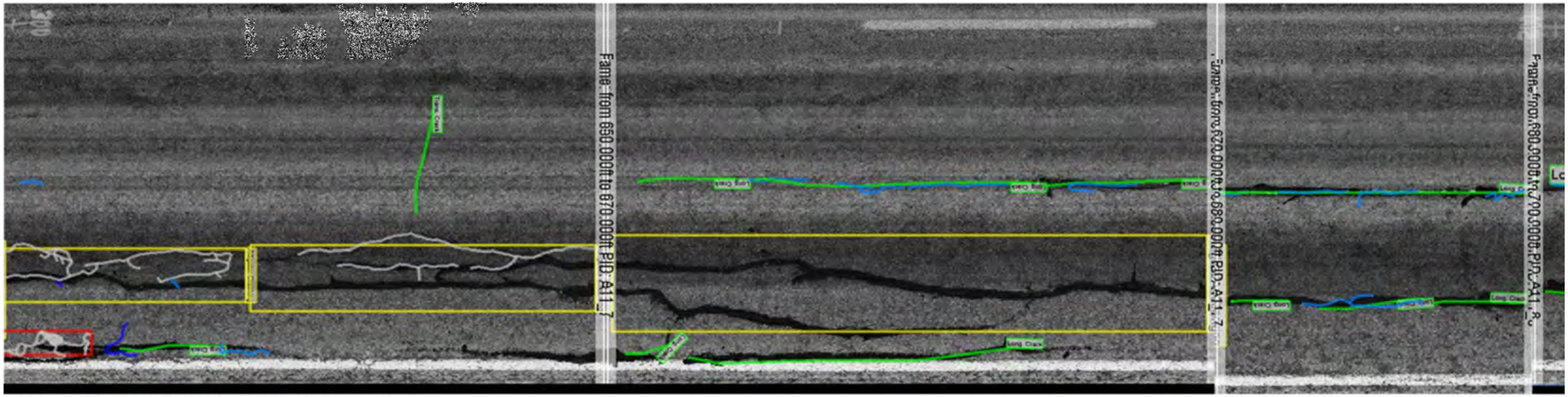
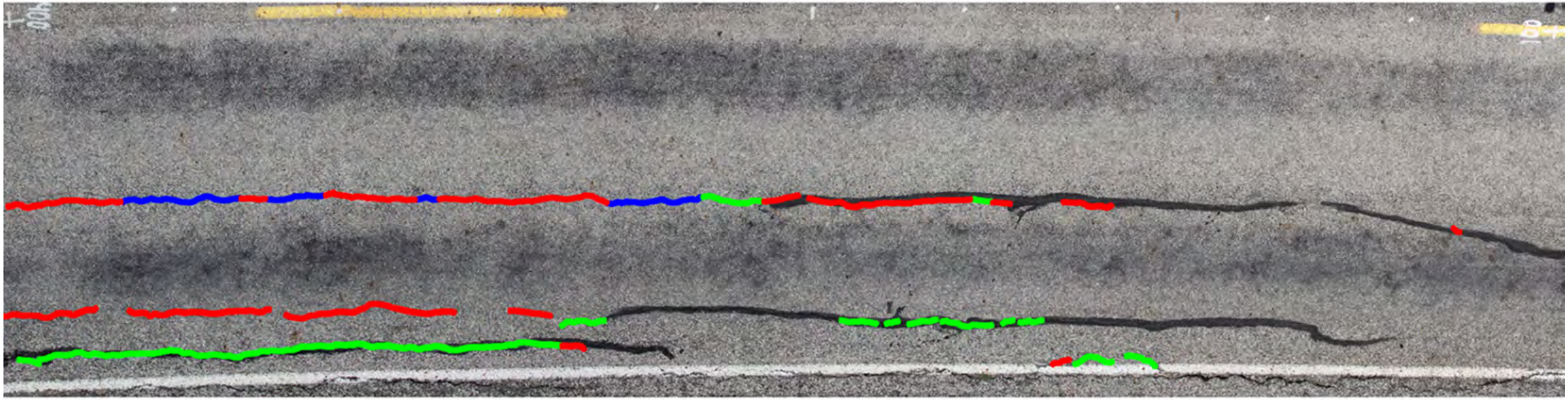


Dynatest (Semi Automated)

Section 9 /// Station 400-450



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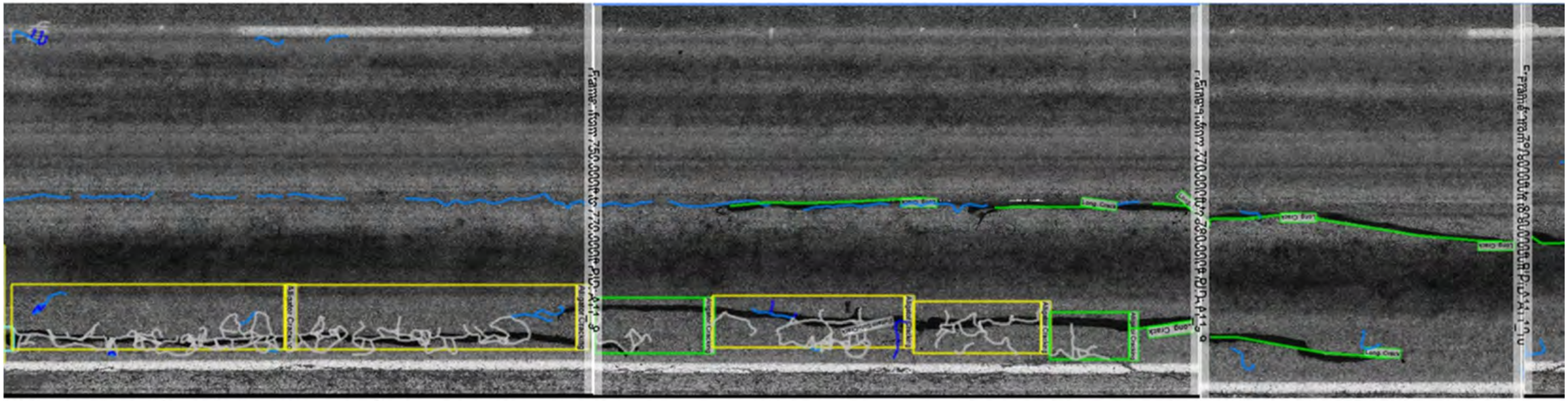
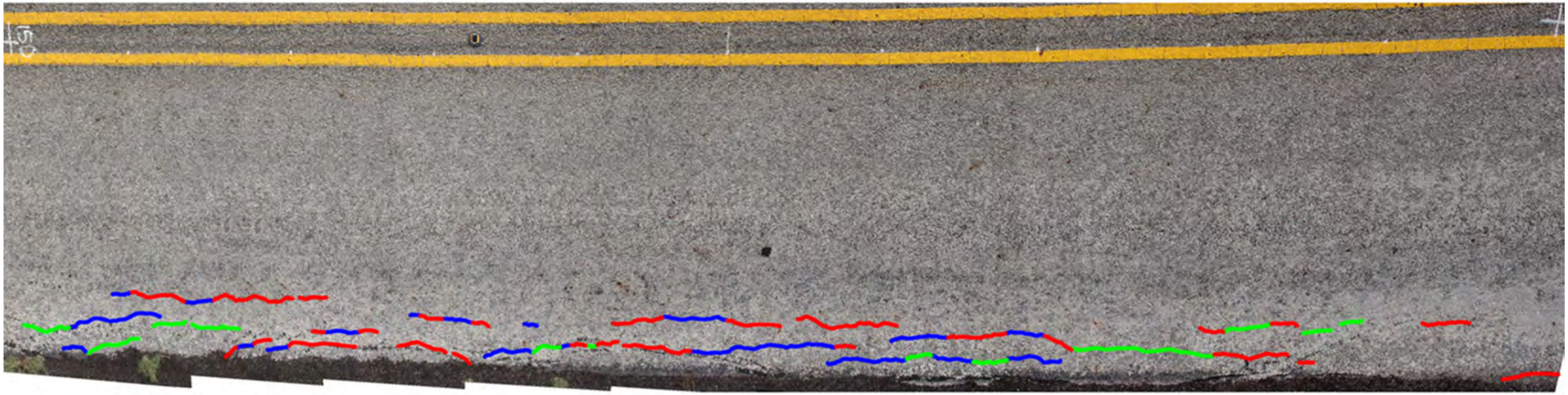


Dynatest (Semi Automated)

Section 10/// Station 150-200



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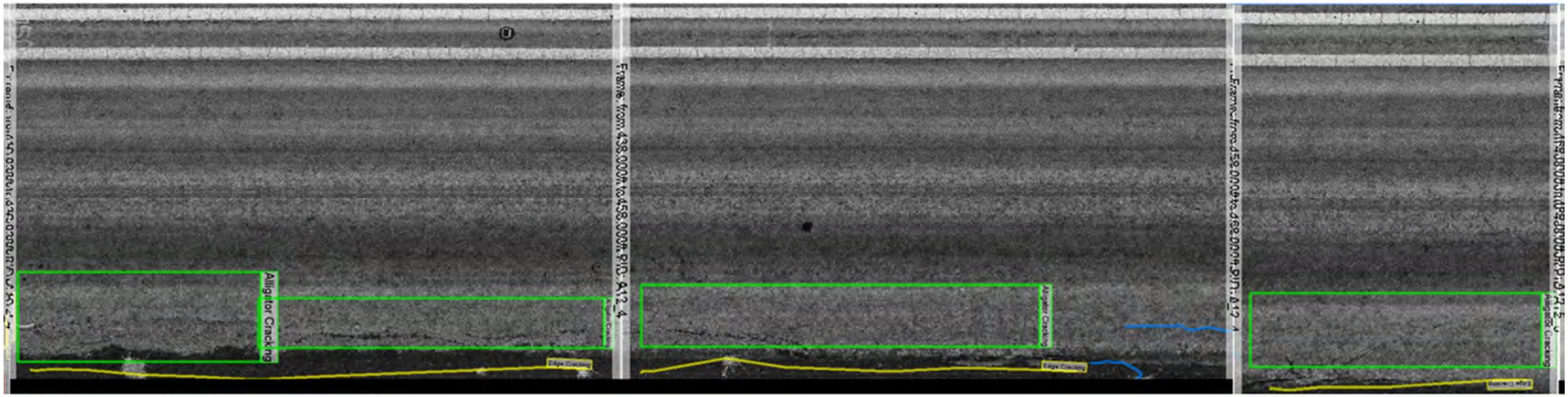
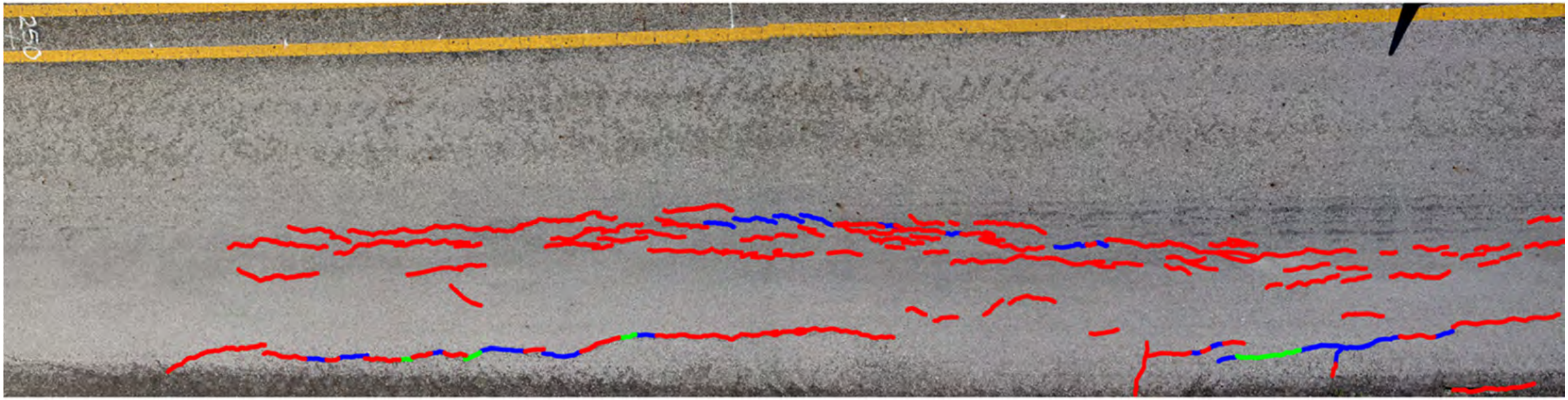


Dynatest (Semi Automated)

Section 10/// Station 250-300



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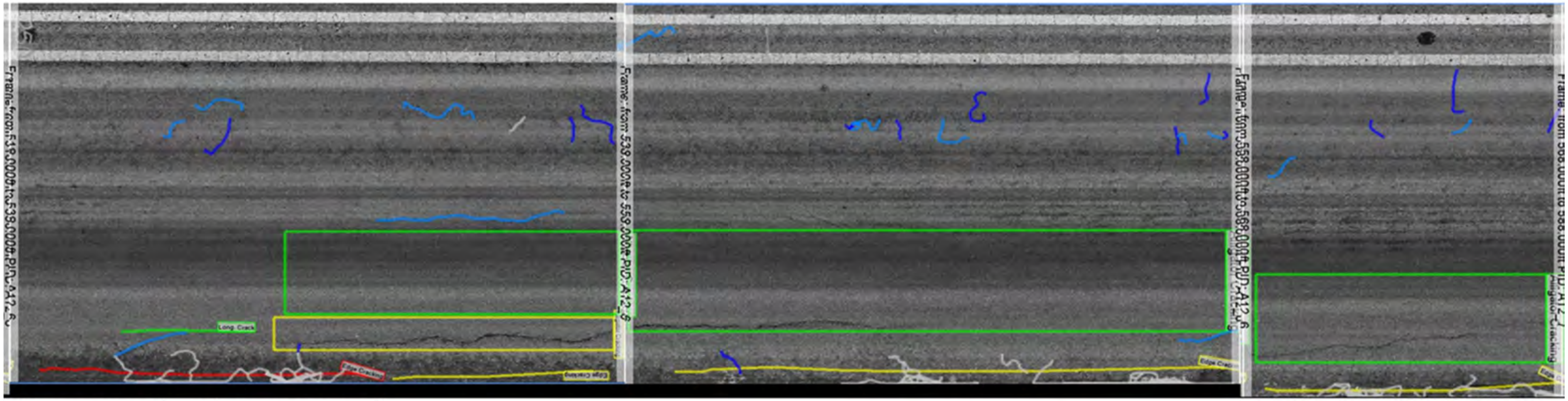
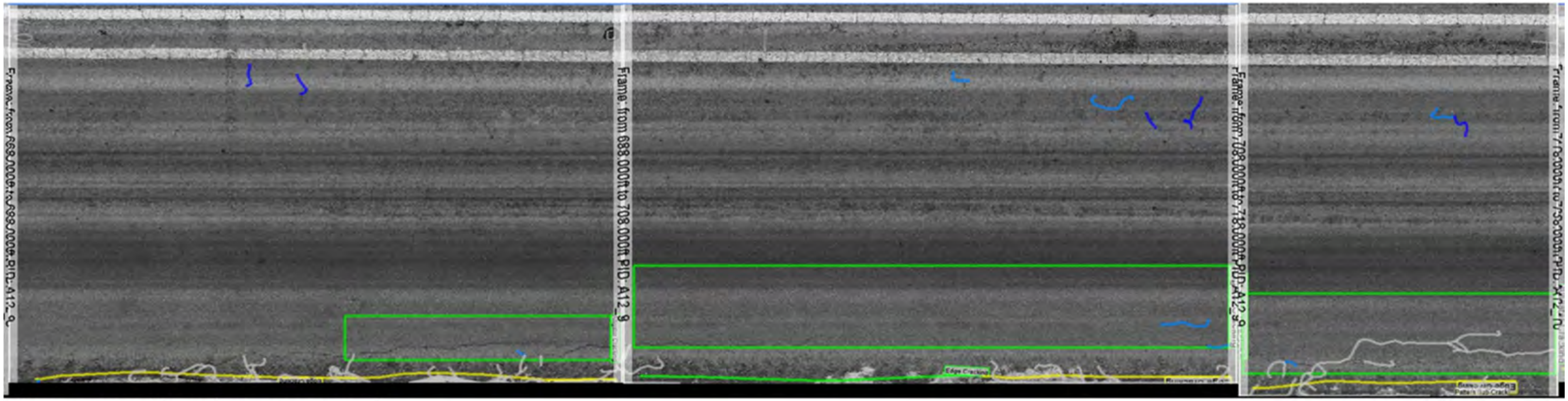


Dynatest (Semi Automated)

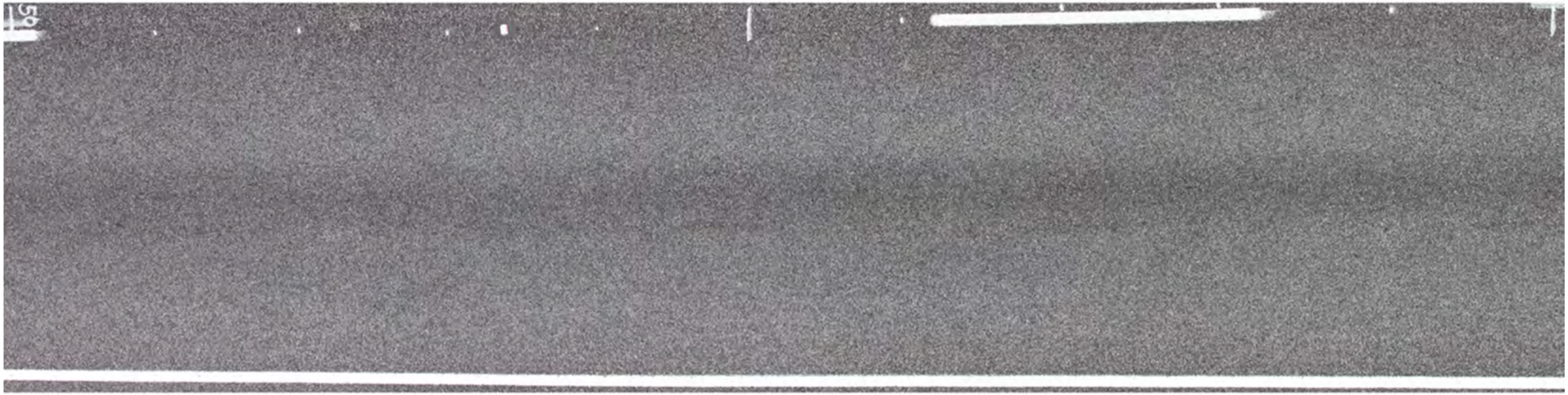
Section 10 /// Station 400-450

Manual Crack Map



Dynatest (Semi Automated)

Section 11 /// Station 050-100



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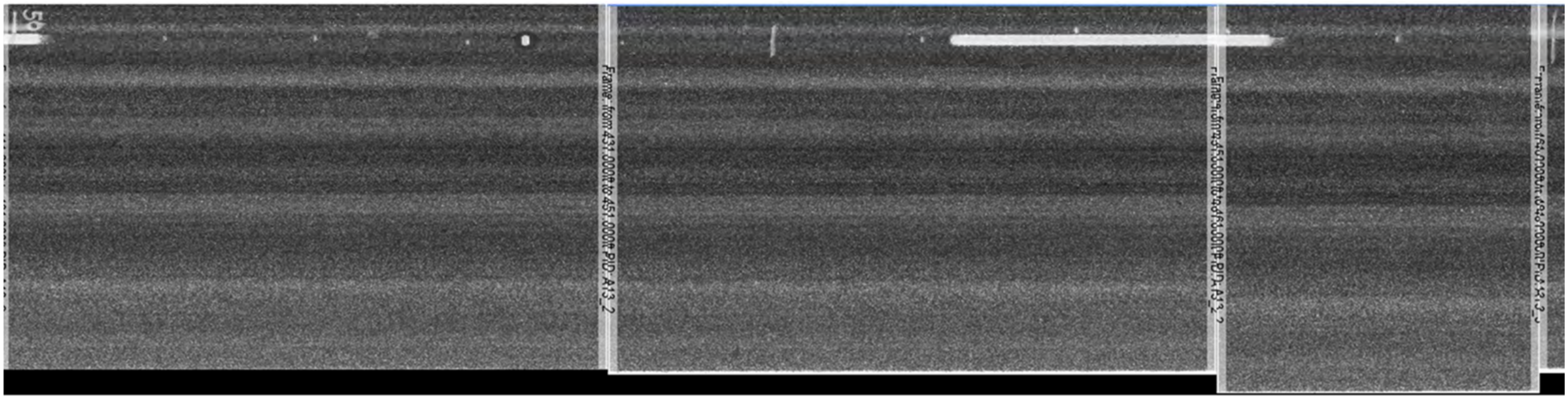
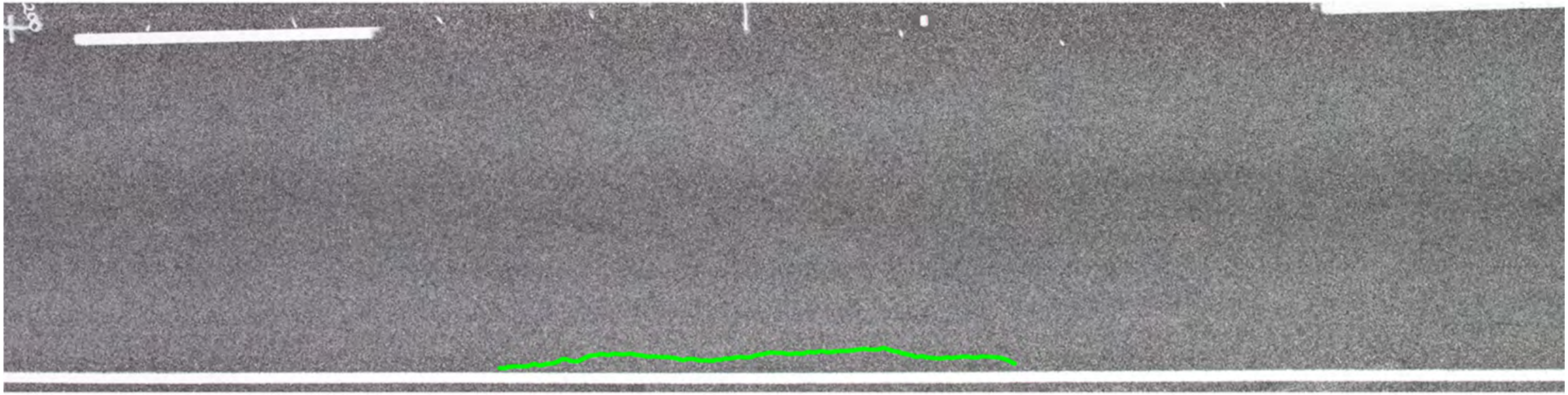


Dynatest (Semi Automated)

Section 11 /// Station 200-250



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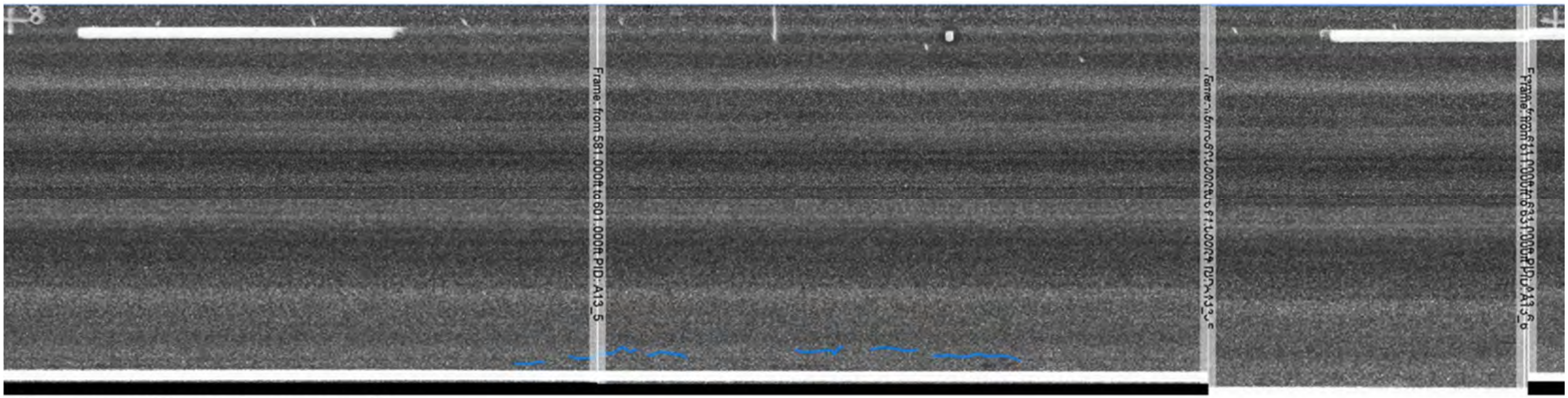

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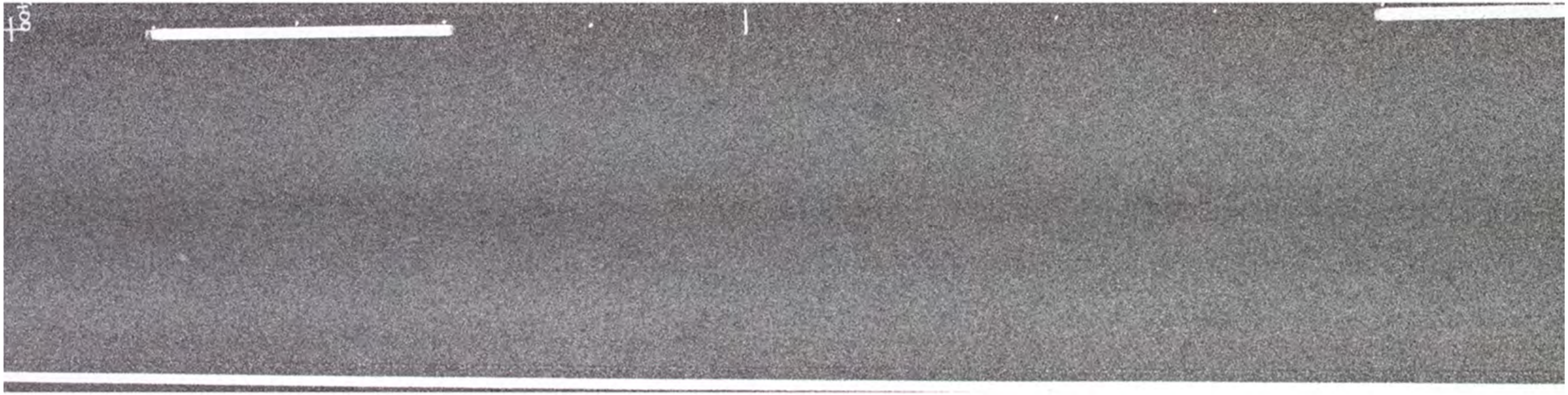
Section 11 /// Station 400-450



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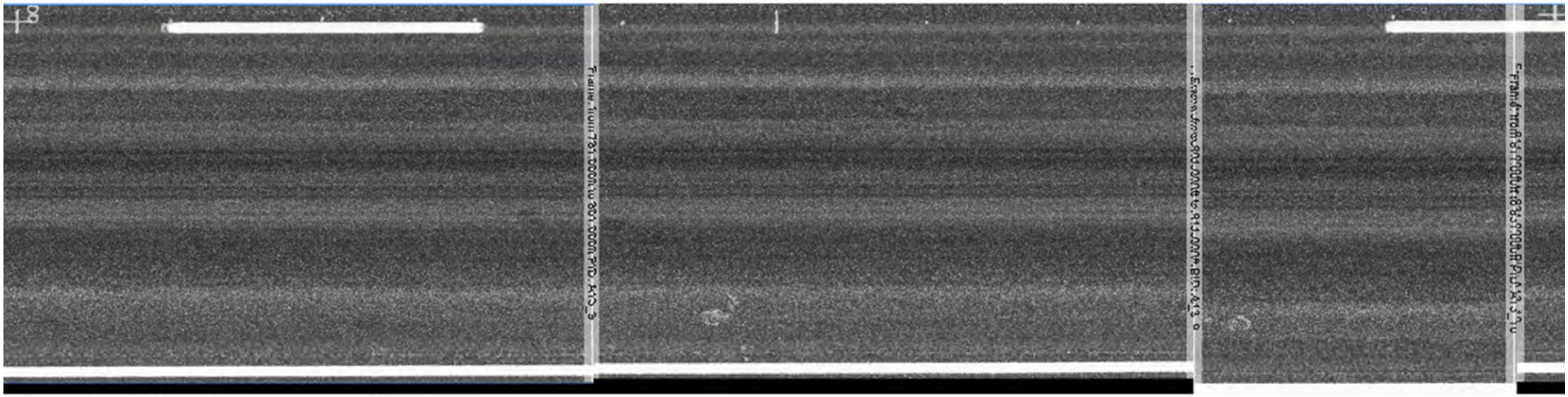
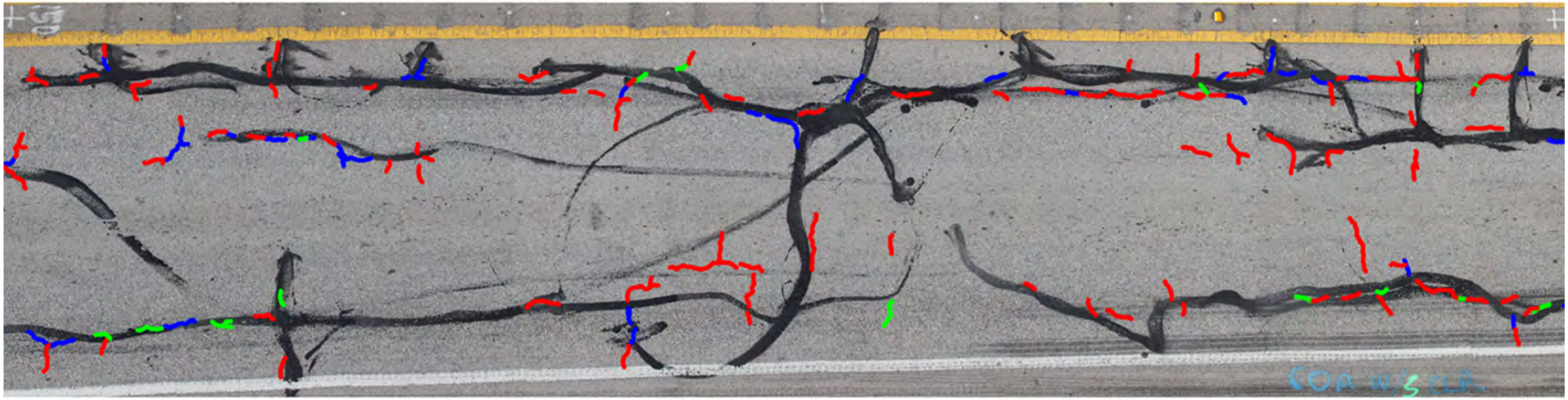
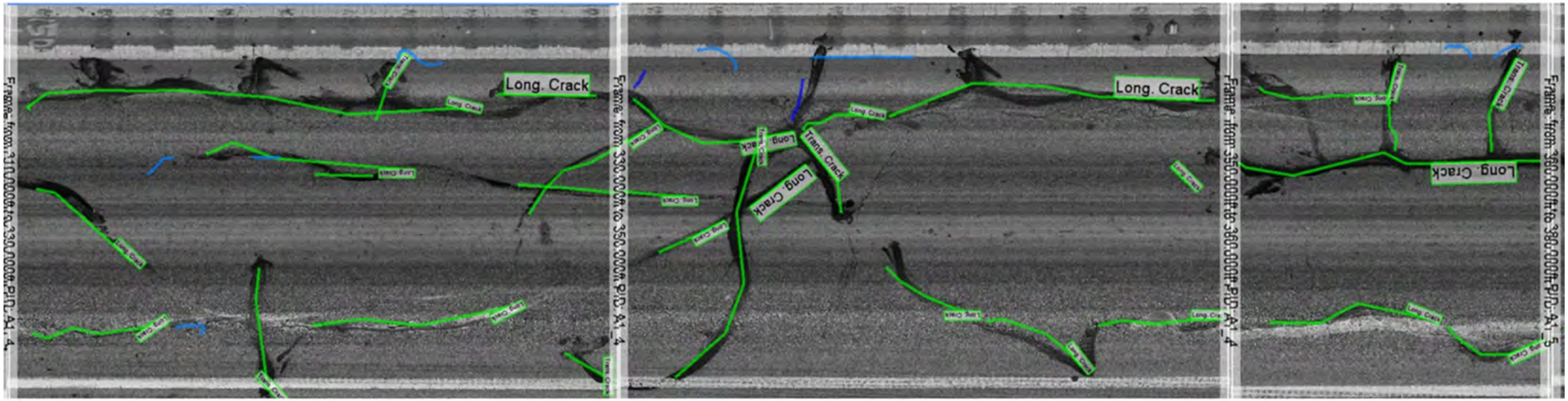


Dynatest (Semi Automated)

Section 12 /// Station 150-200



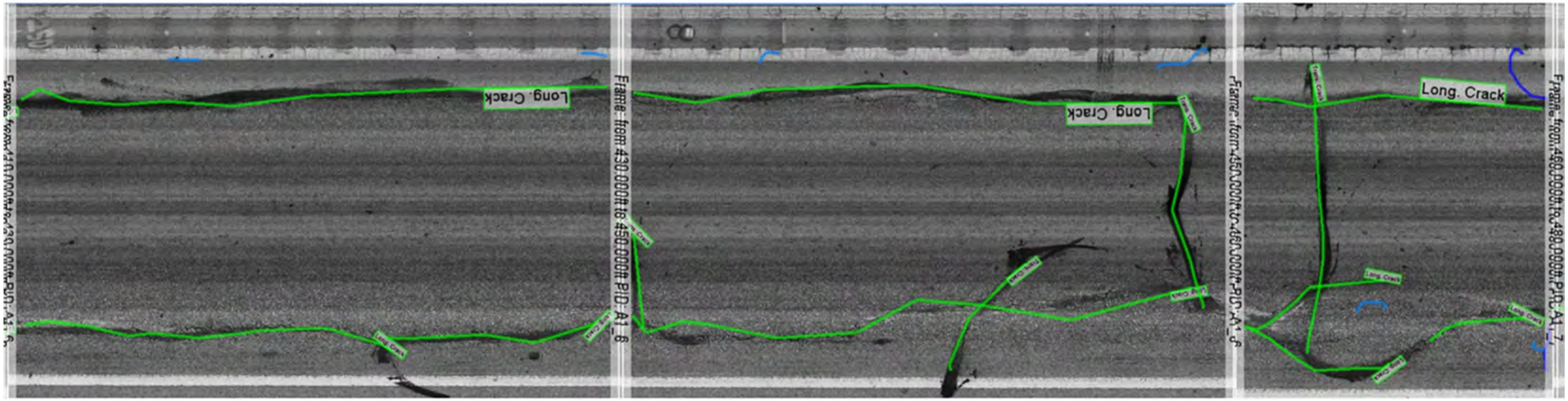
Manual Crack Map



Dynatest (Semi Automated)

Section 12 /// Station 250-300

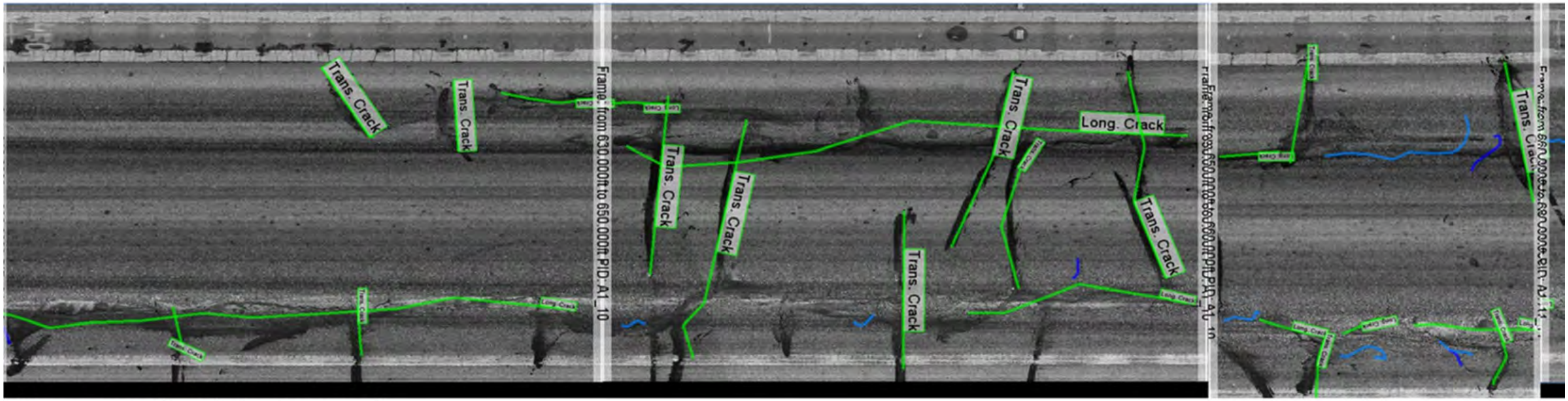
Manual Crack Map



Dynatest (Semi Automated)

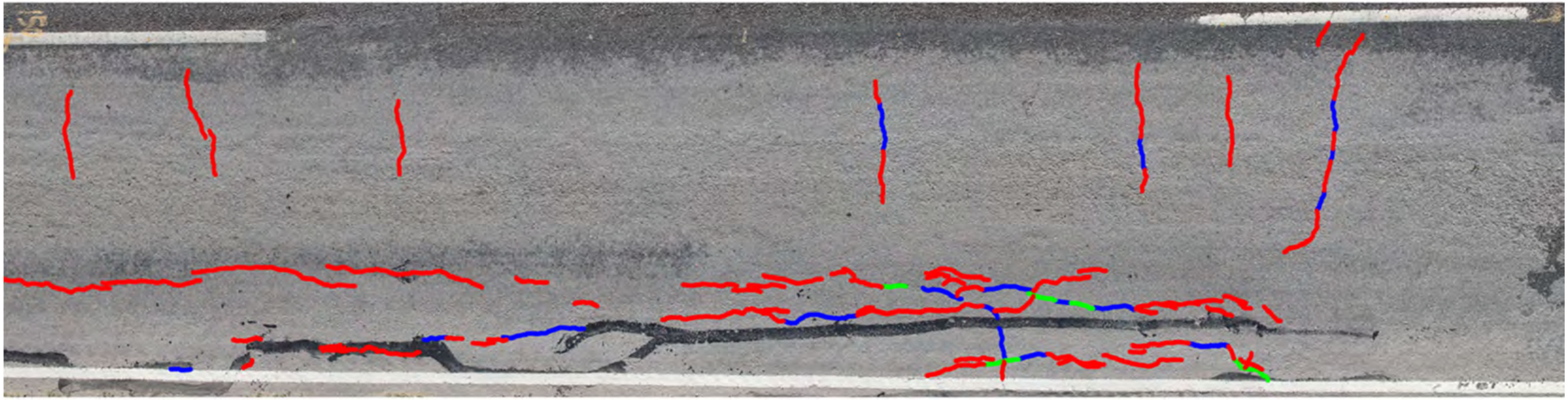
Section 12 /// Station 450-500

Manual Crack Map

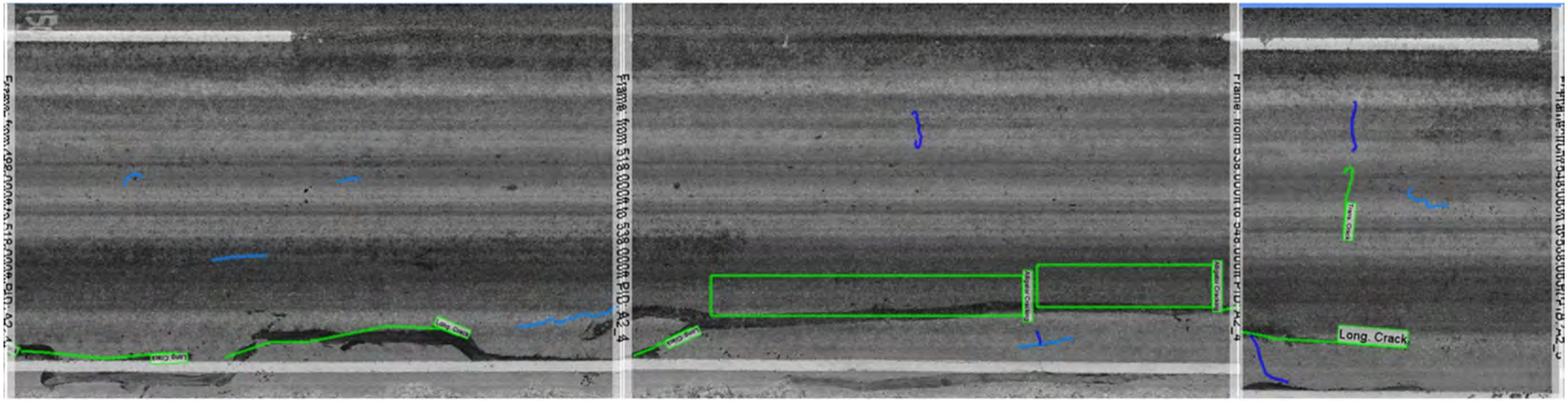


Dynatest (Semi Automated)

Section 13 /// Station 150-200

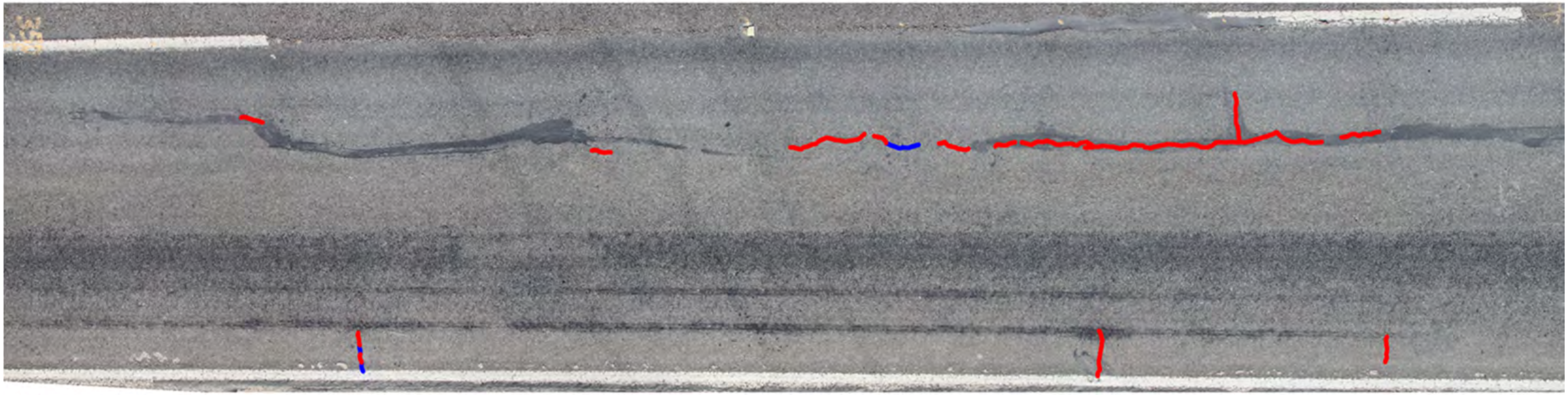


Manual Crack Map

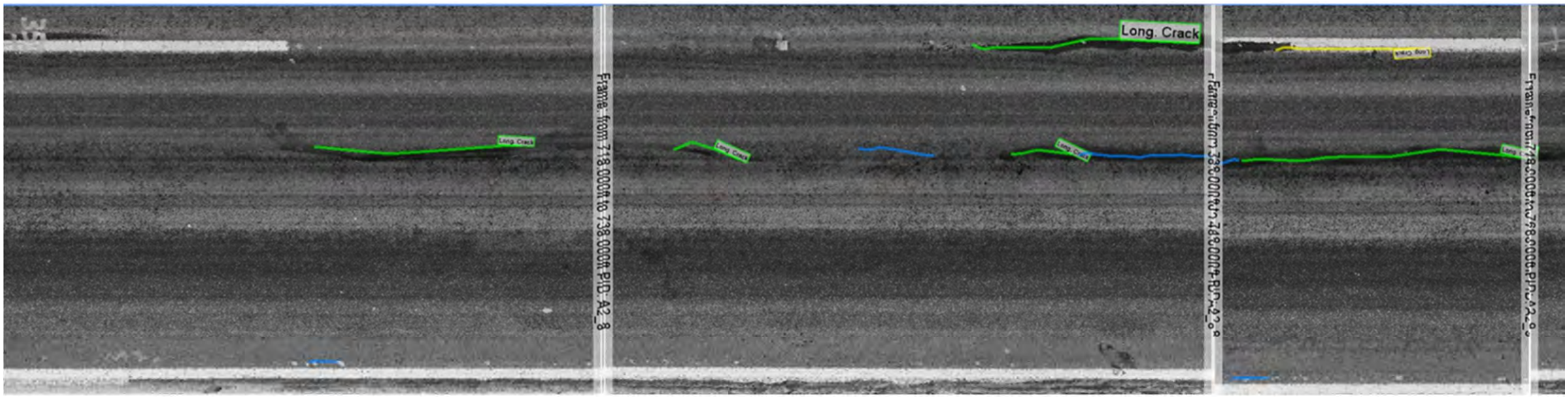


Dynatest (Semi Automated)

Section 13 /// Station 350-400

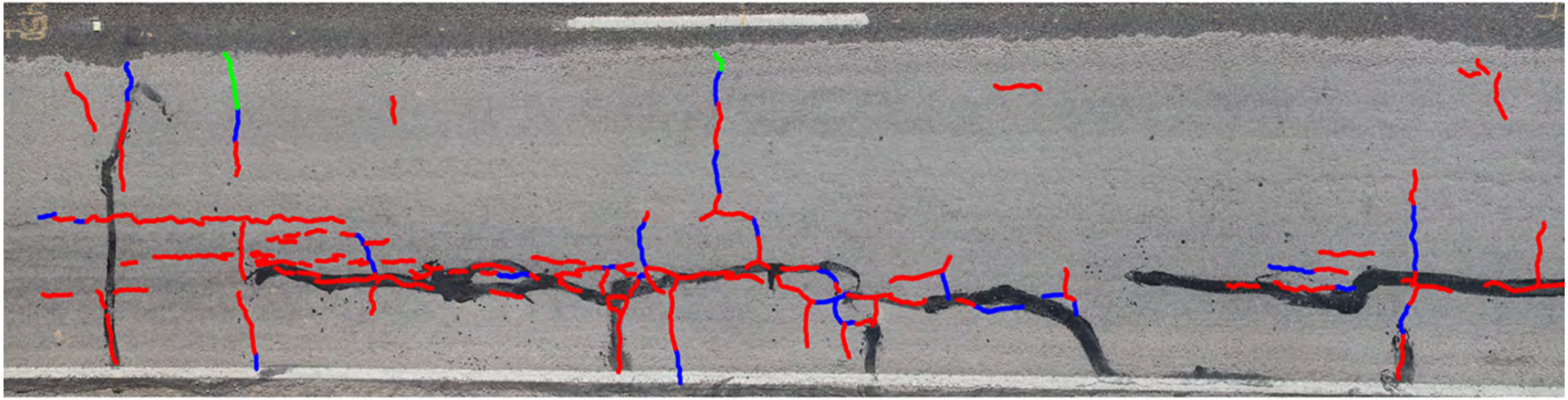


Manual Crack Map

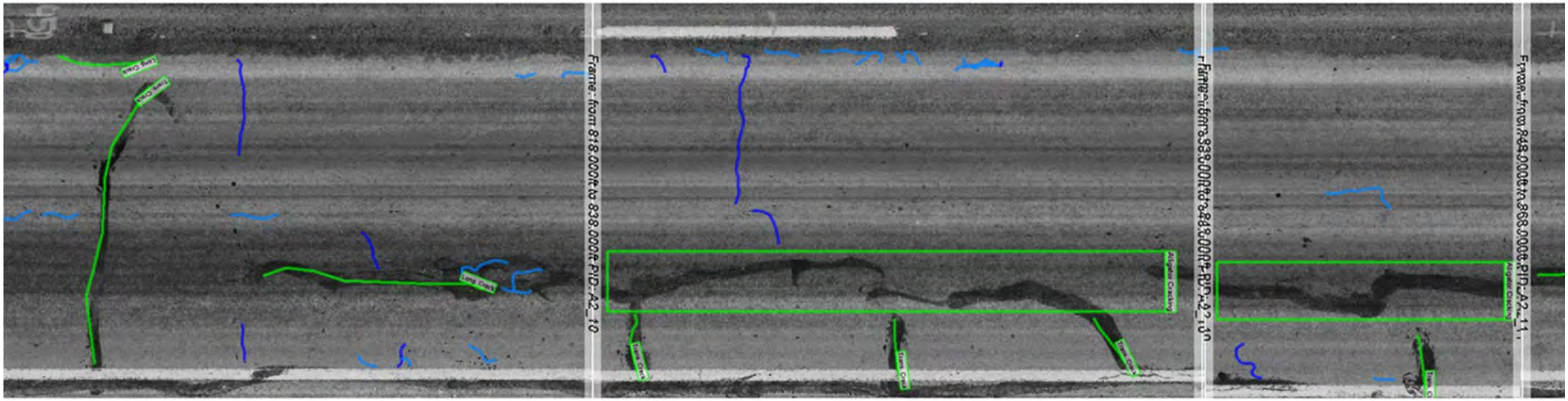


Dynatest (Semi Automated)

Section 13 /// Station 450-500

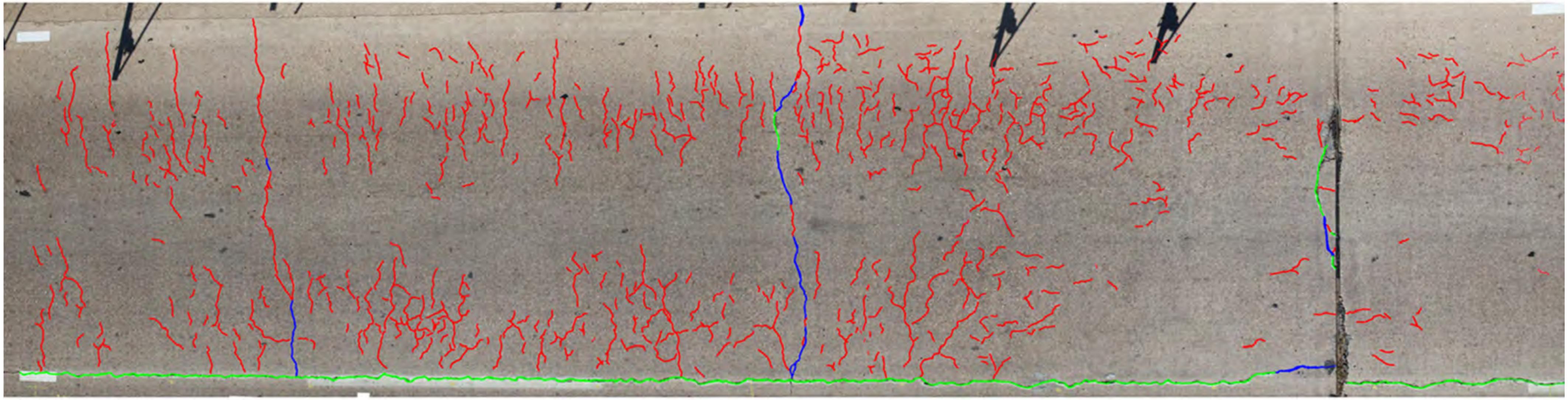


Manual Crack Map



Dynatest (Semi Automated)

Section 17 /// Station 050-100



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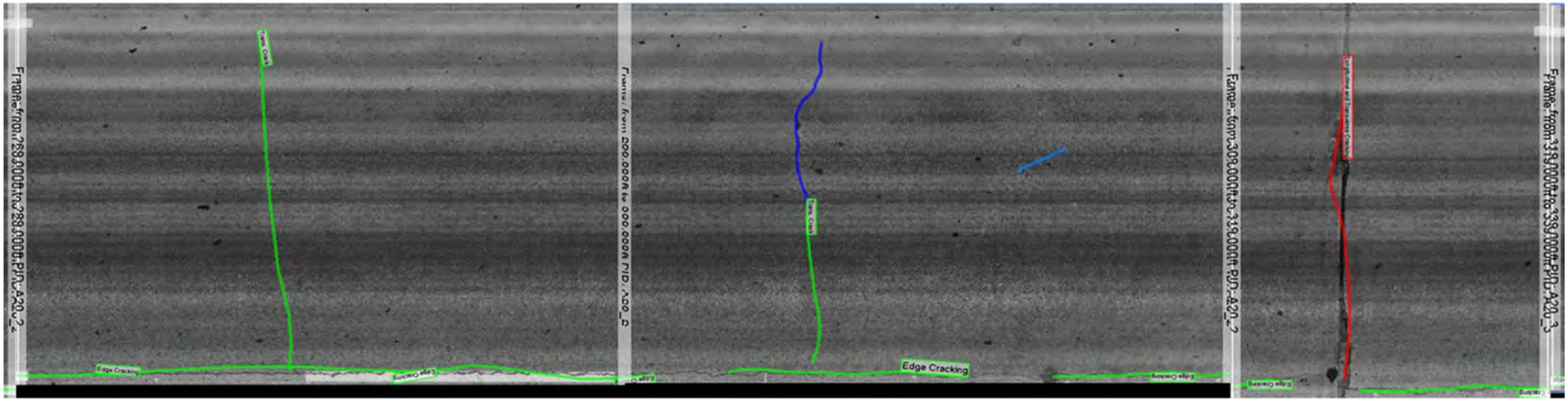
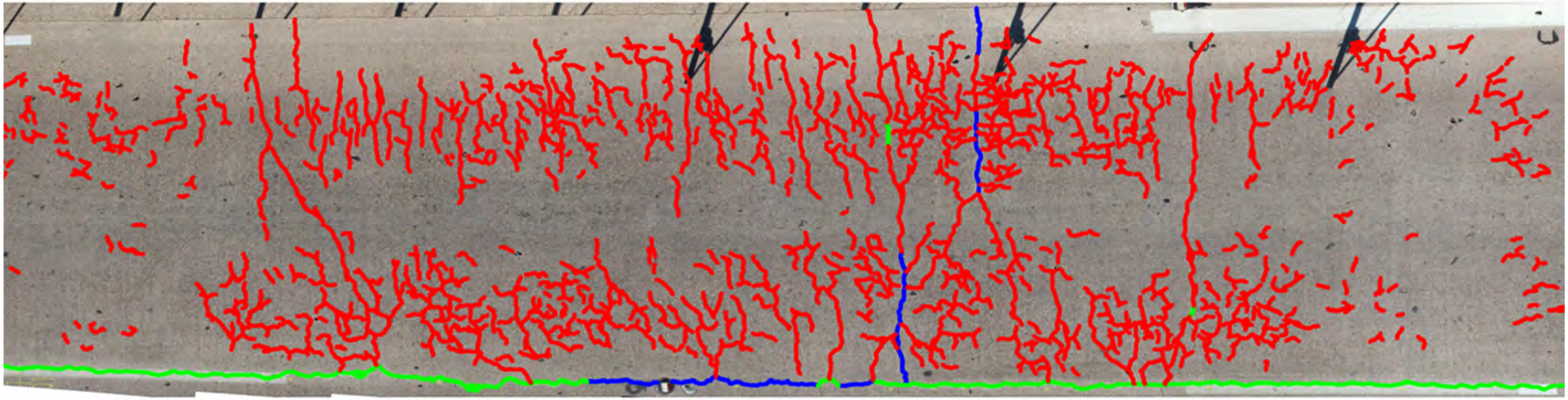


Dynatest (Semi Automated)

Section 17 /// Station 100-150



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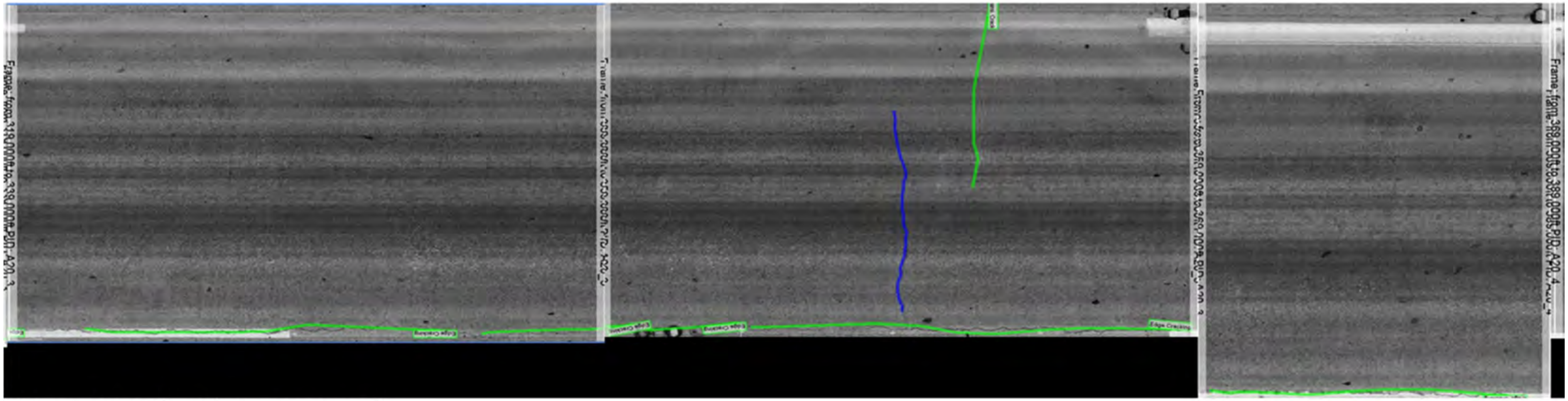
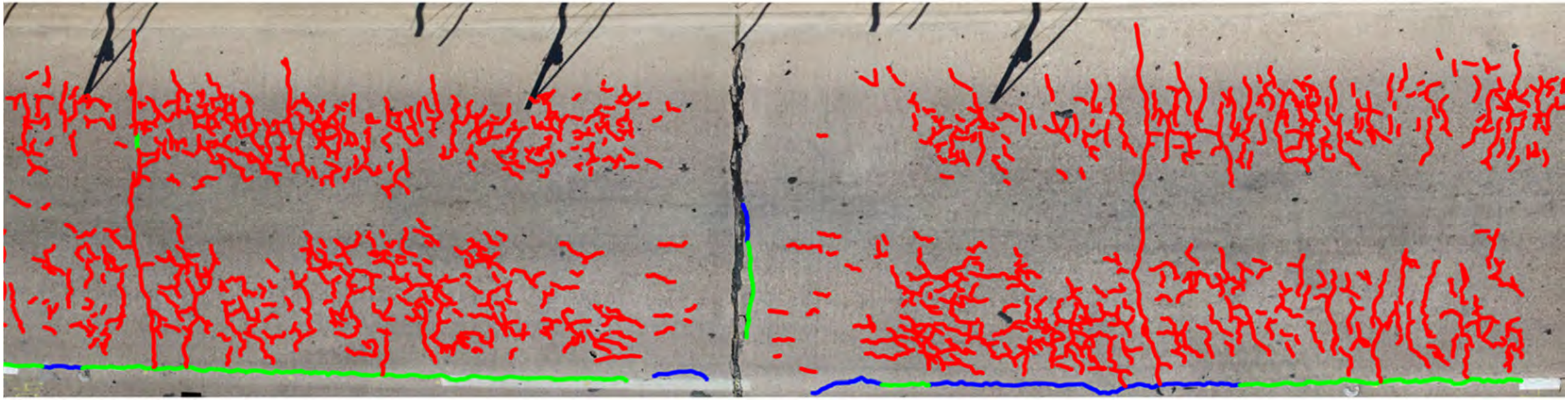


Dynatest (Semi Automated)

Section 17 /// Station 400-450



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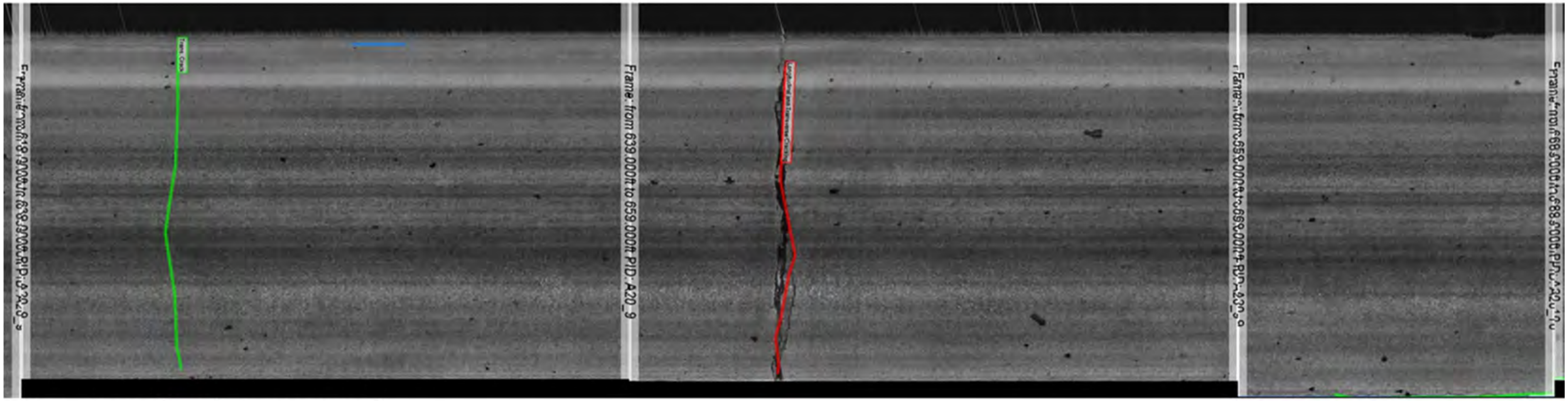
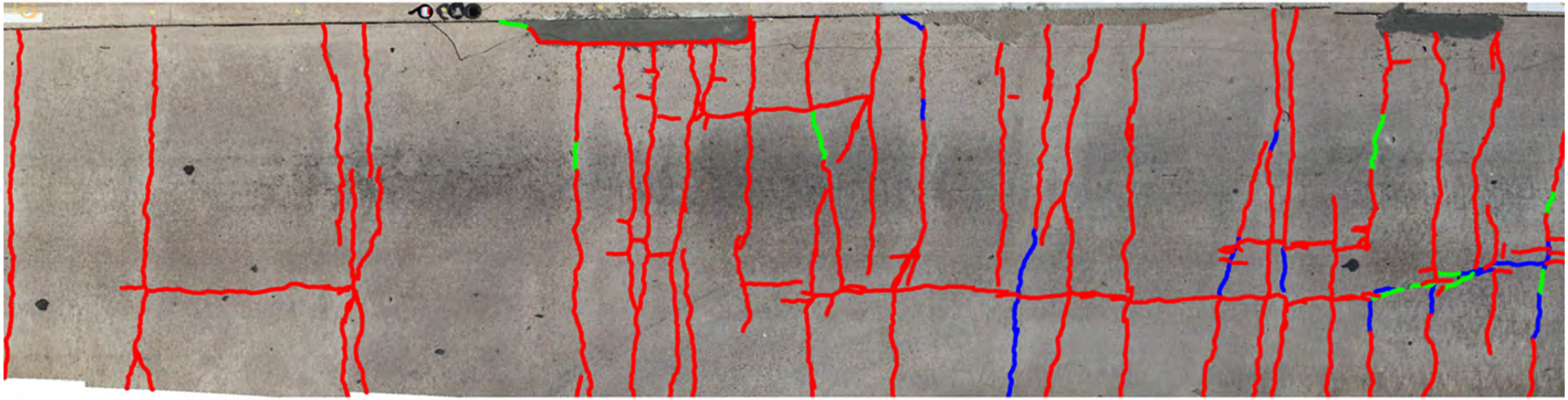
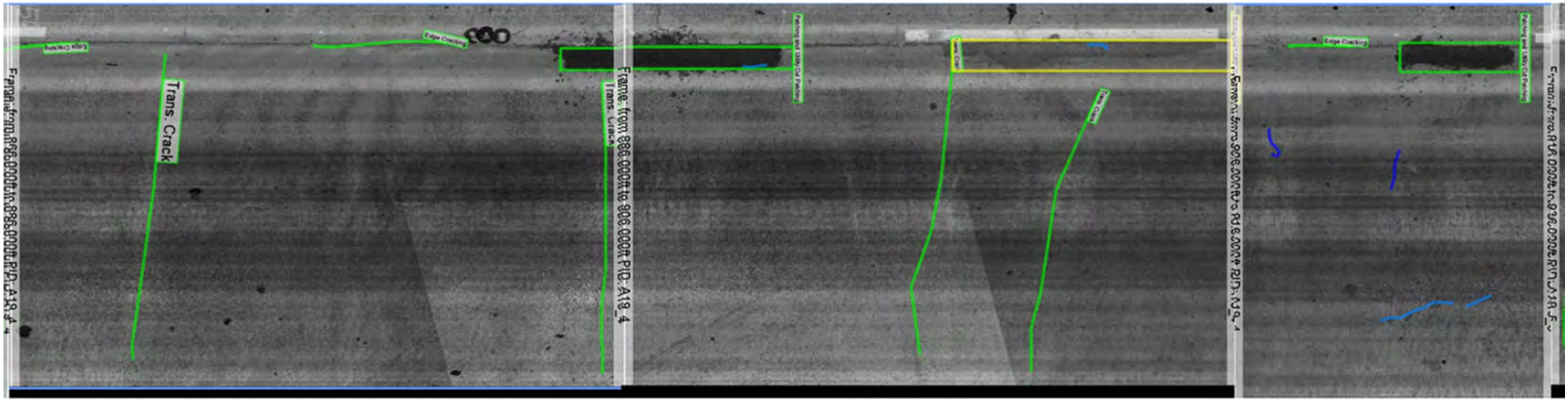


Dynatest (Semi Automated)

Section 19 /// Station 150-200



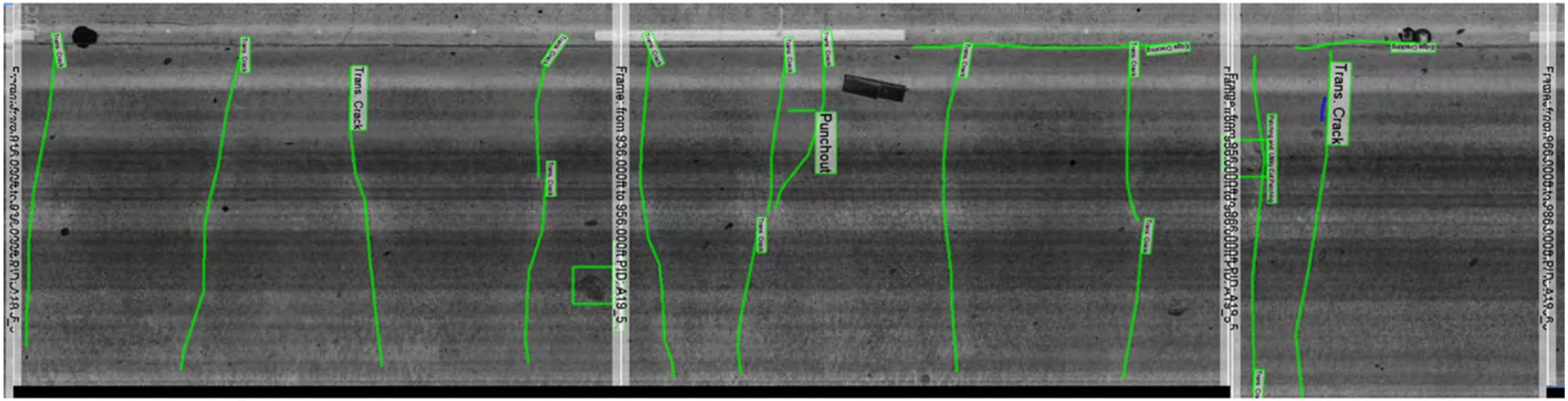
Manual Crack Map



Dynatest (Semi Automated)

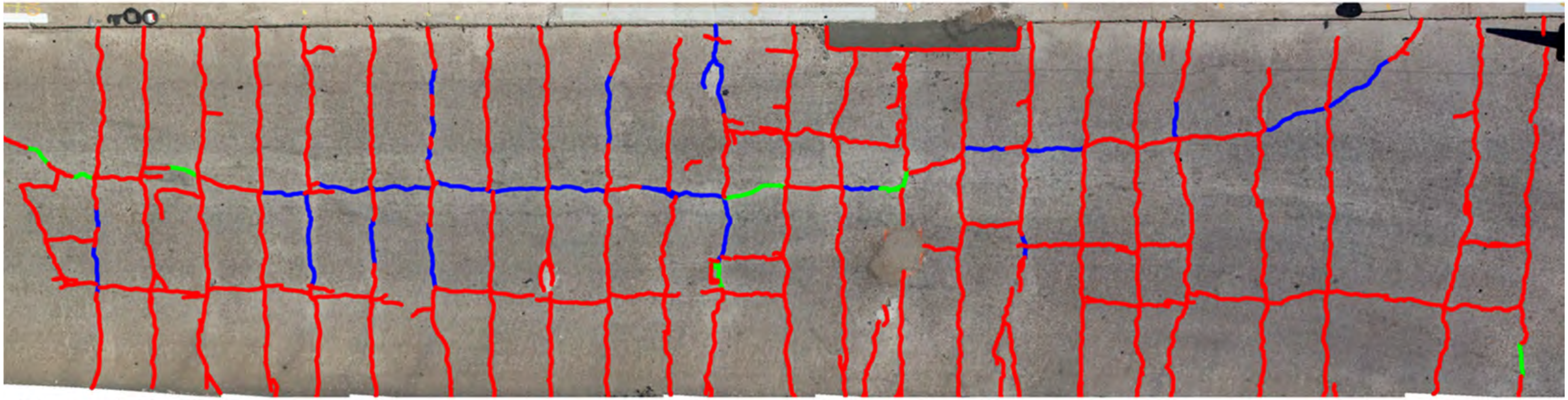
Section 19 /// Station 200-250

Manual Crack Map

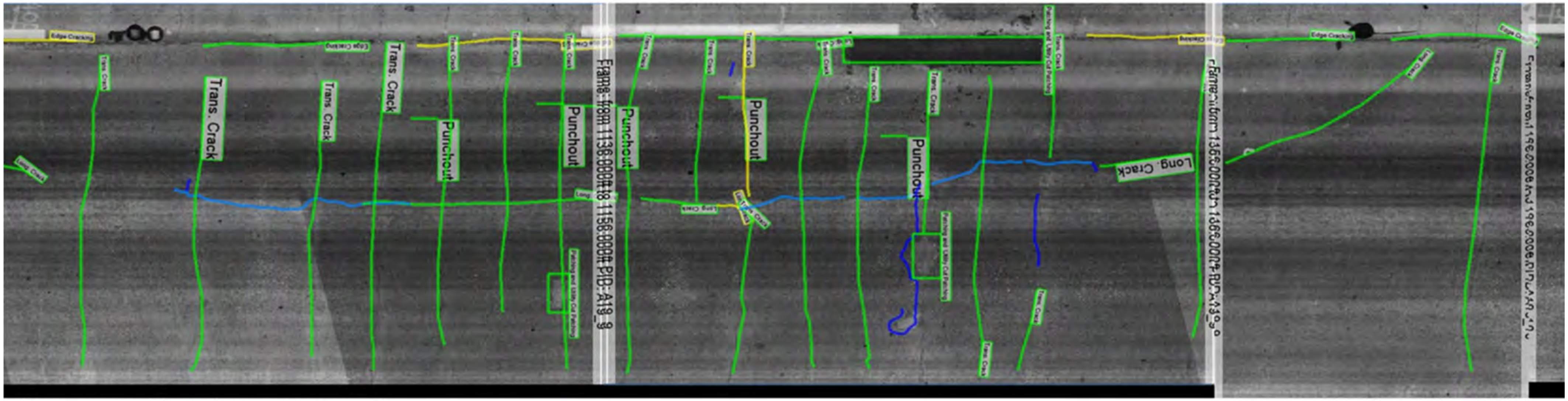


Dynatest (Semi Automated)

Section 19 /// Station 400-450



Manual Crack Map



Dynatest (Semi Automated)

Appendix A.5

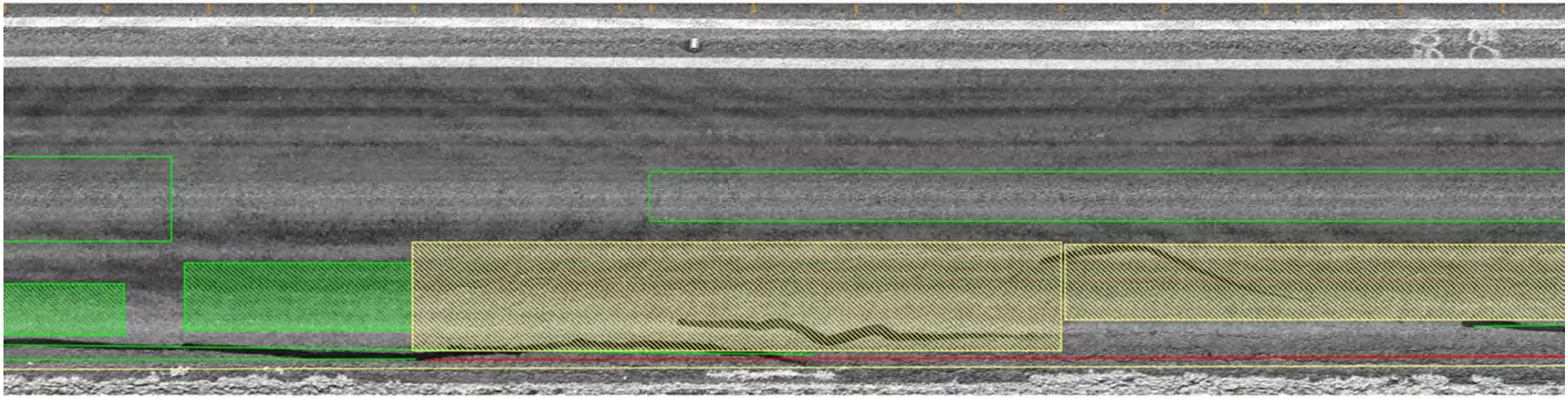
Crack Maps Comparison

Fugro

fully automated

Section 2 /// Station 000-050

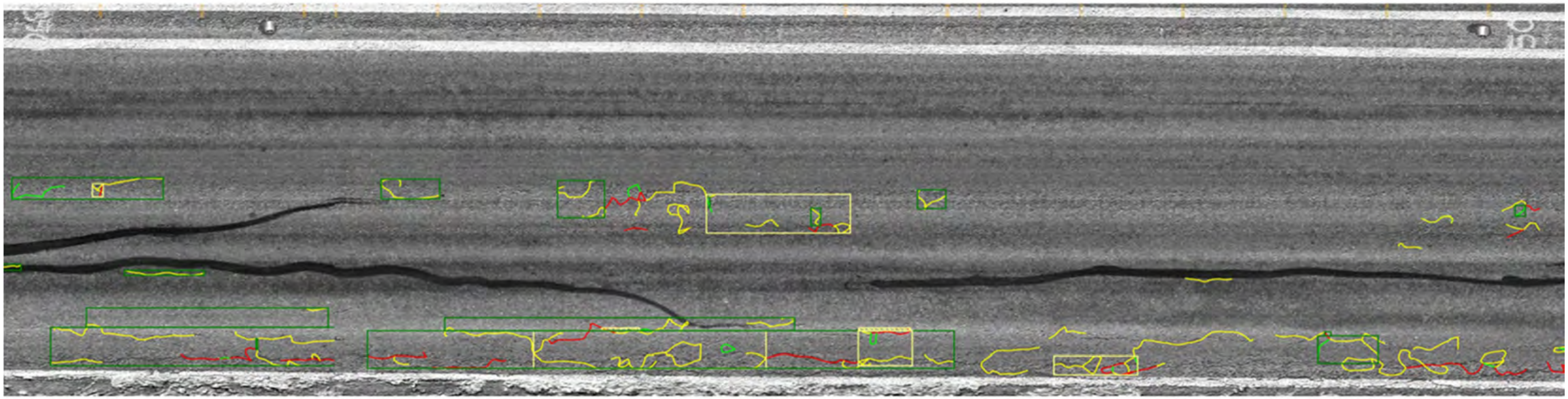
Manual Crack Map



Fugro (Fully Automated)

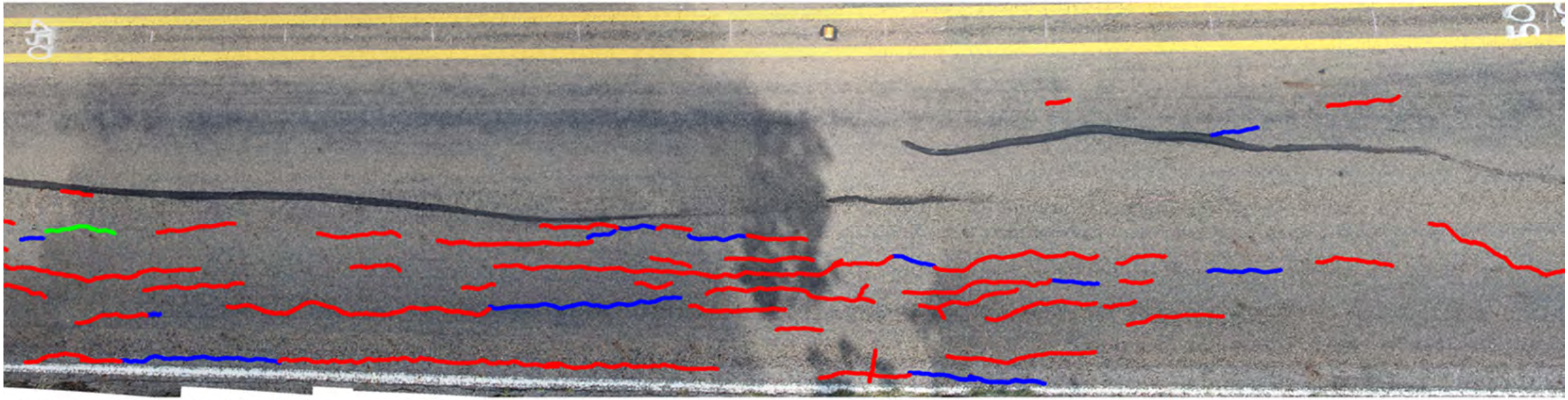
Section 2 /// Station 350-400

Manual Crack Map

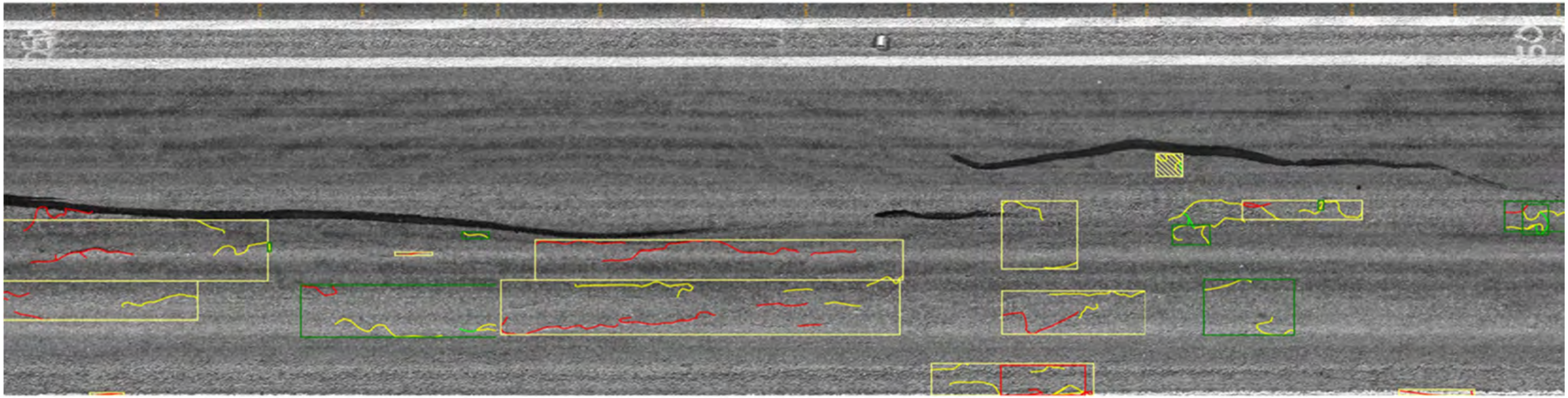


Fugro (Fully Automated)

Section 2 /// Station 450-500

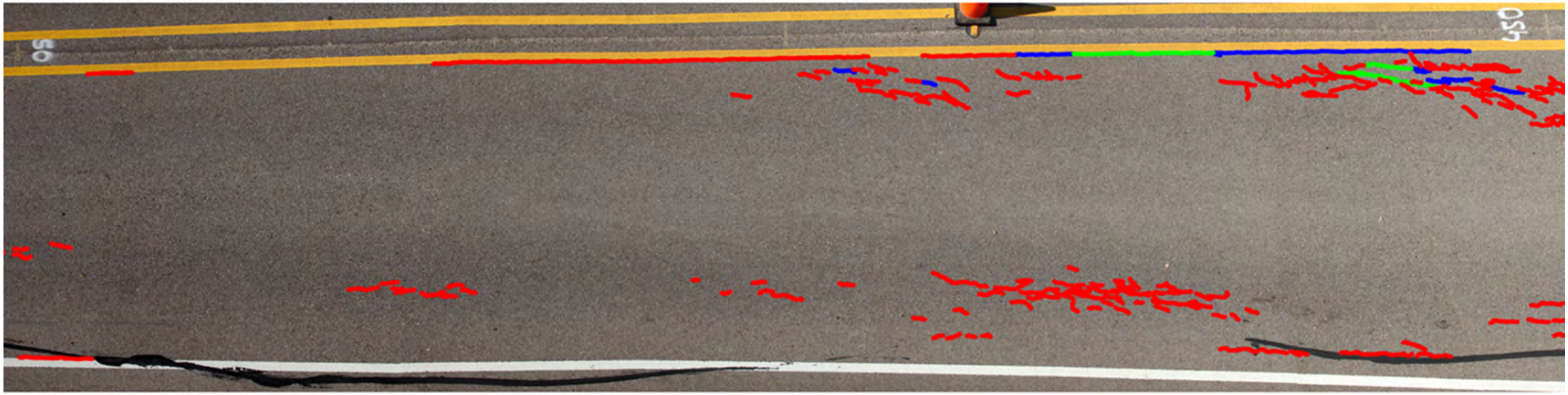


Manual Crack Map



Fugro (Fully Automated)

Section 4 /// Station 050-100



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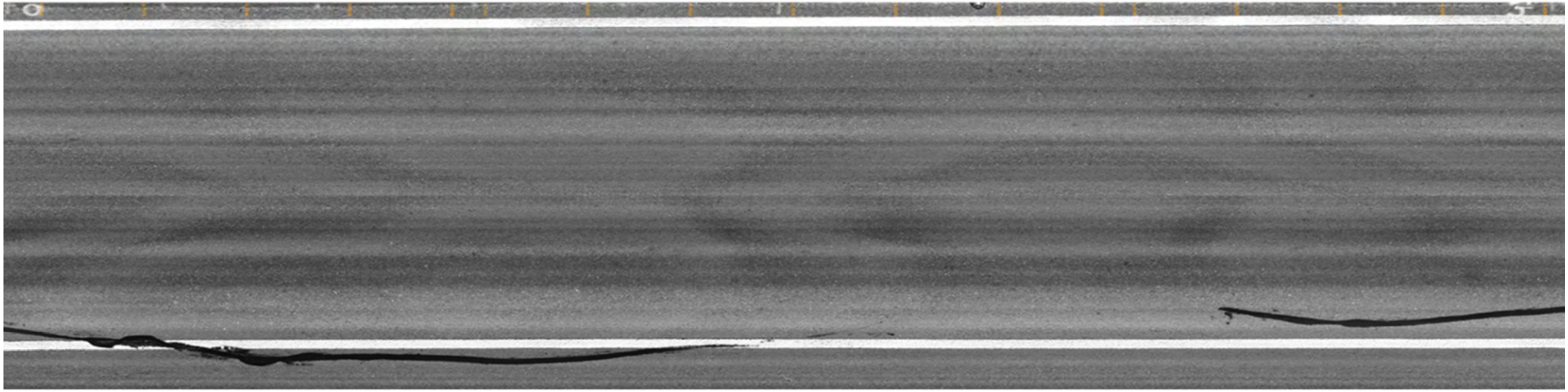
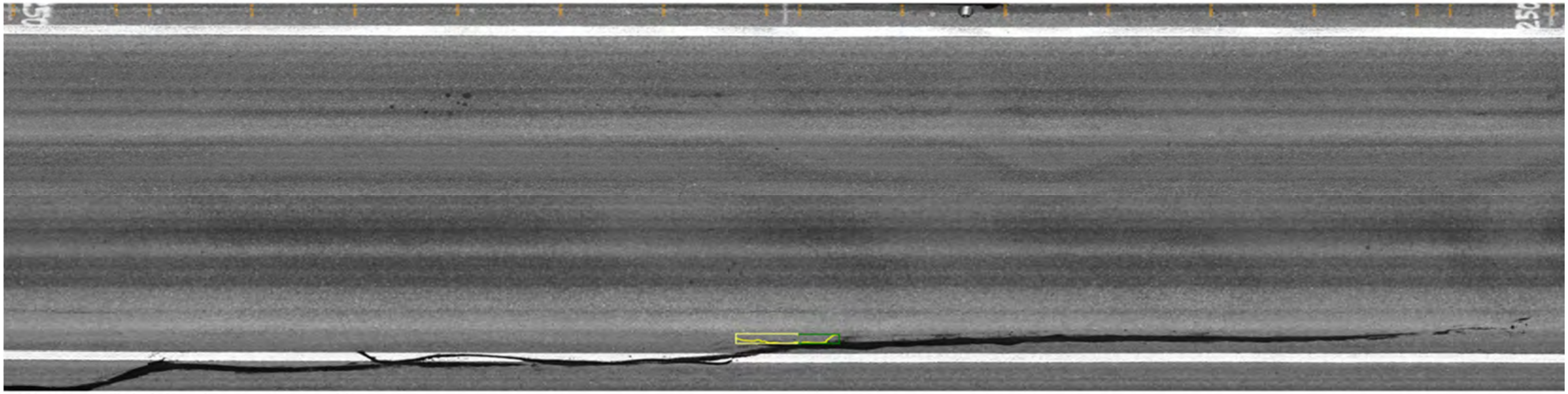


Fugro (Fully Automated)

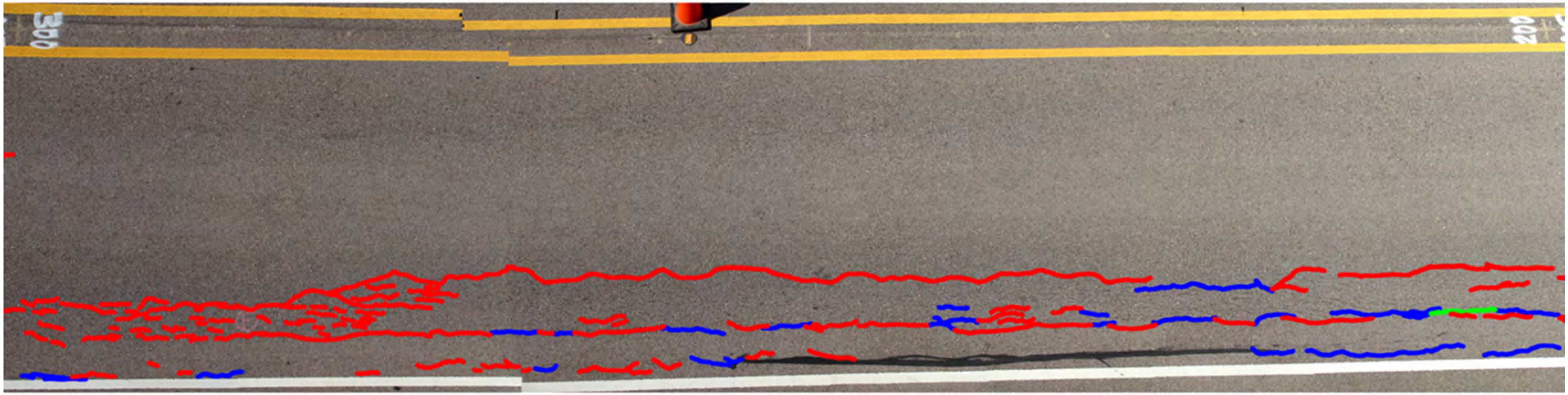
Section 4 /// Station 250-300

Manual Crack Map

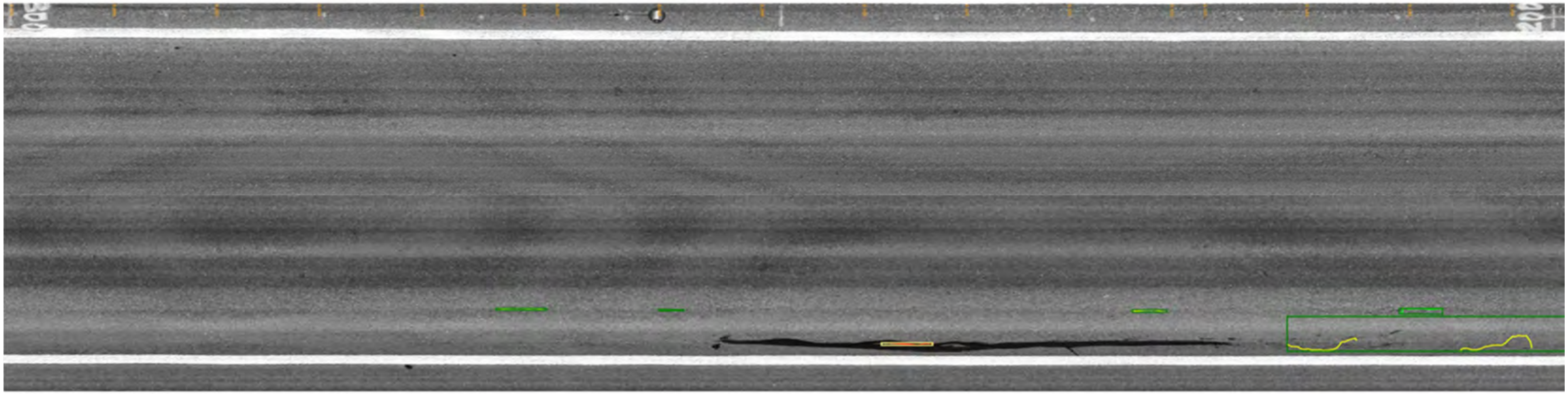


Fugro (Fully Automated)

Section 4 /// Station 300-350



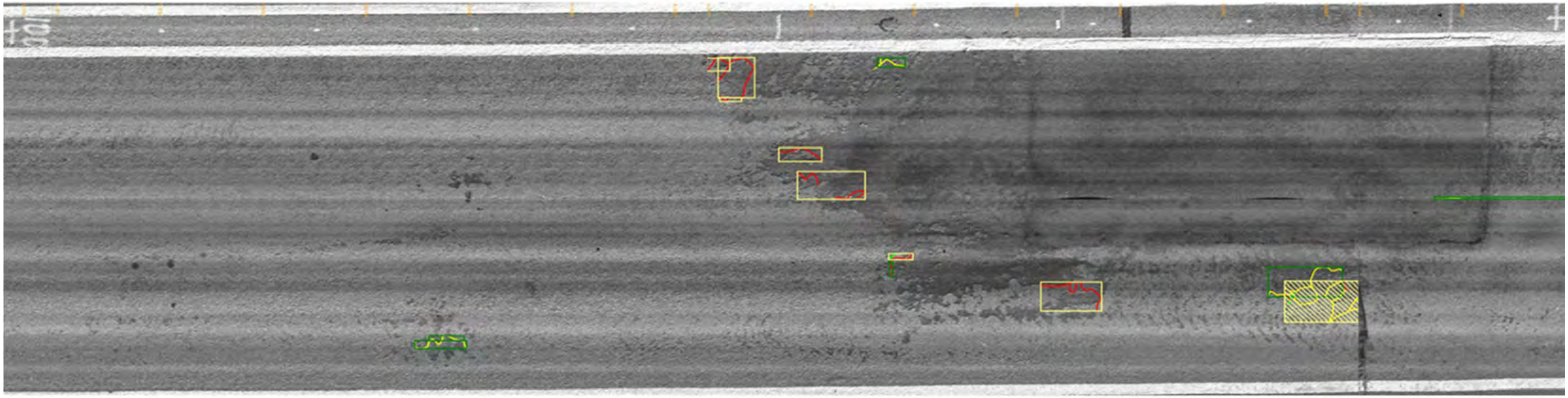
Manual Crack Map



Fugro (Fully Automated)

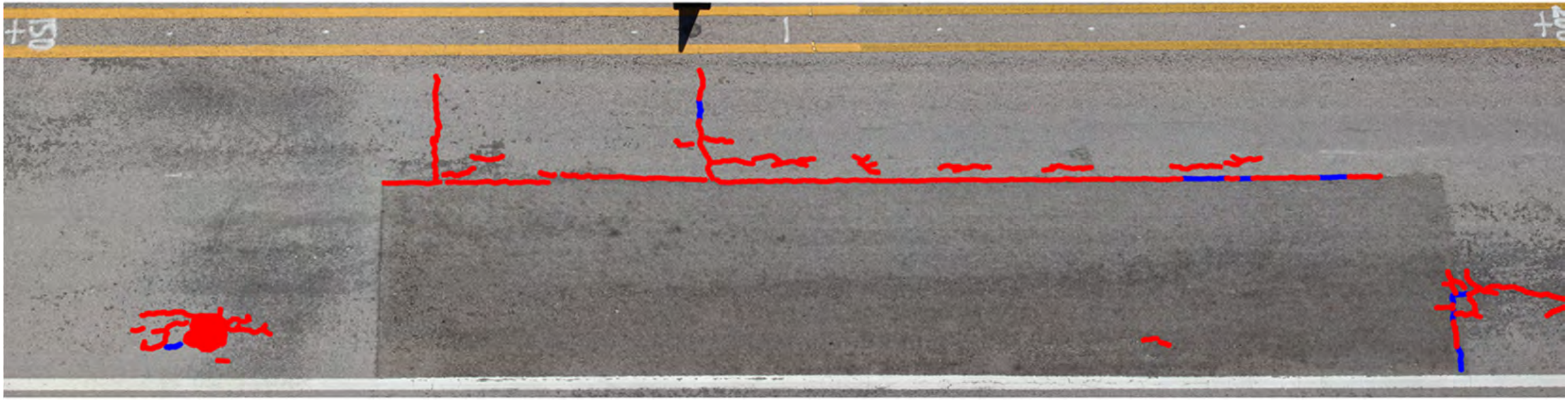
Section 6 /// Station 100-150

Manual Crack Map



Fugro (Fully Automated)

Section 6 /// Station 150-200



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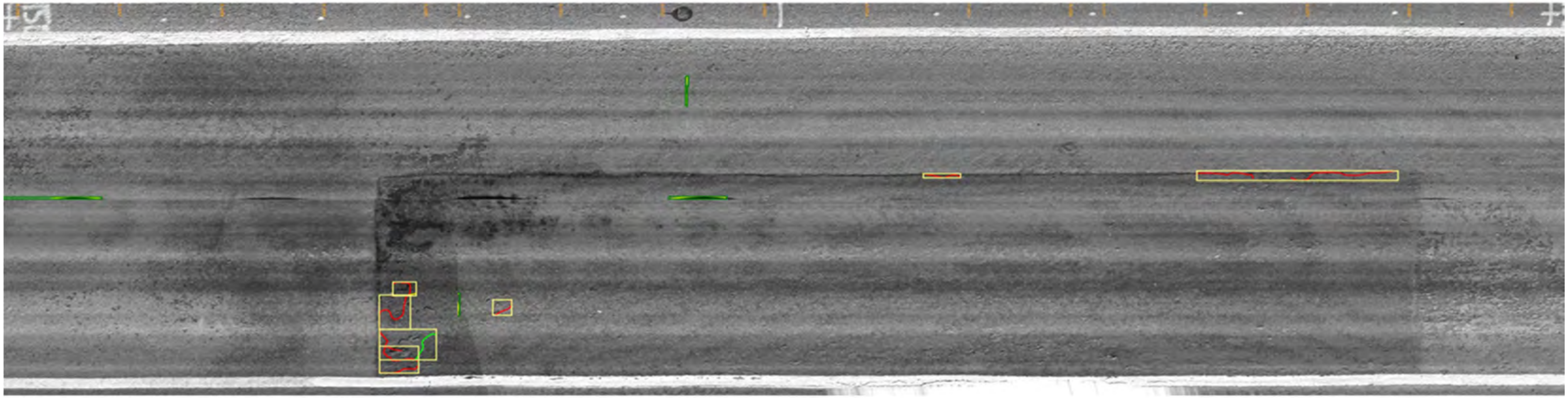
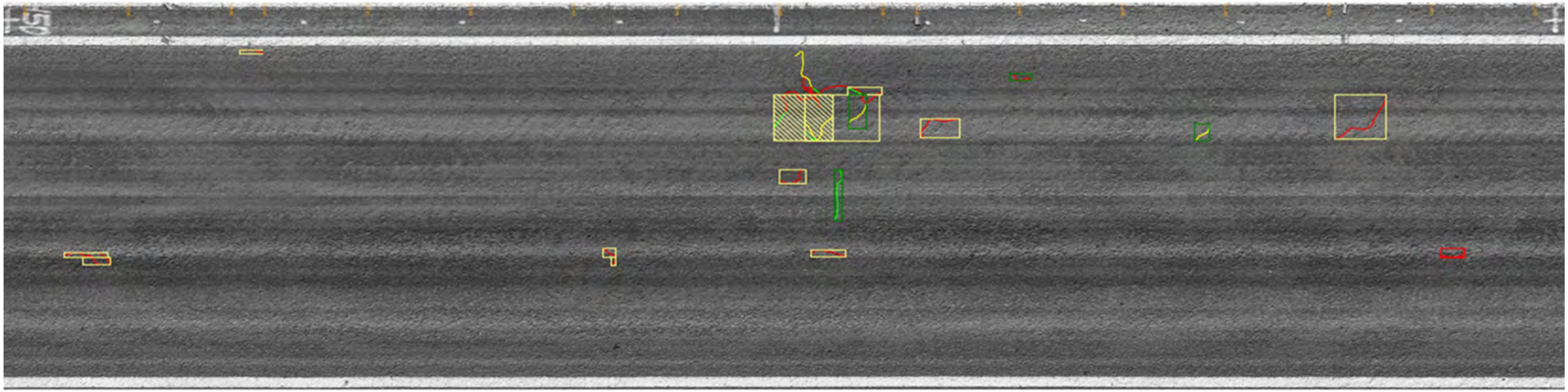


Fugro (Fully Automated)

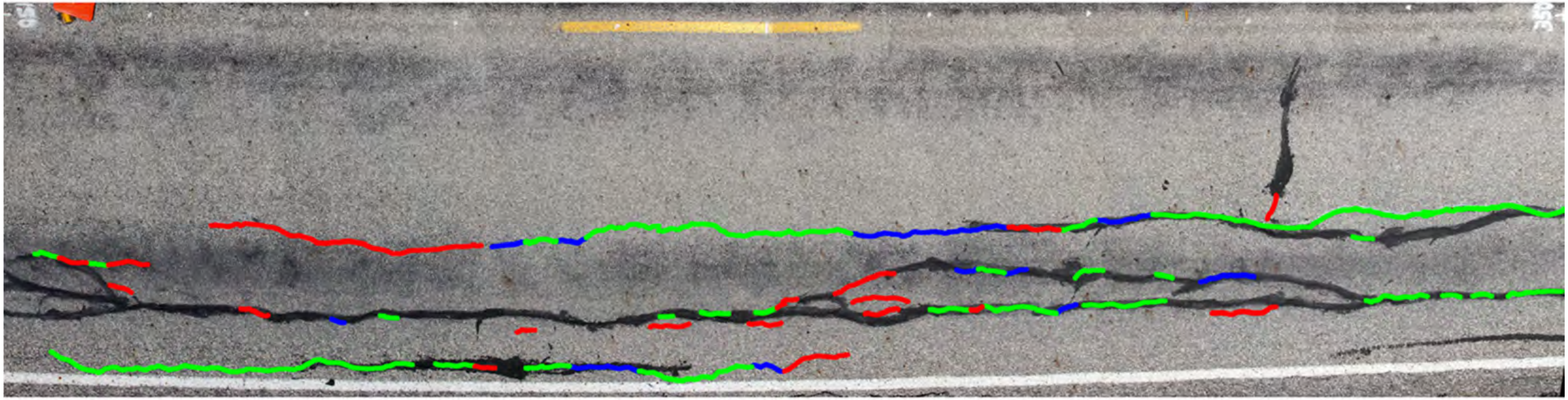
Section 6 /// Station 450-500

Manual Crack Map



Fugro (Fully Automated)

Section 9 /// Station 150-200



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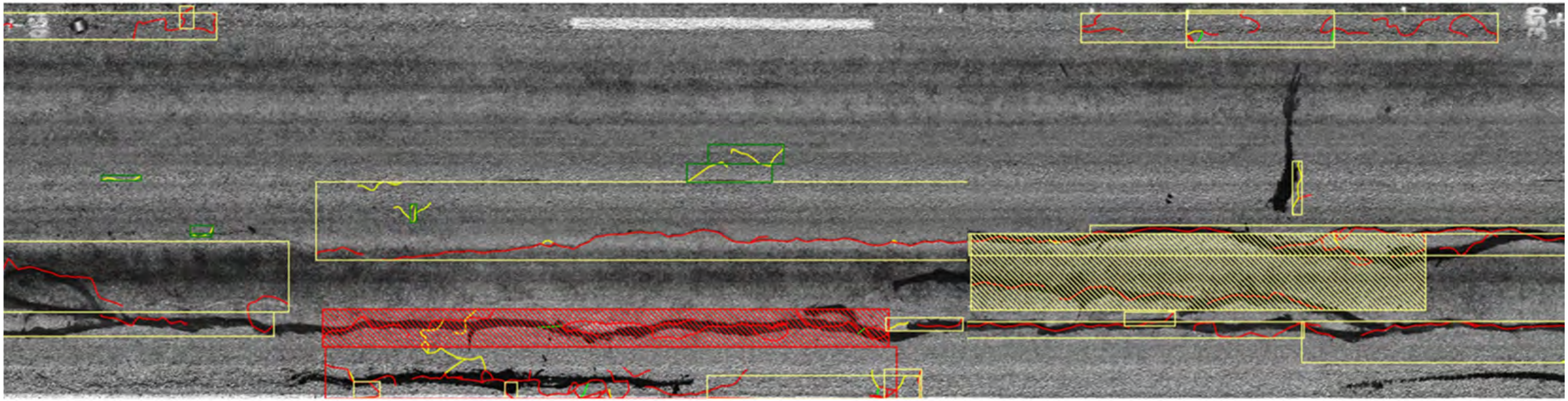
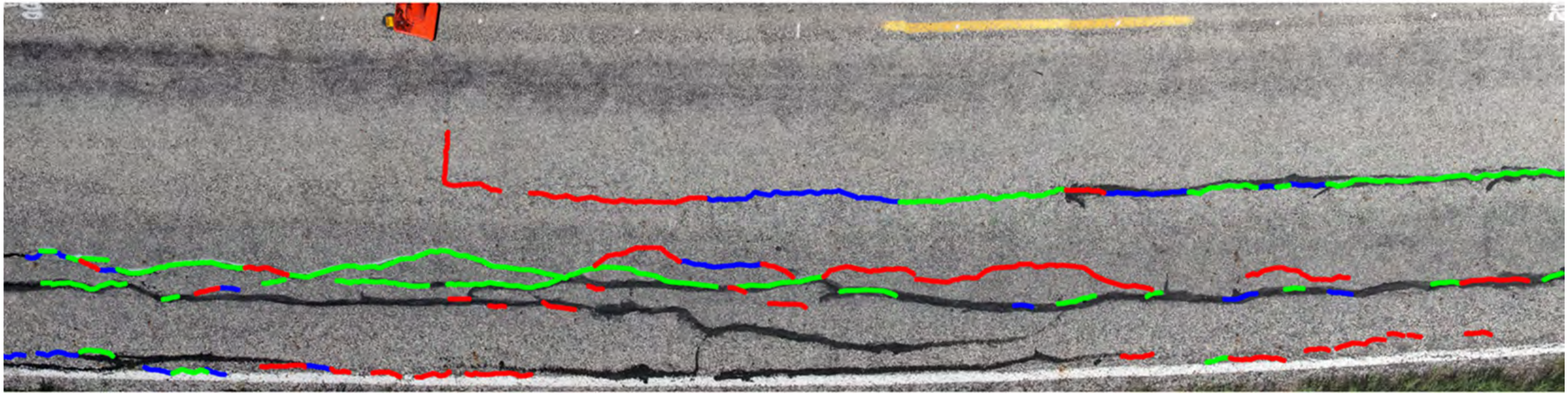


Fugro (Fully Automated)

Section 9 /// Station 300-350



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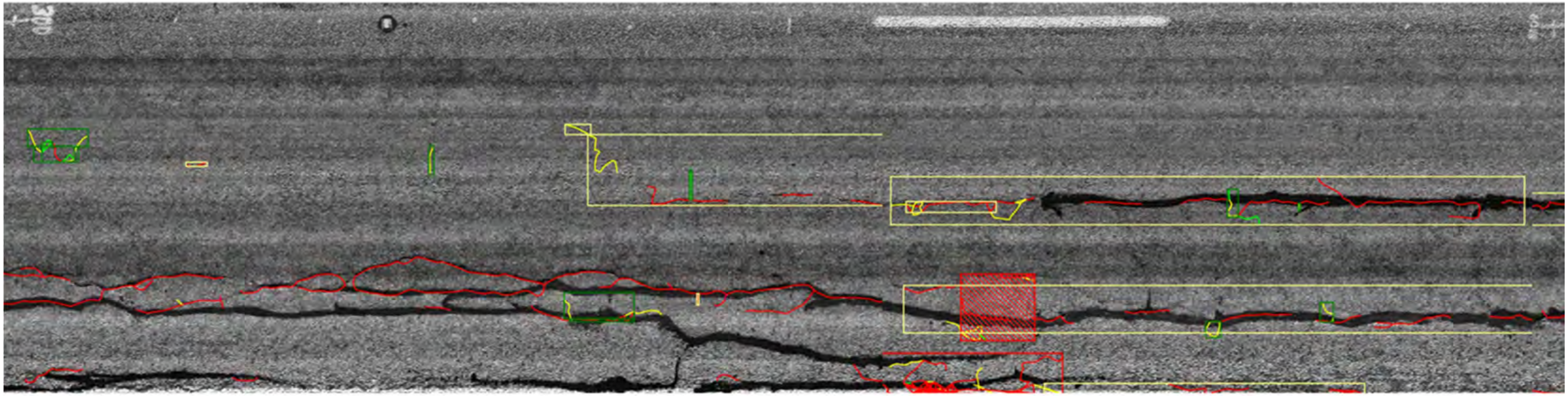
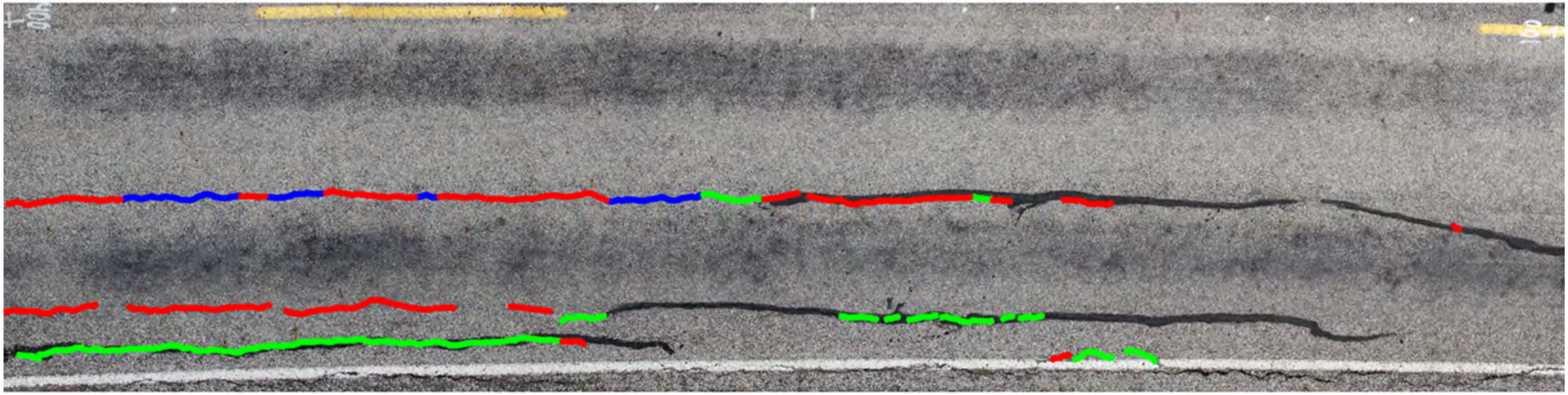


Fugro (Fully Automated)

Section 9 /// Station 400-450



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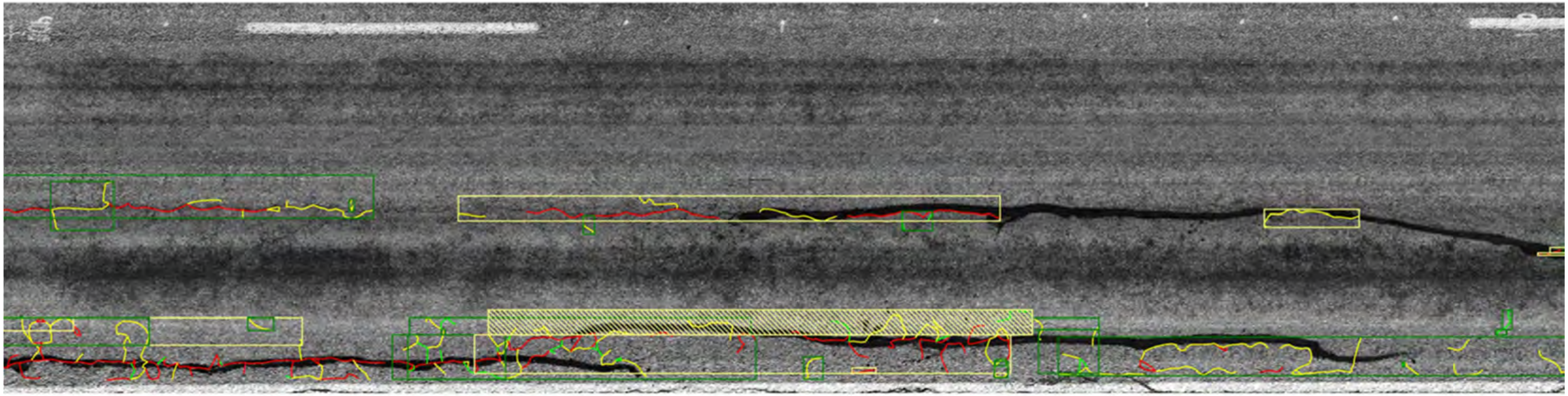
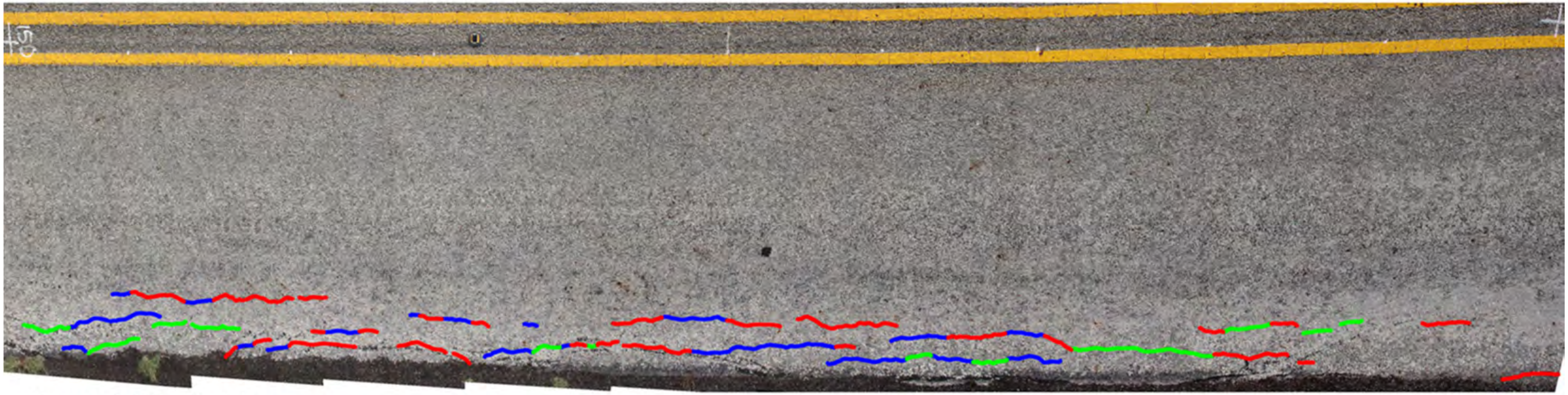


Fugro (Fully Automated)

Section 10/// Station 150-200



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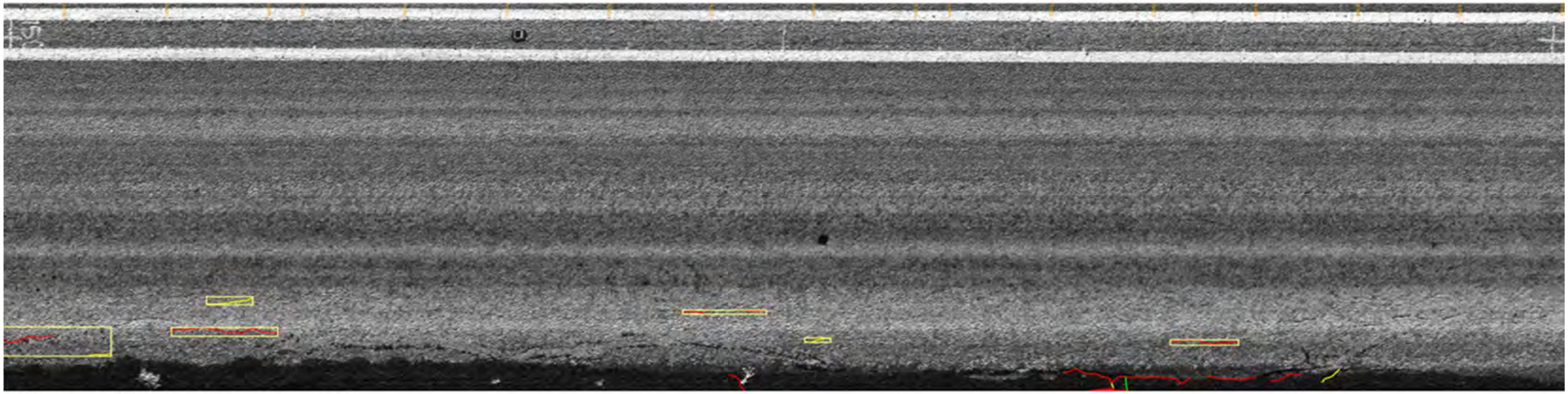
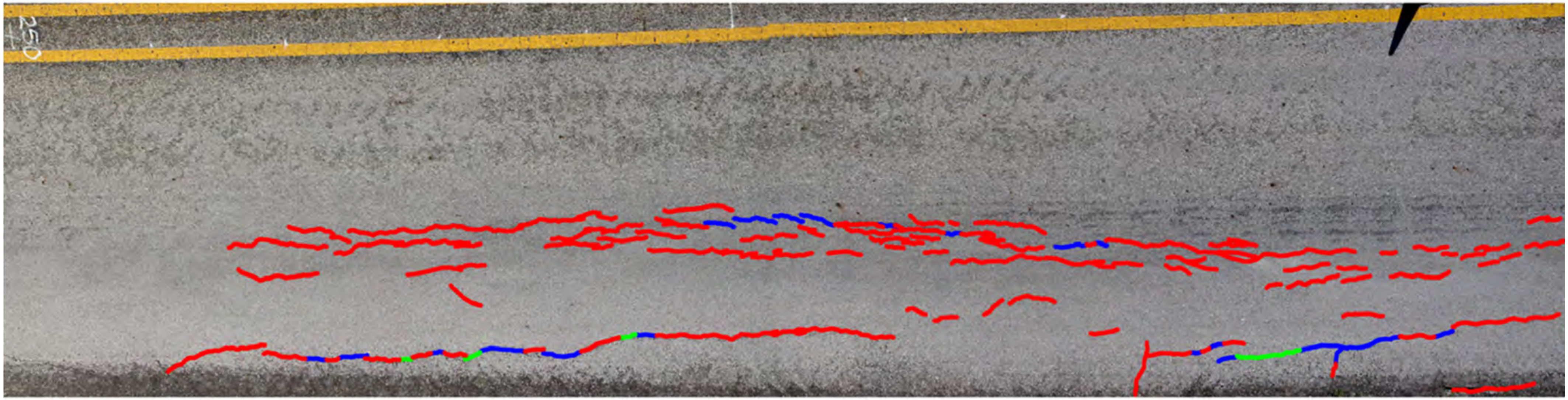


Fugro (Fully Automated)

Section 10/// Station 250-300



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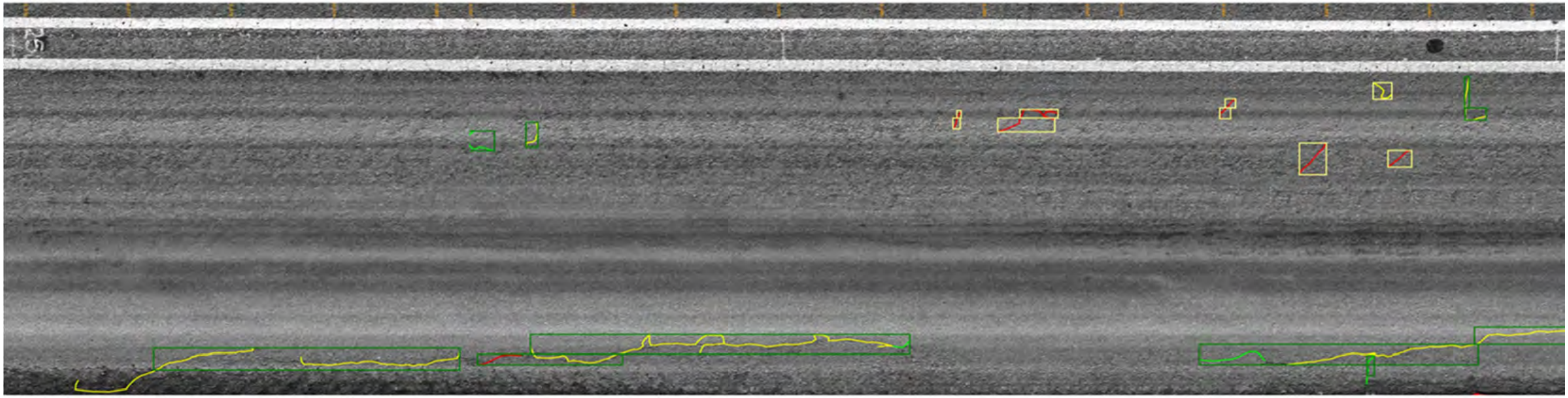
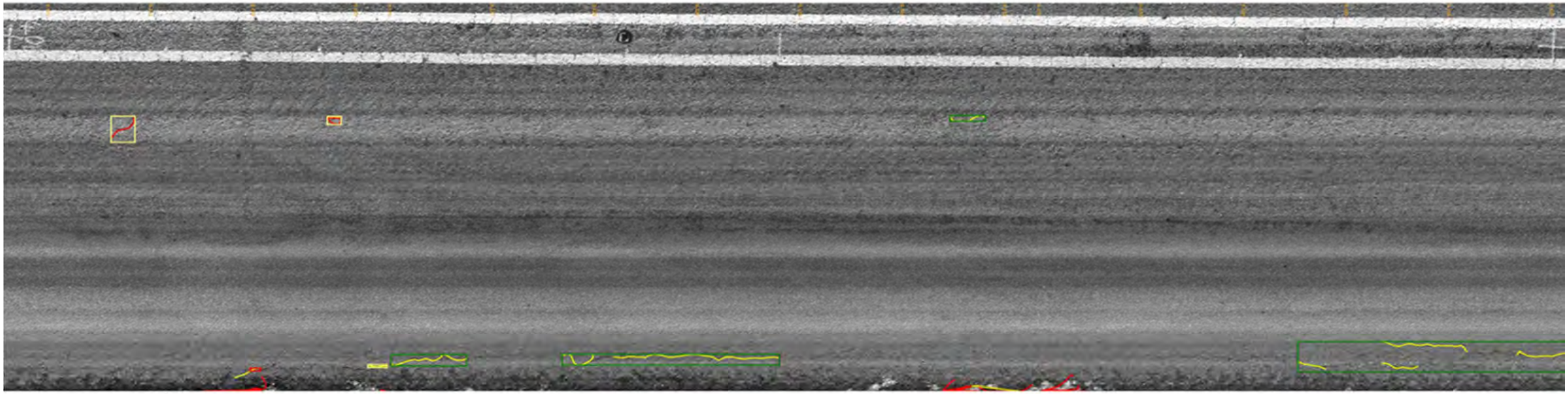


Fugro (Fully Automated)

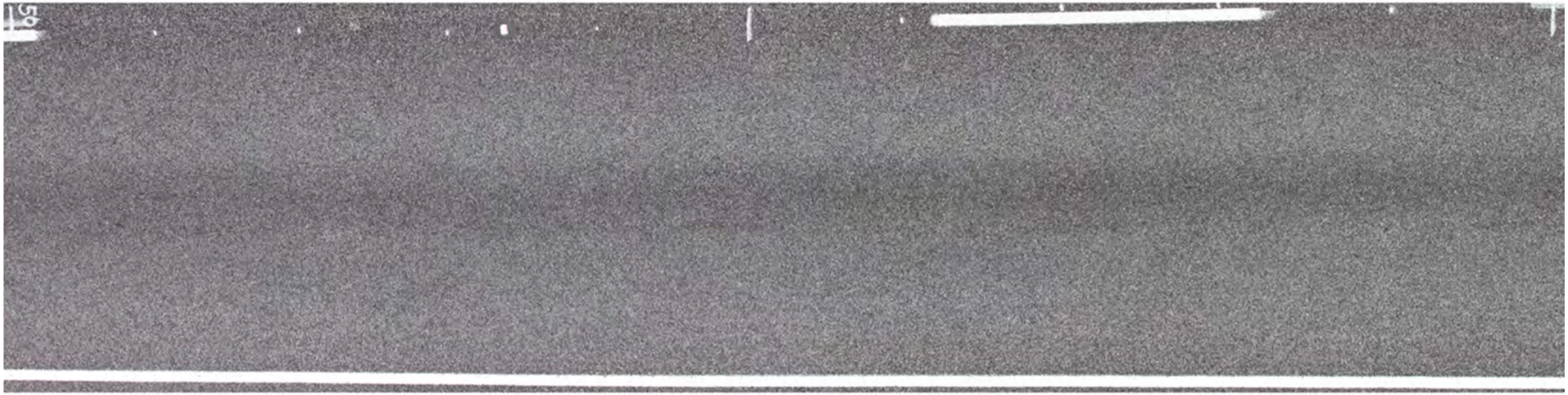
Section 10 /// Station 400-450

Manual Crack Map



Fugro (Fully Automated)

Section 11 /// Station 050-100



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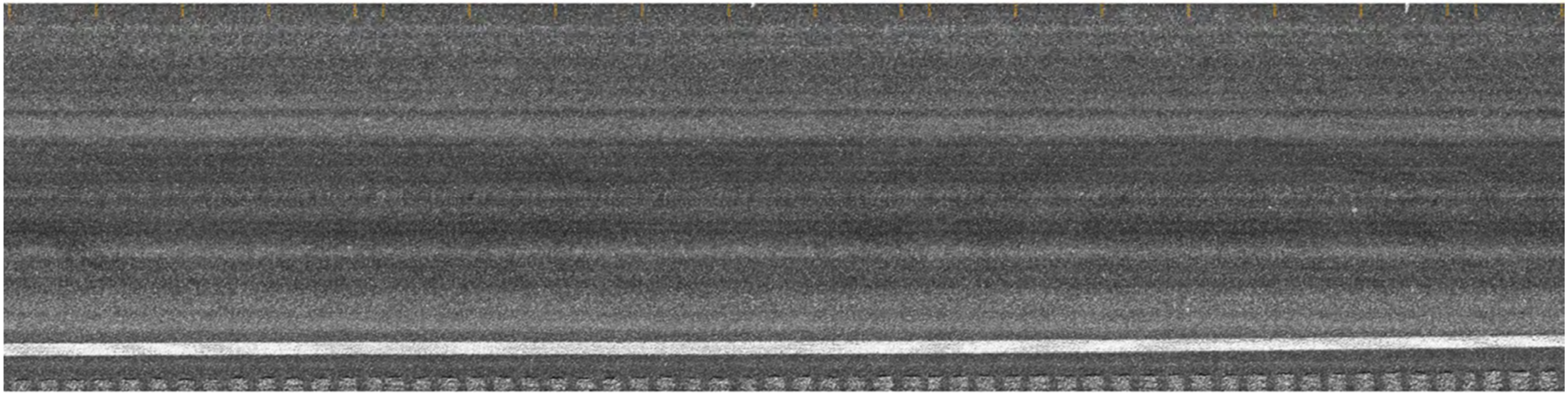
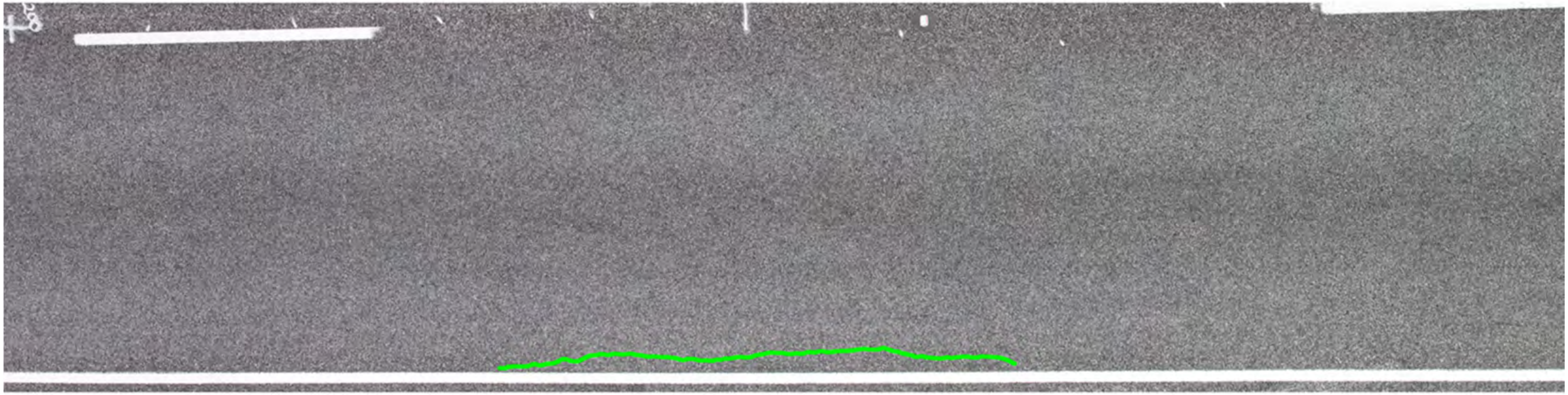


Fugro (Fully Automated)

Section 11 /// Station 200-250



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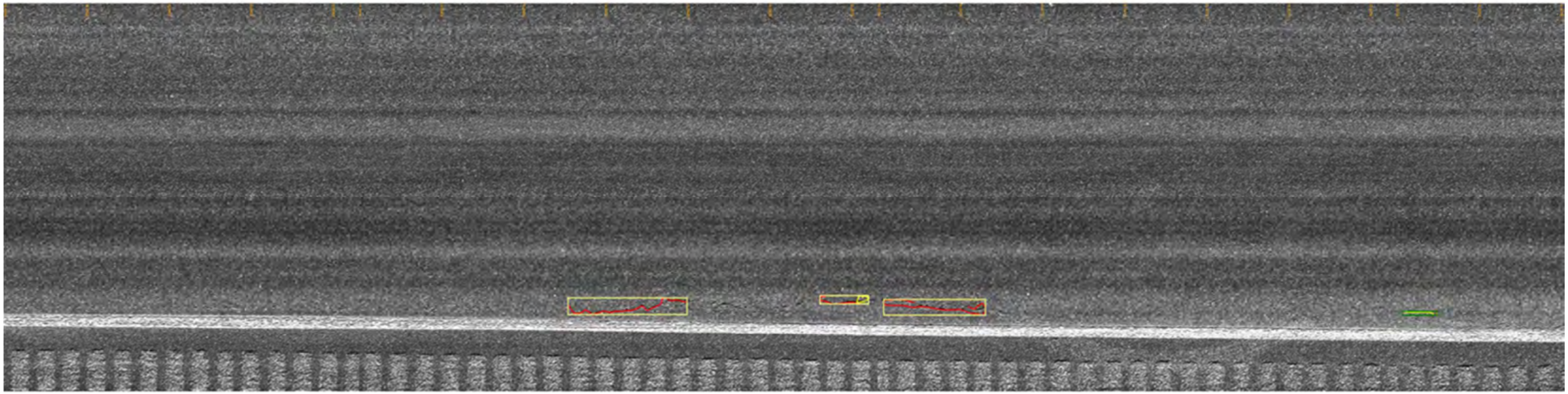
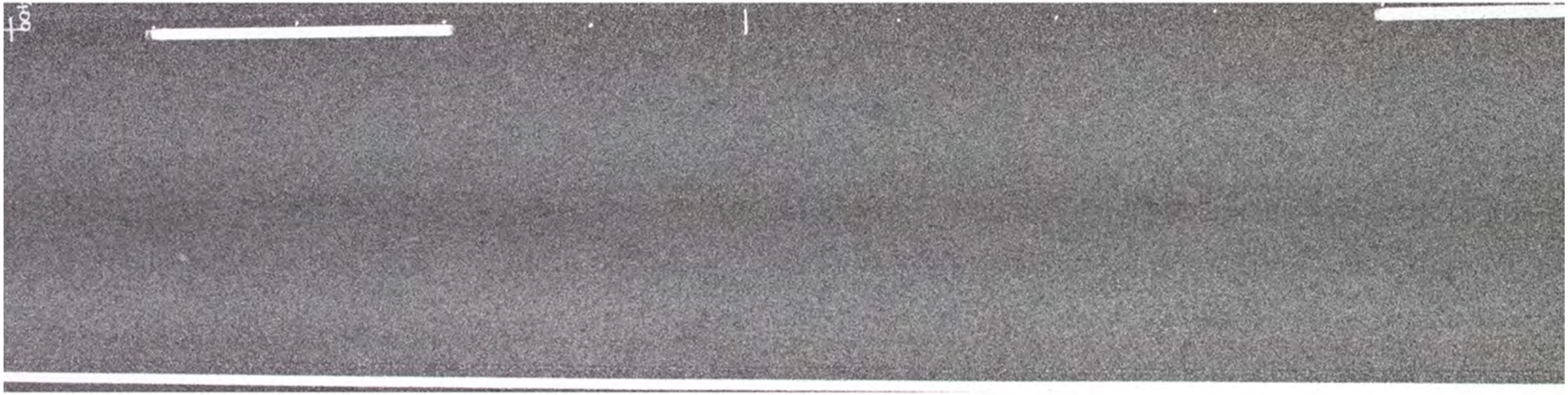


Fugro (Fully Automated)

Section 11 /// Station 400-450



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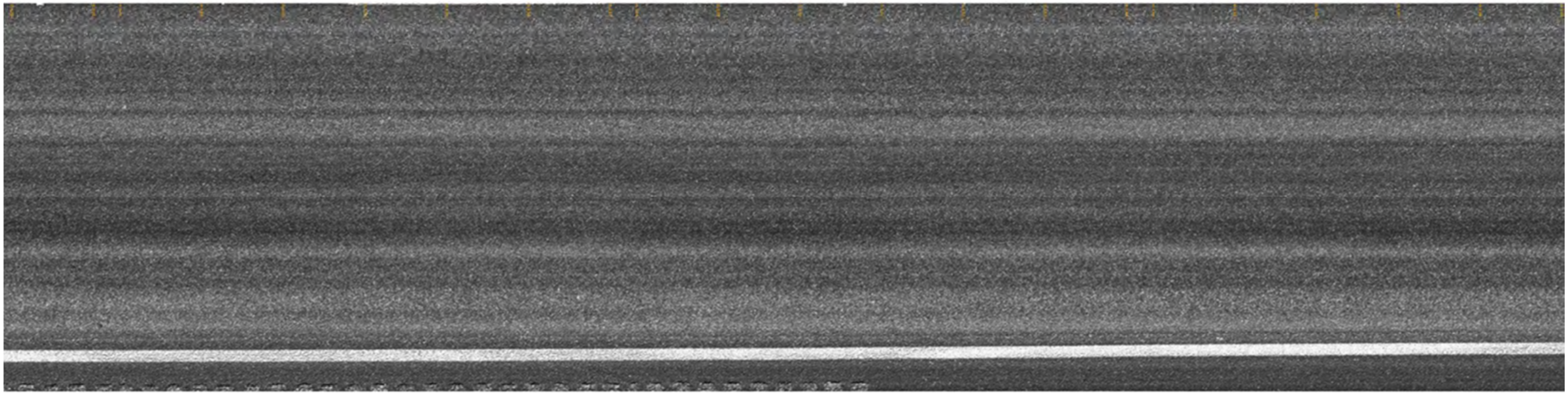
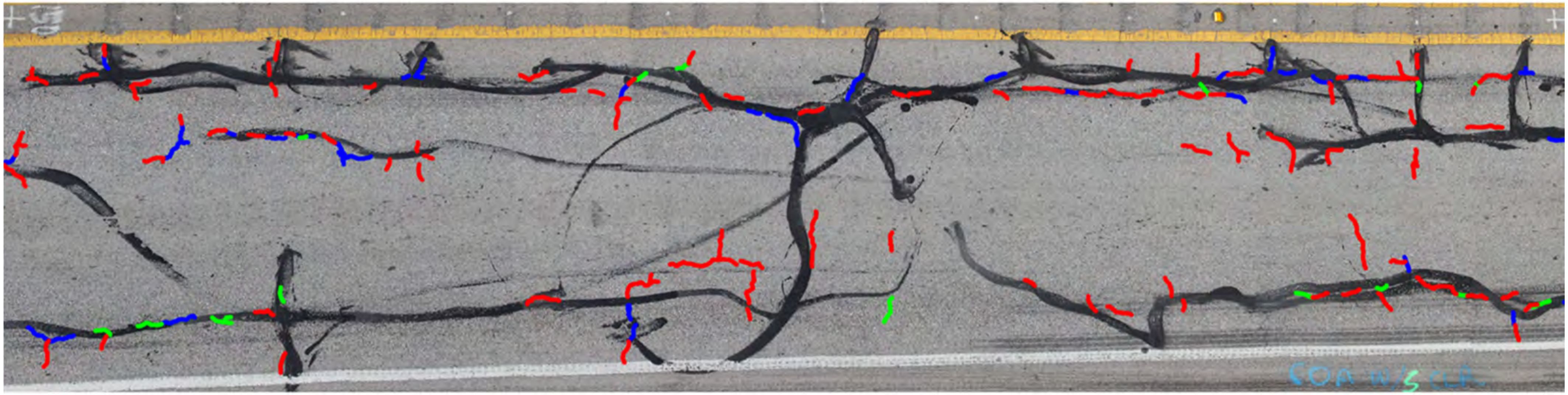
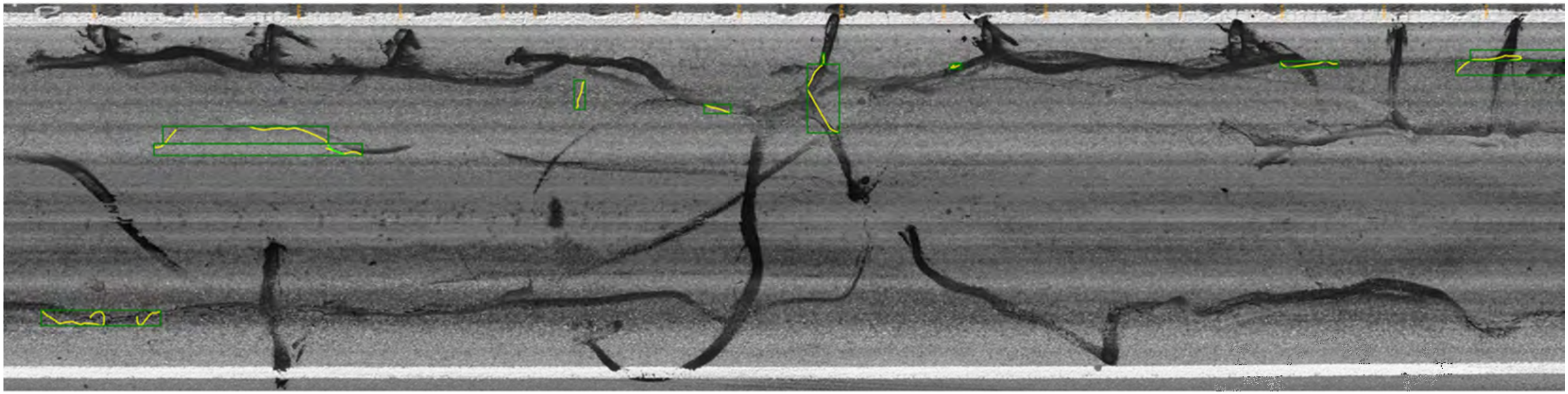


Fugro (Fully Automated)

Section 12 /// Station 150-200



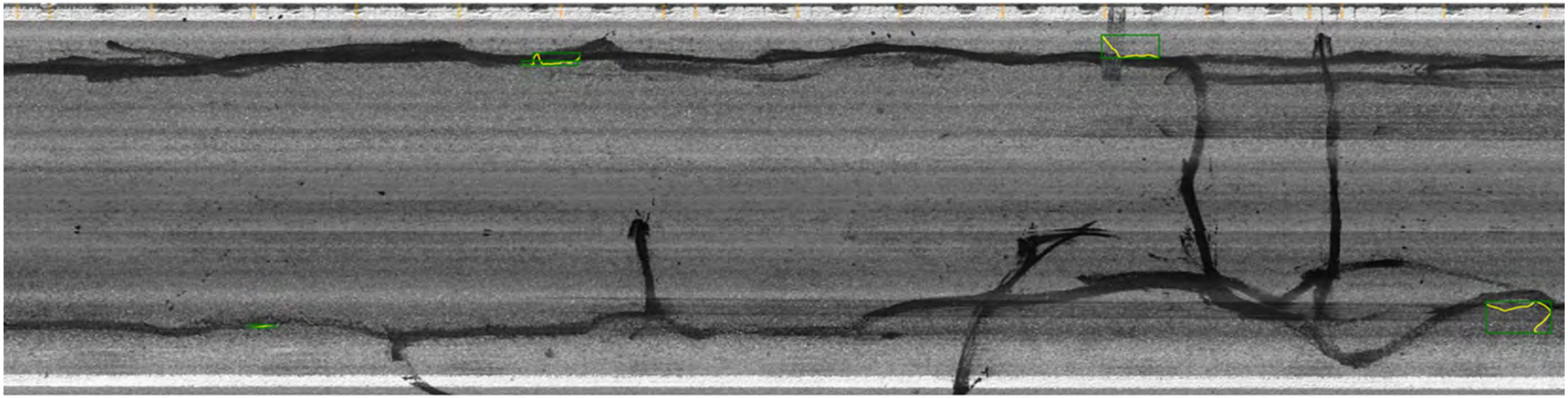
Manual Crack Map



Fugro (Fully Automated)

Section 12 /// Station 250-300

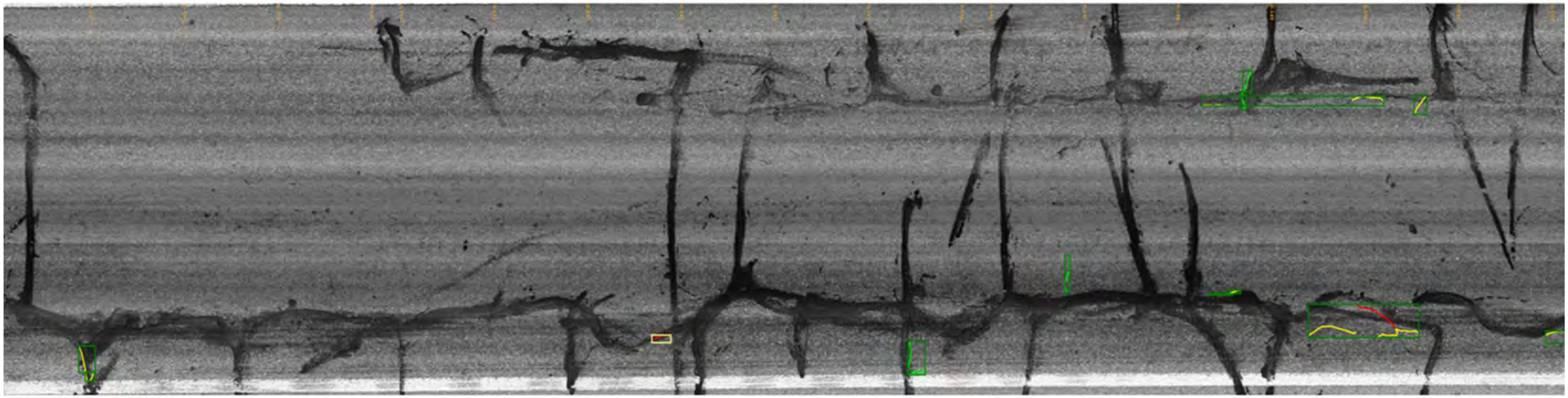
Manual Crack Map



Fugro (Fully Automated)

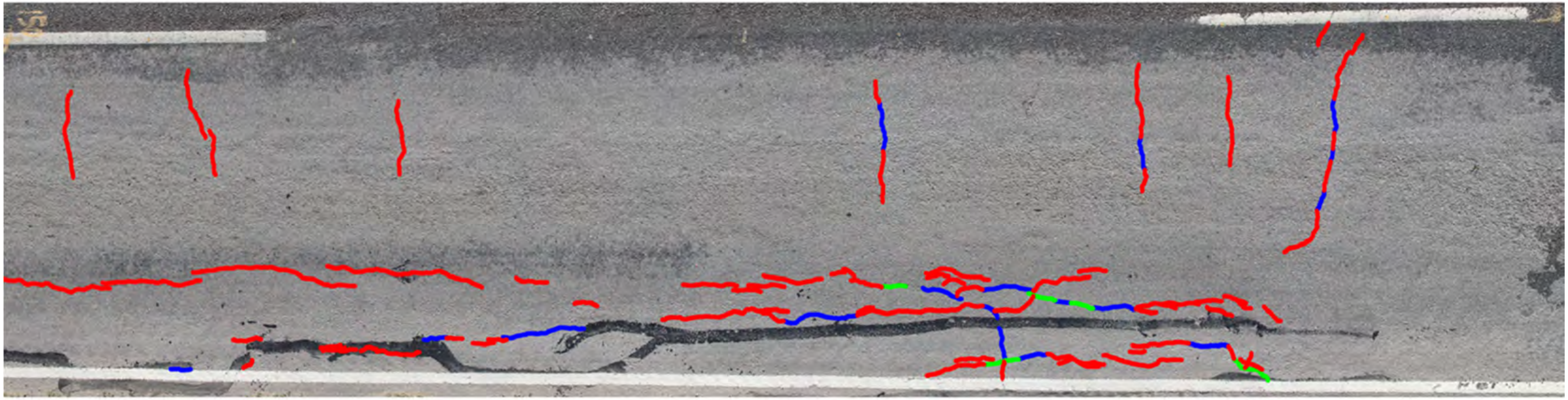
Section 12 /// Station 450-500

Manual Crack Map

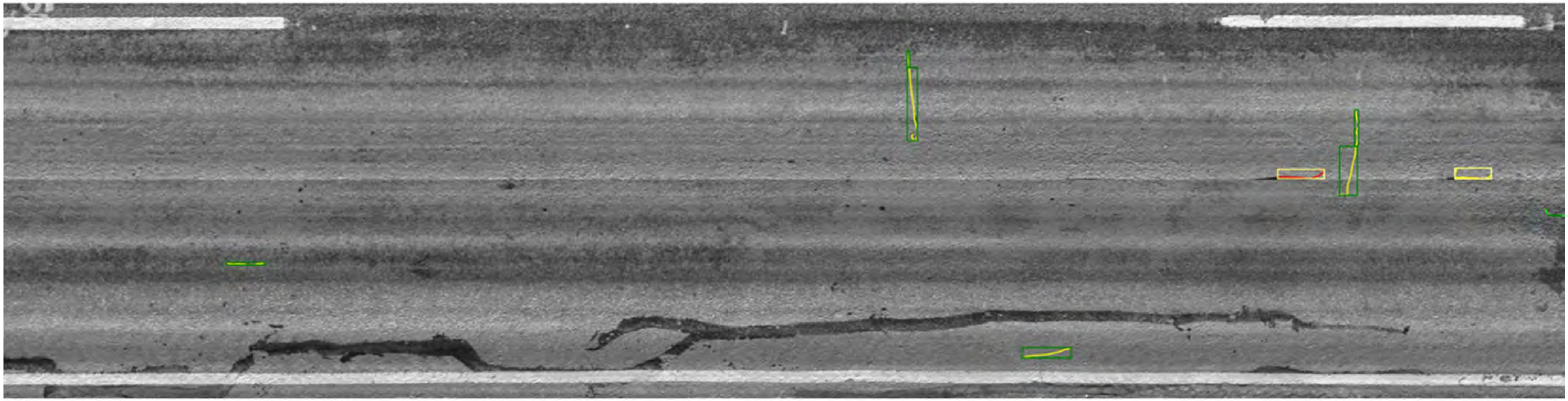


Fugro (Fully Automated)

Section 13 /// Station 150-200

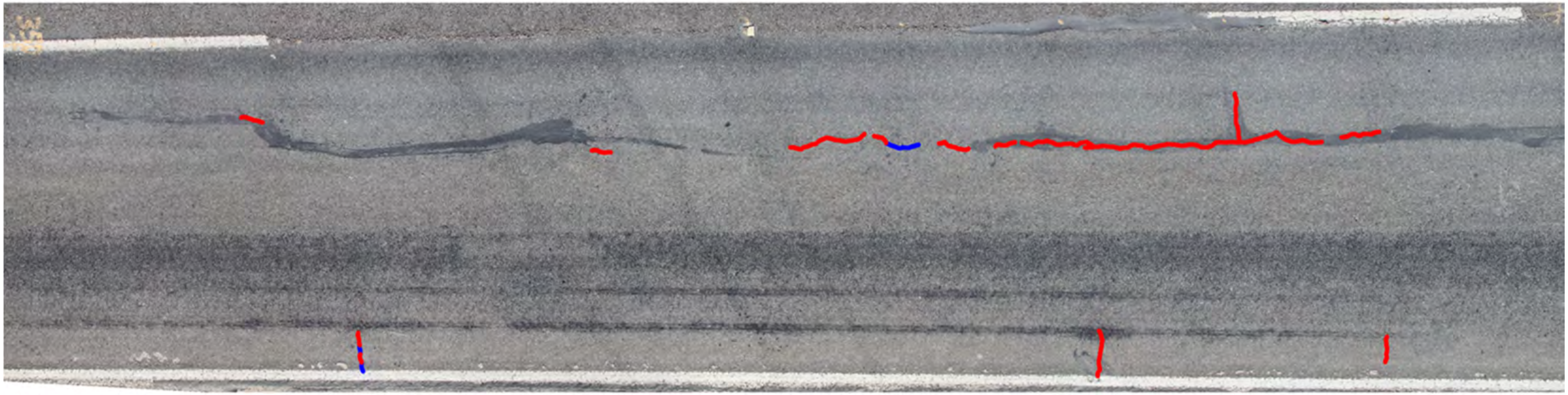


Manual Crack Map

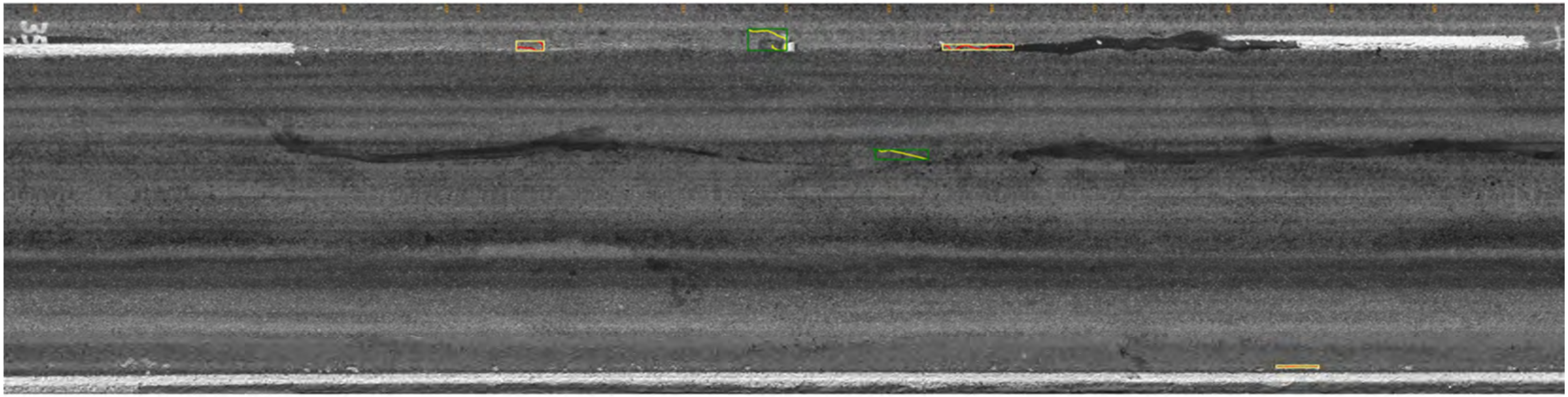


Fugro (Fully Automated)

Section 13 /// Station 350-400

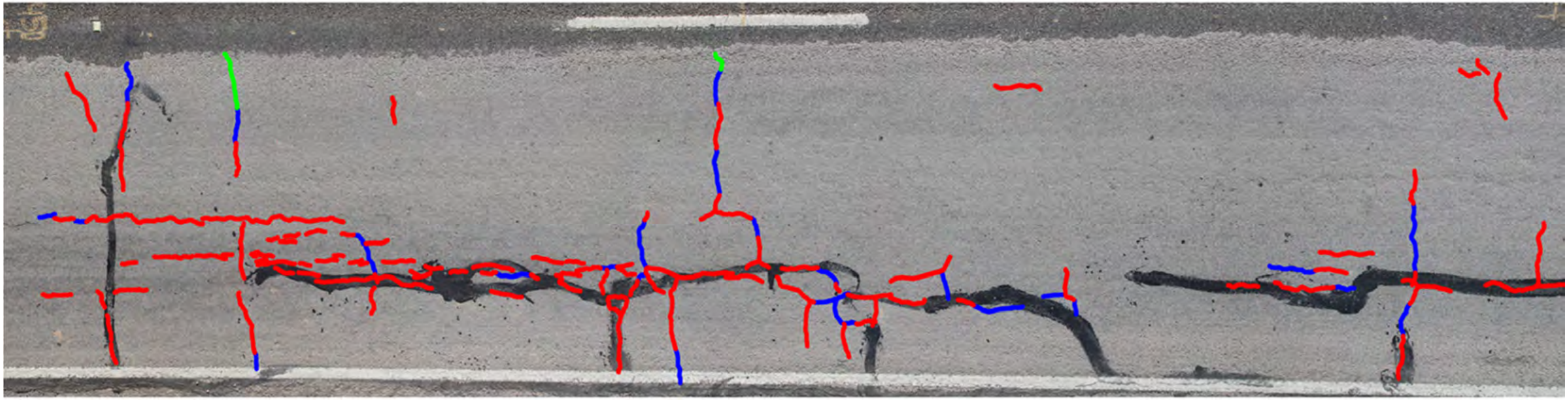


Manual Crack Map



Fugro (Fully Automated)

Section 13 /// Station 450-500



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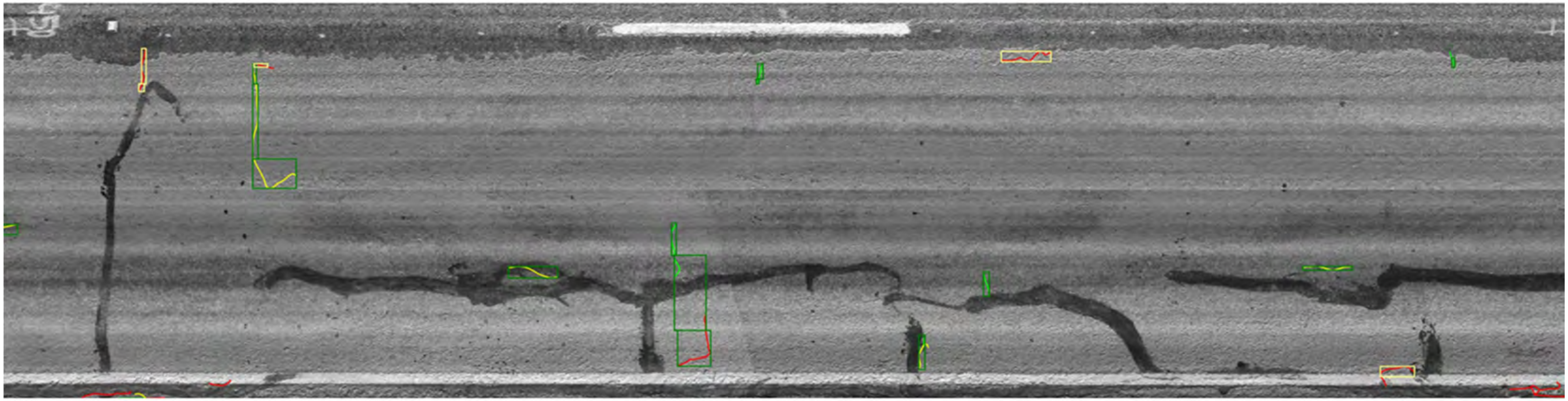
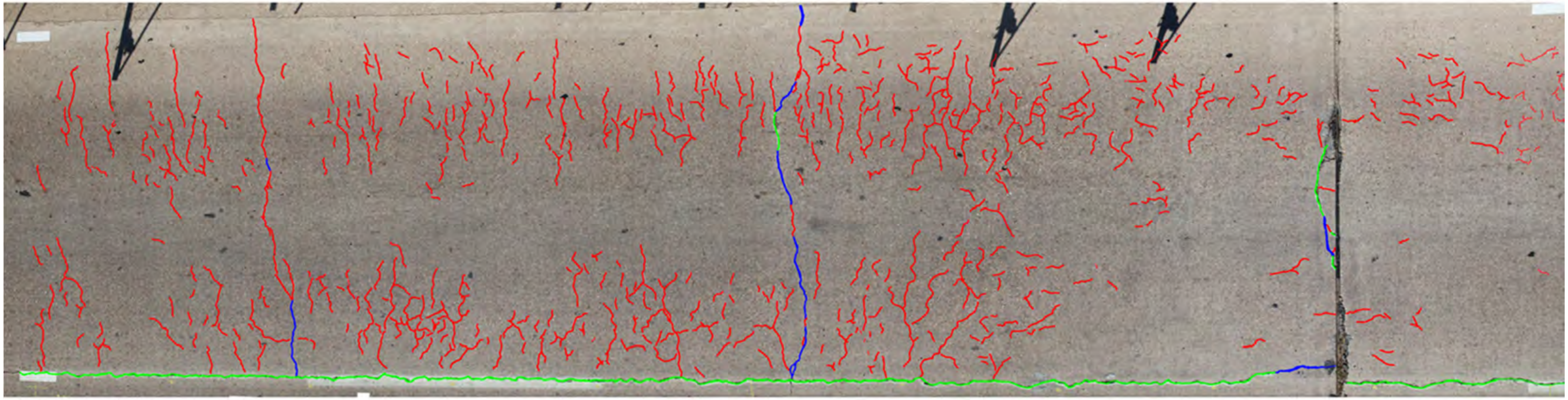


Fugro (Fully Automated)

Section 17 /// Station 050-100



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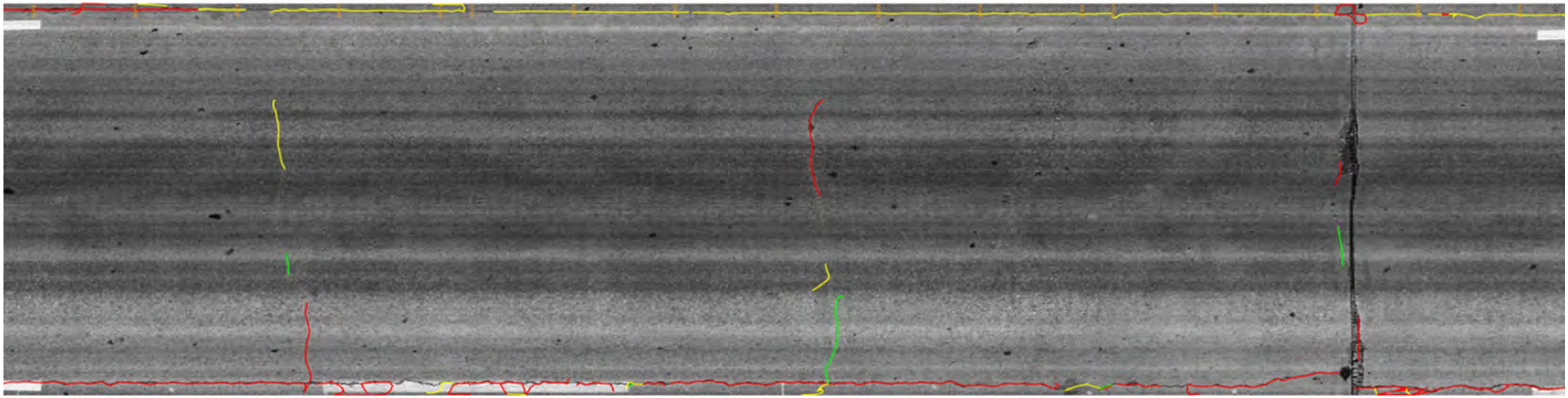
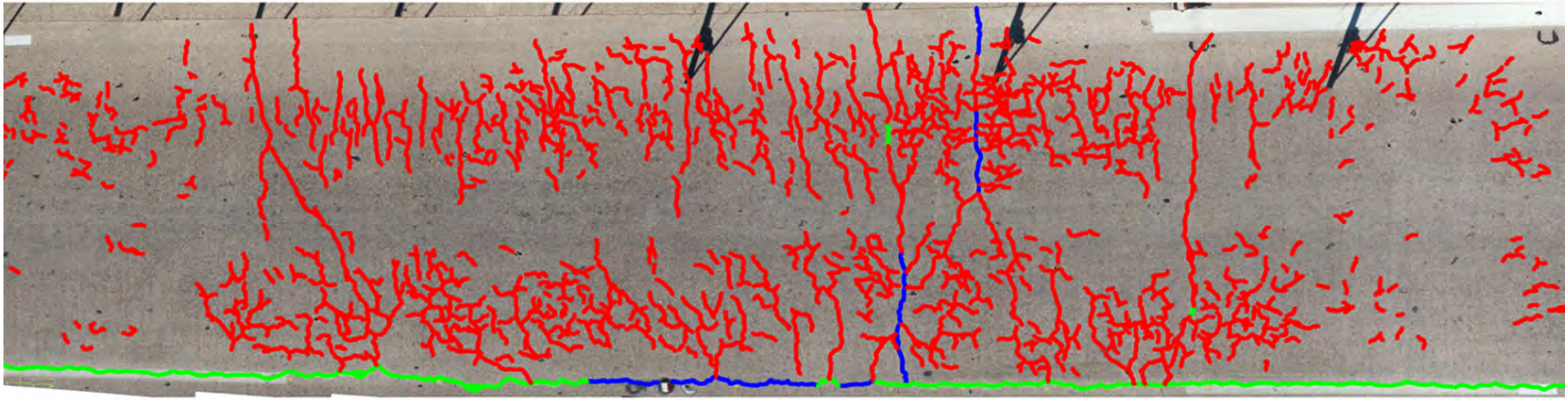


Fugro (Fully Automated)

Section 17 /// Station 100-150



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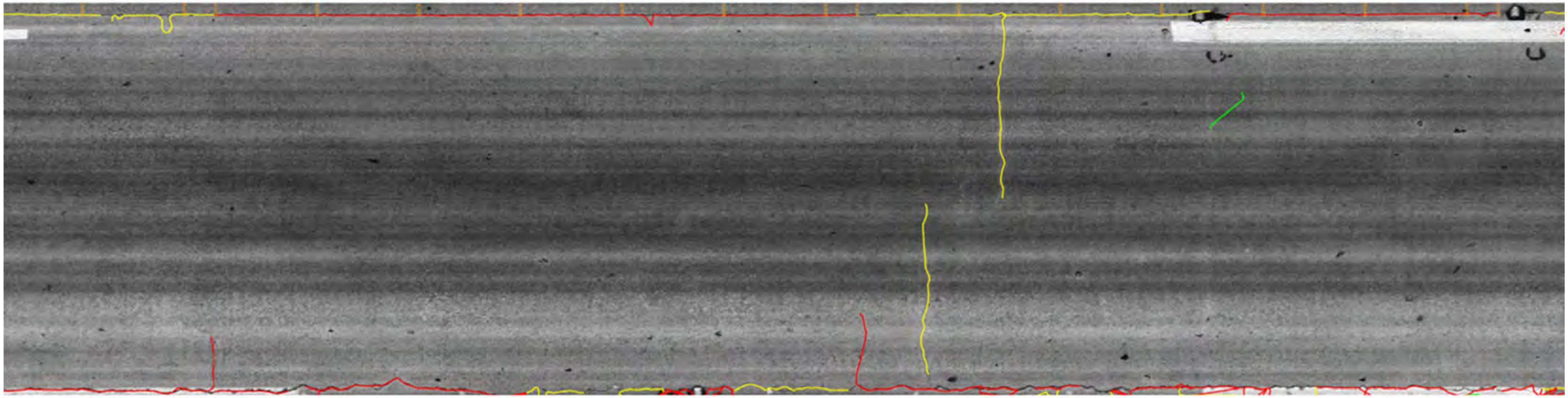
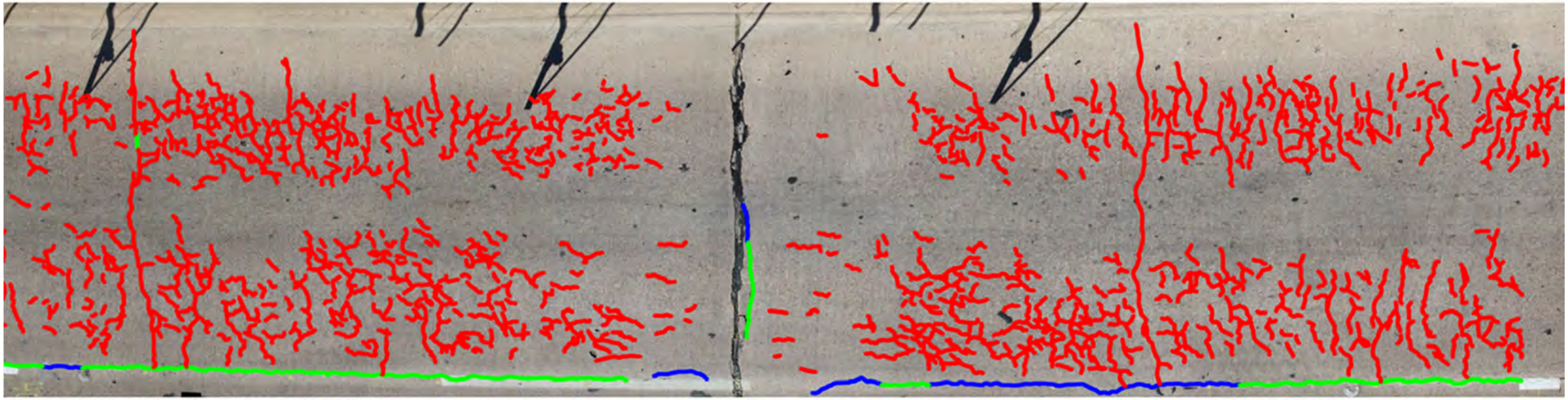
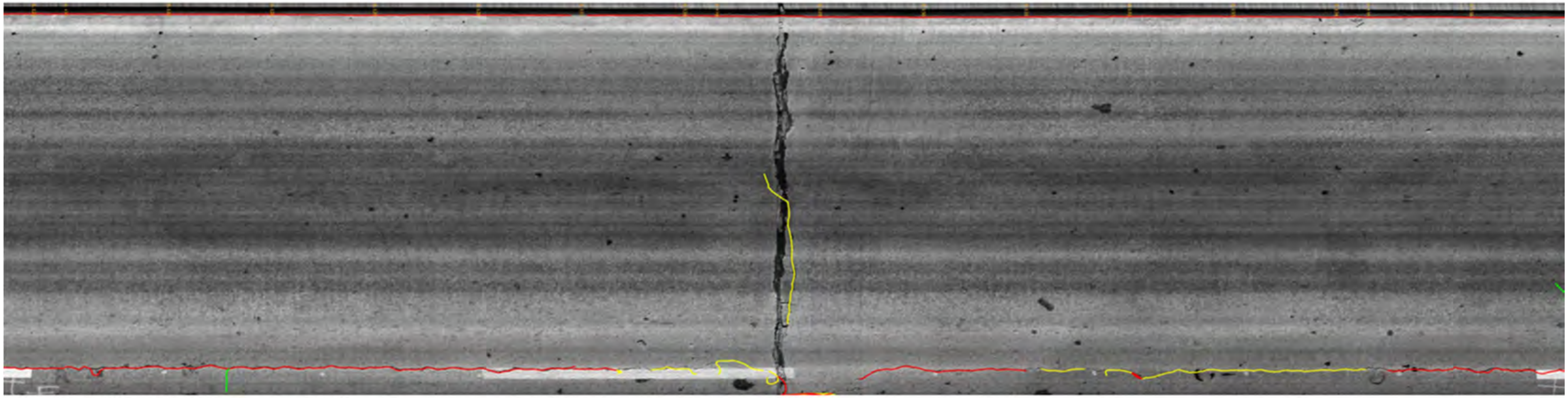


Fugro (Fully Automated)

Section 17 /// Station 400-450

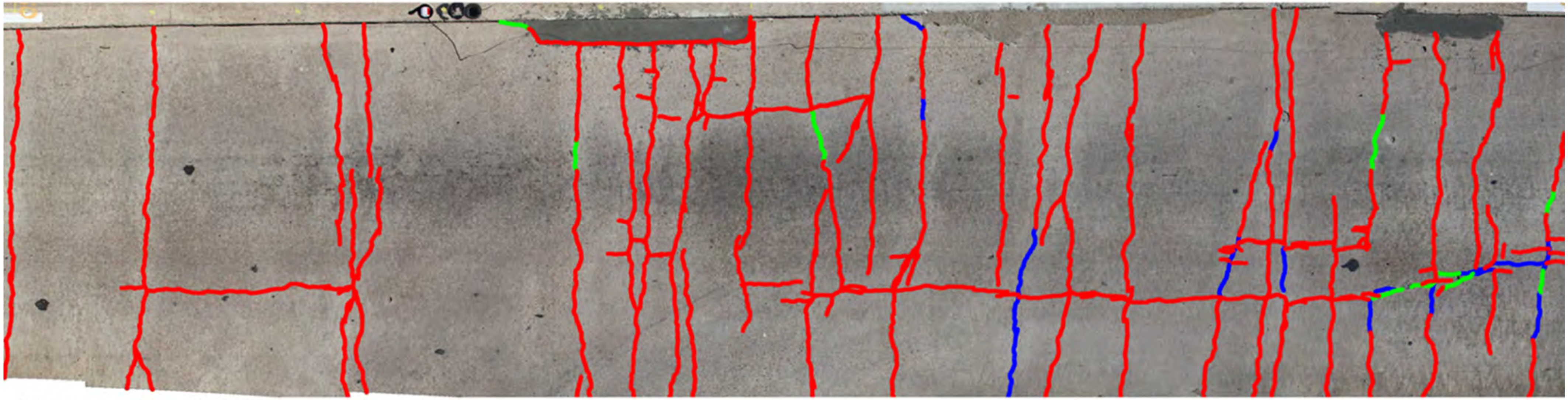


Manual Crack Map

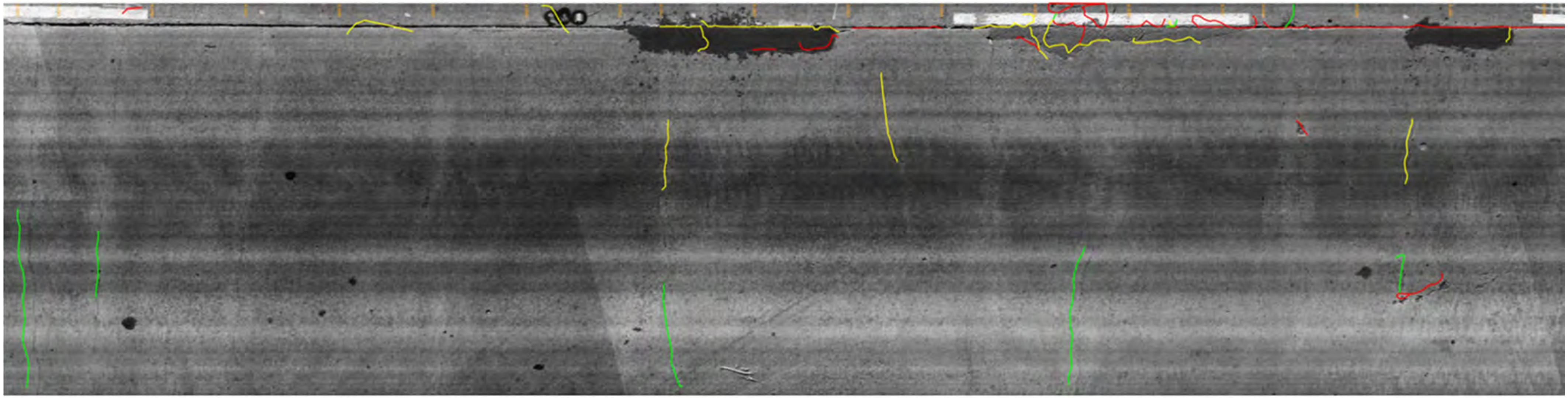


Fugro (Fully Automated)

Section 19 /// Station 150-200



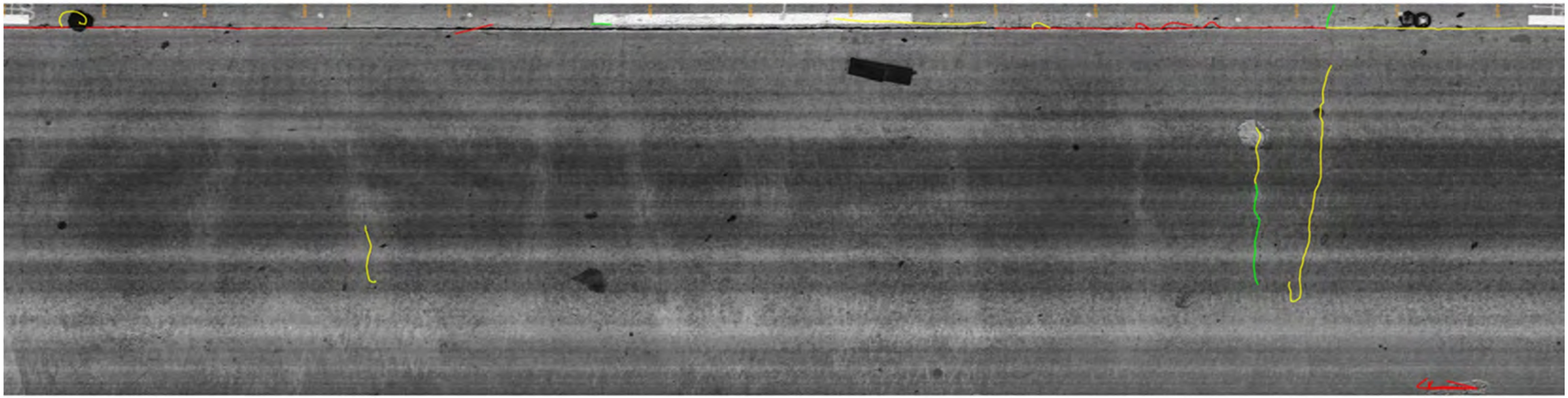
Manual Crack Map



Fugro (Fully Automated)

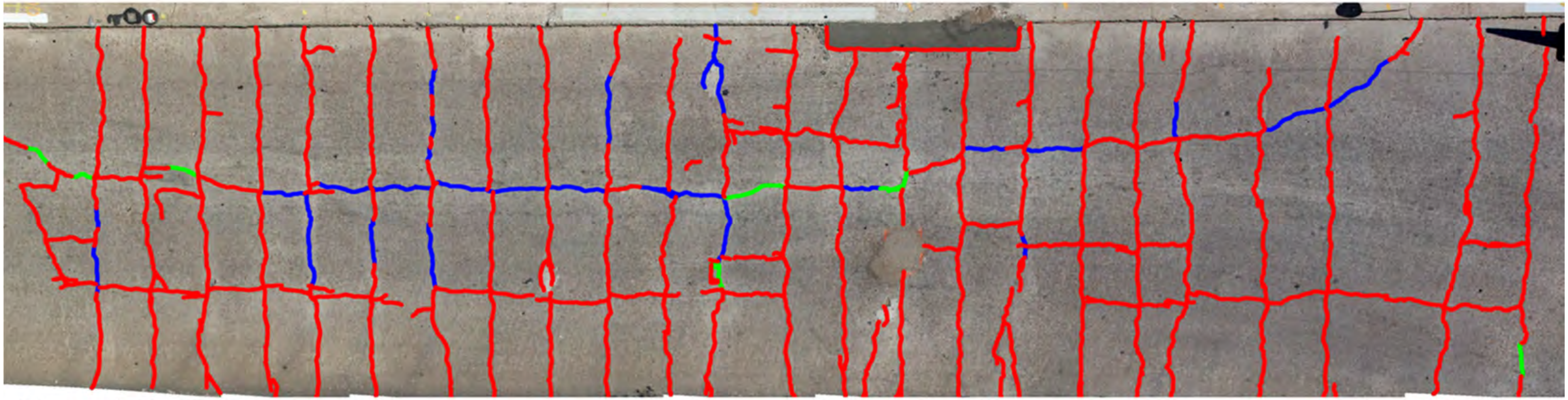
Section 19 /// Station 200-250

Manual Crack Map

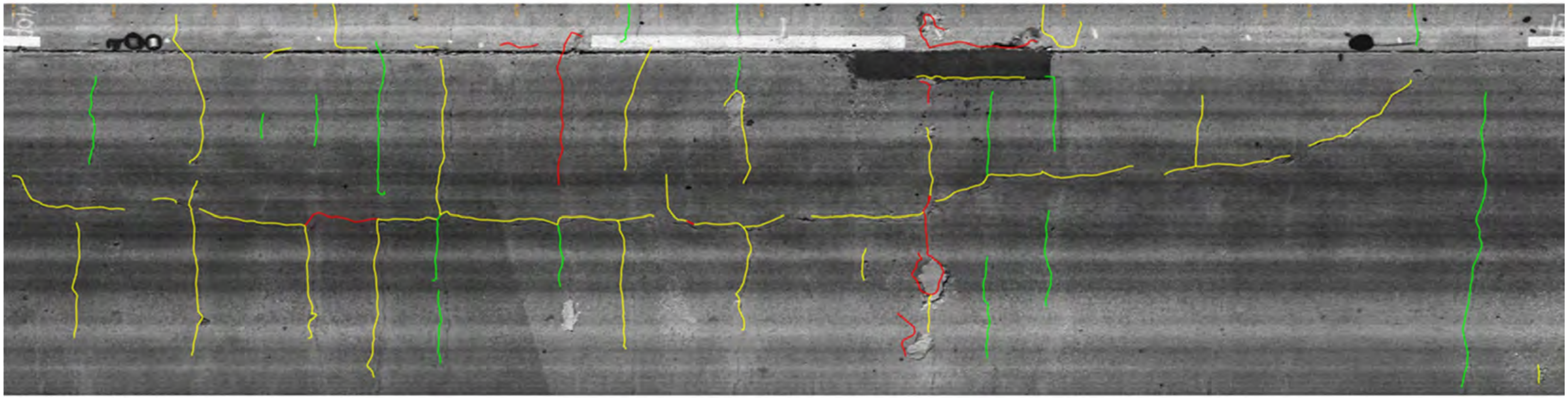


Fugro (Fully Automated)

Section 19 /// Station 400-450



Manual Crack Map



Fugro (Fully Automated)

Appendix A.6

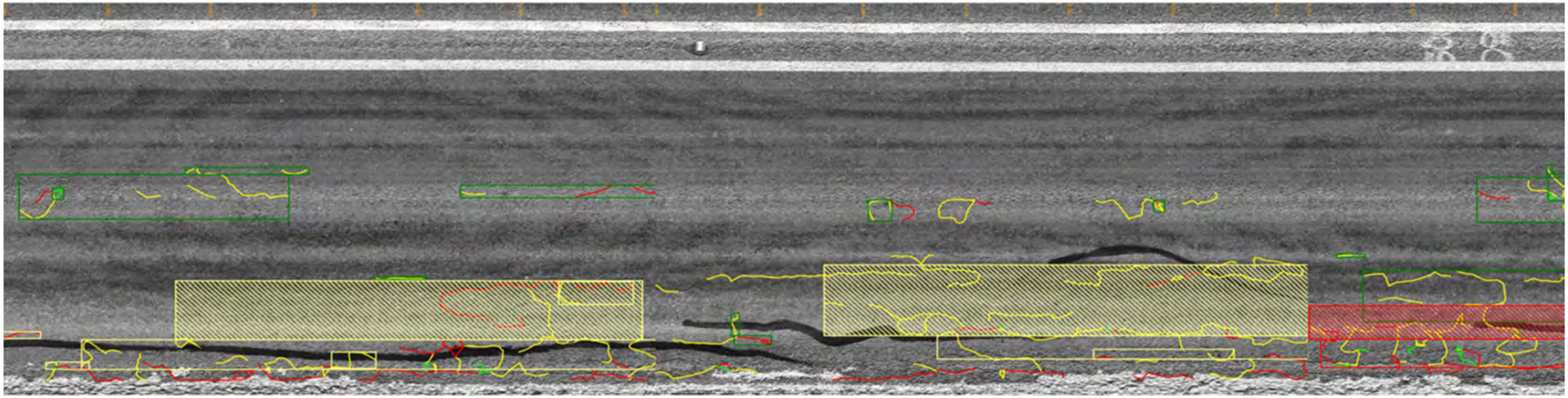
Crack Maps Comparison

Fugro

semi automated

Section 2 /// Station 000-050

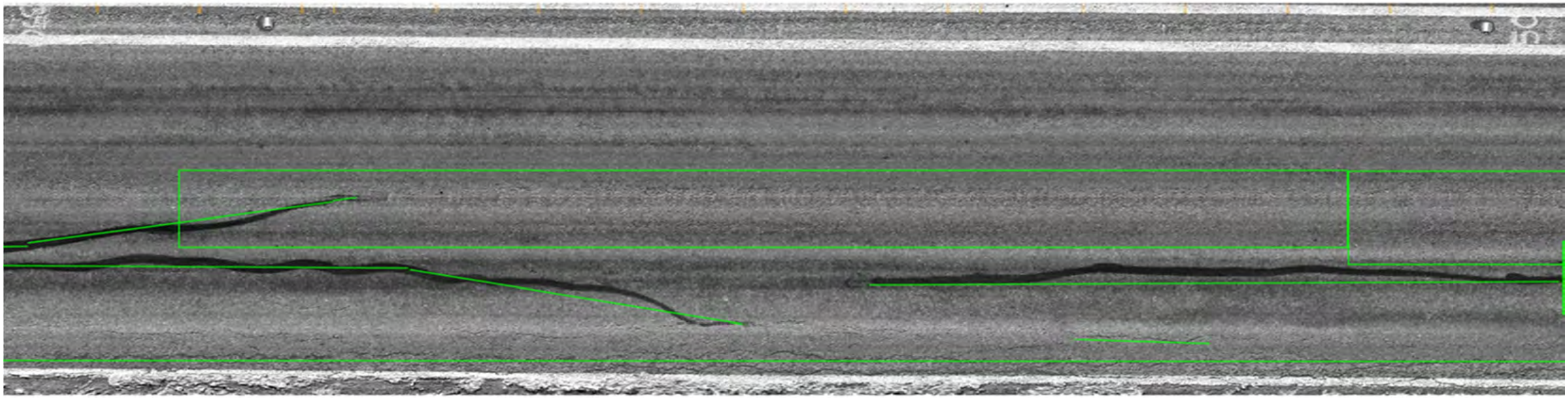
Manual Crack Map



Fugro (Semi Automated)

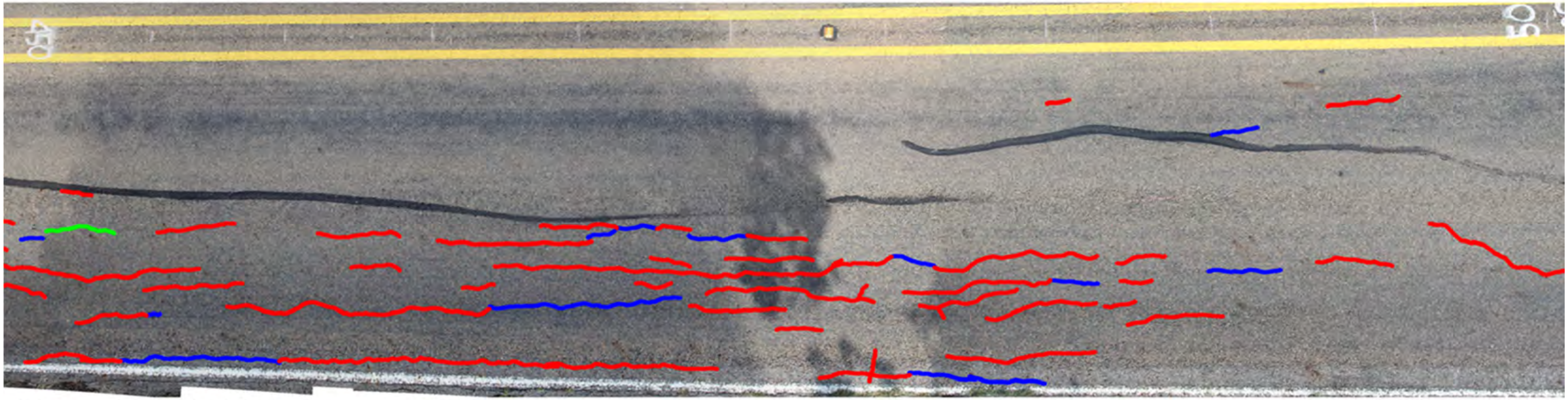
Section 2 /// Station 350-400

Manual Crack Map

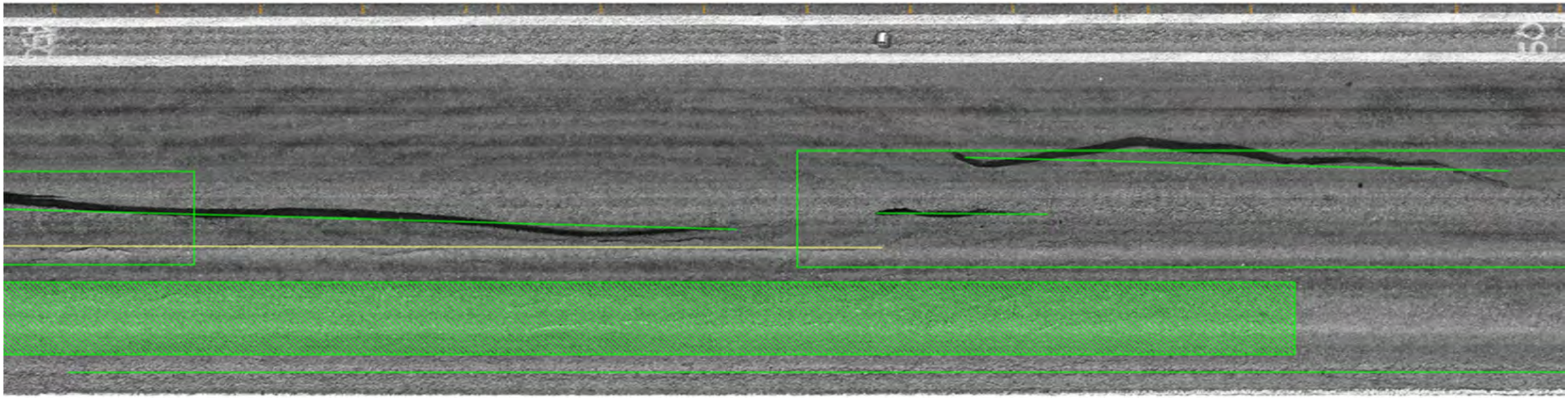


Fugro (Semi Automated)

Section 2 /// Station 450-500

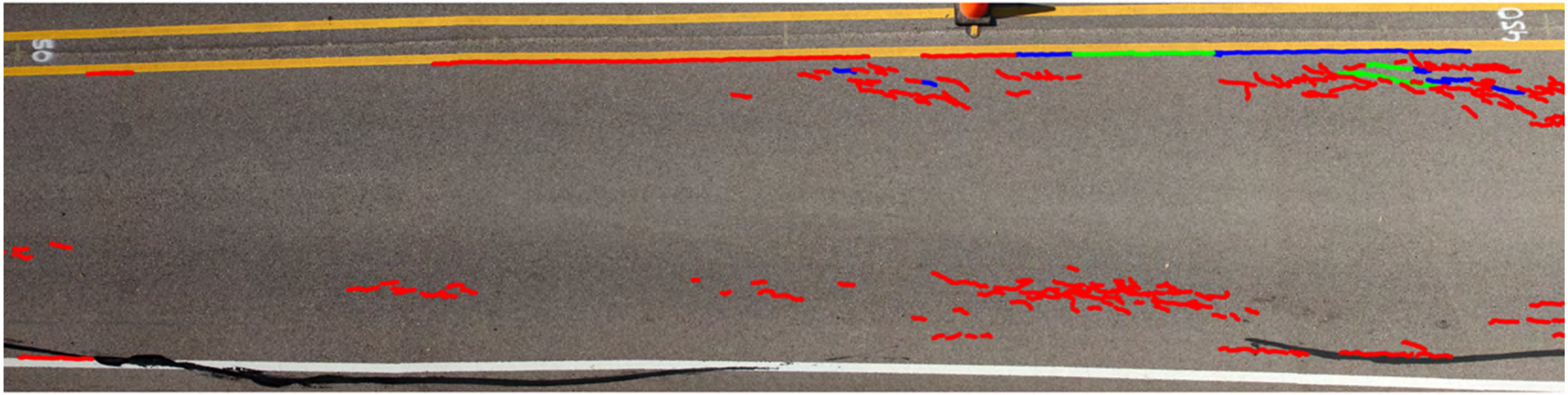


Manual Crack Map

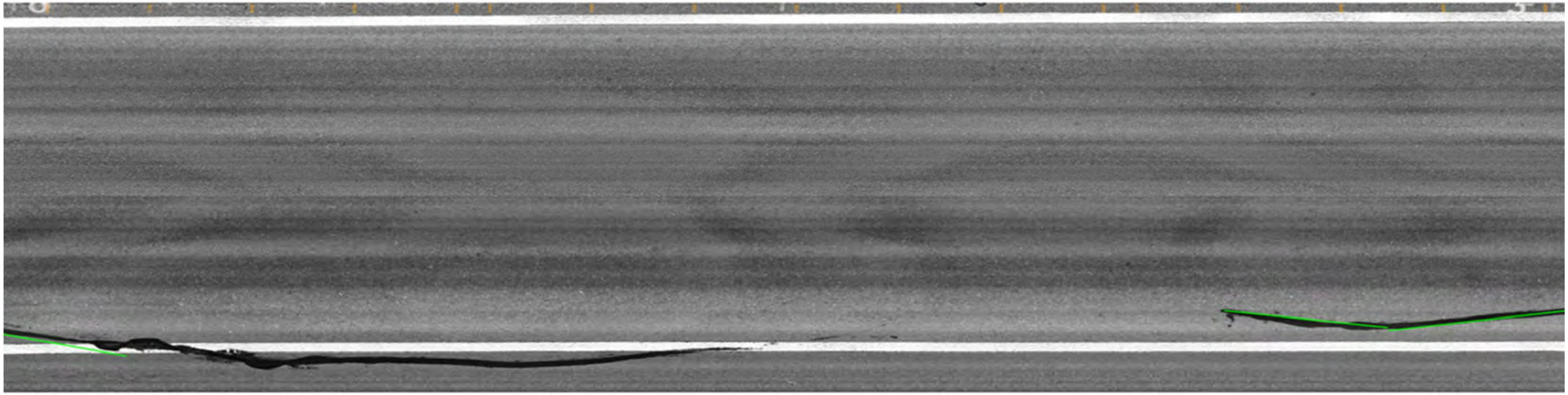


Fugro (Semi Automated)

Section 4 /// Station 050-100



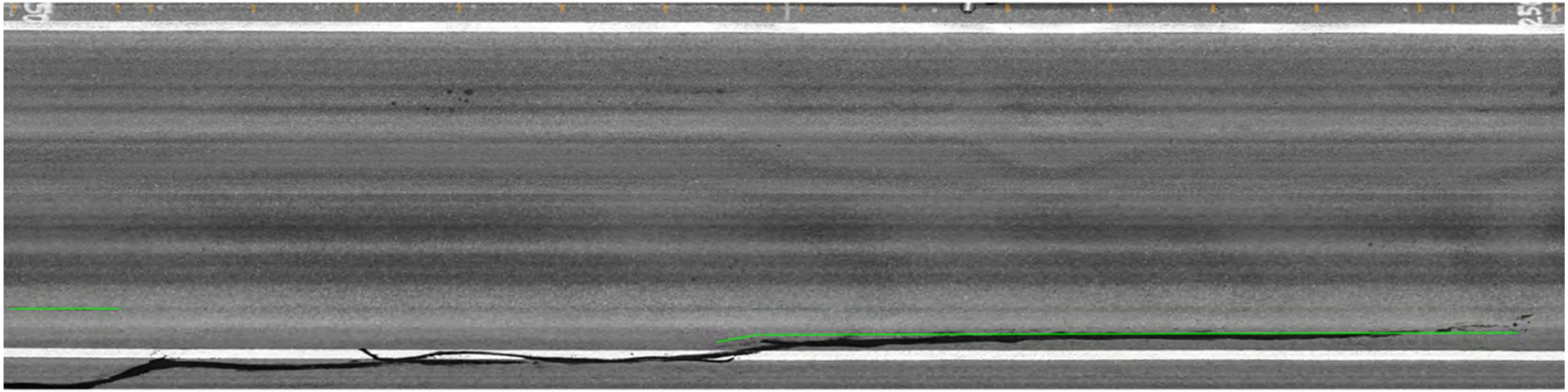
Manual Crack Map



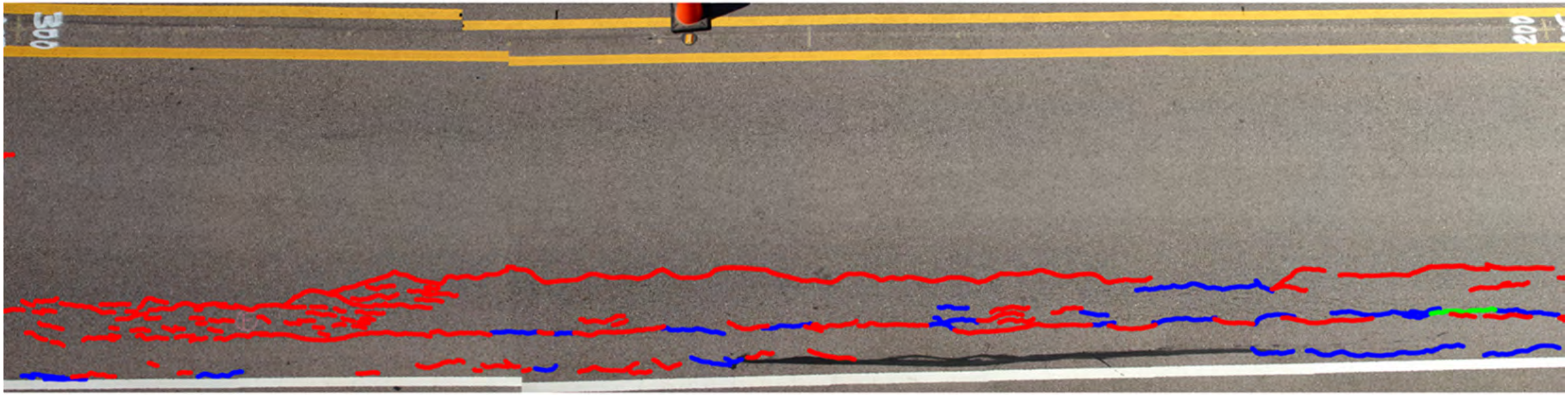
Fugro (Semi Automated)

Section 4 /// Station 250-300

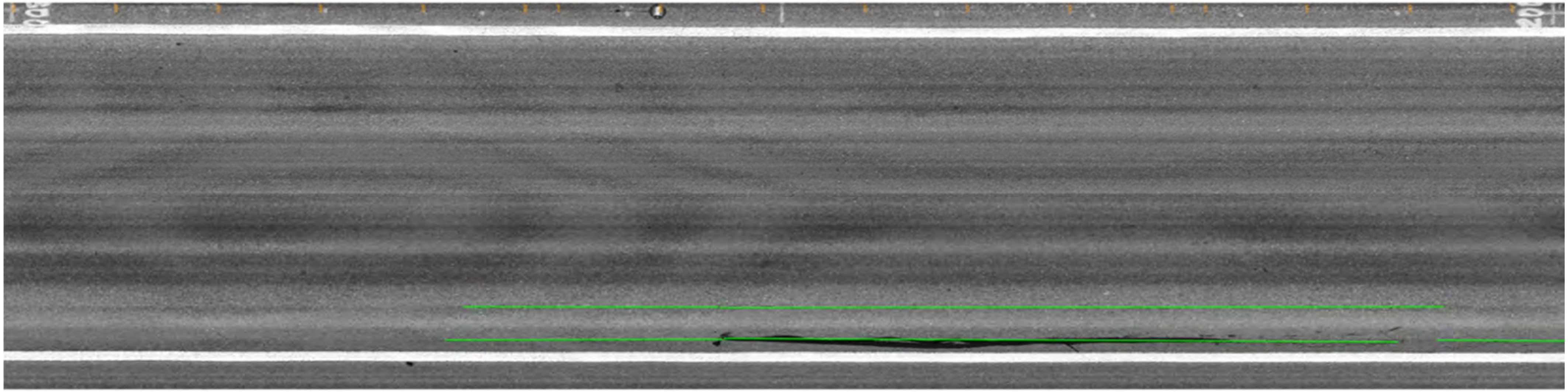
Manual Crack Map


Fugro (Semi Automated)

Section 4 /// Station 300-350



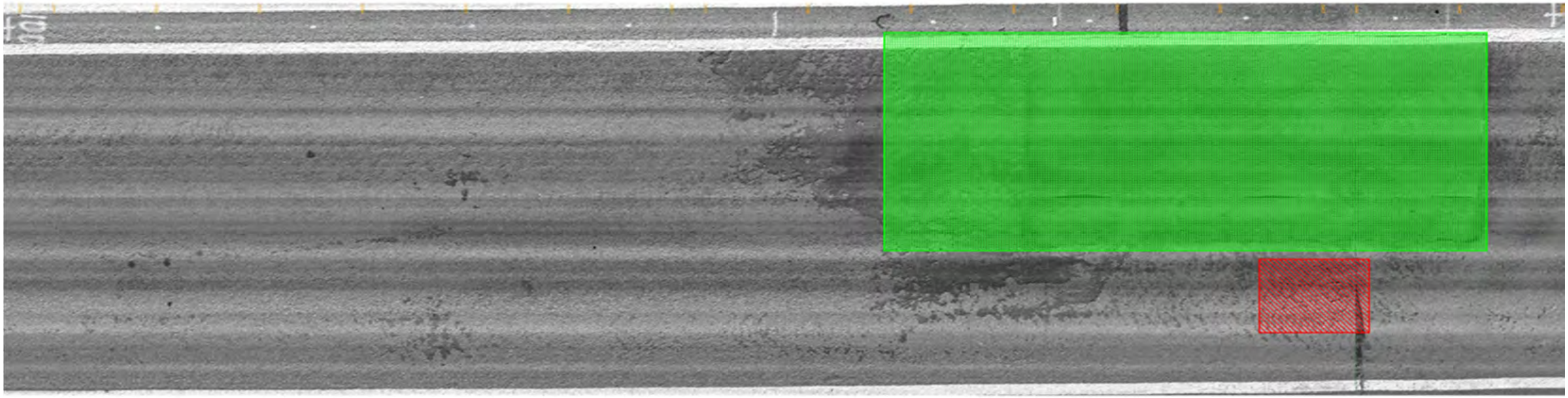
Manual Crack Map



Fugro (Semi Automated)

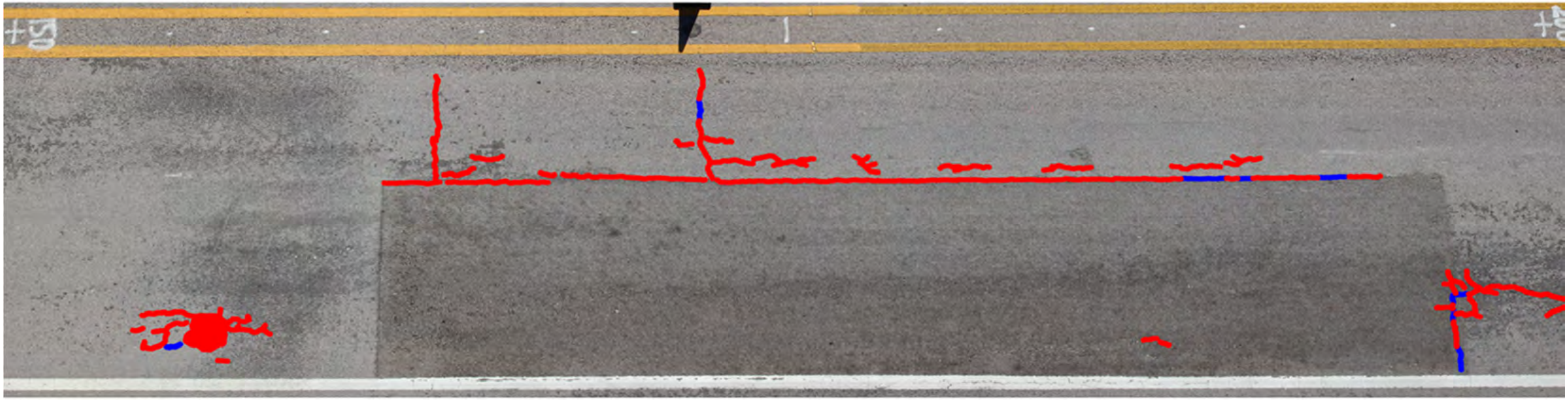
Section 6 /// Station 100-150

Manual Crack Map

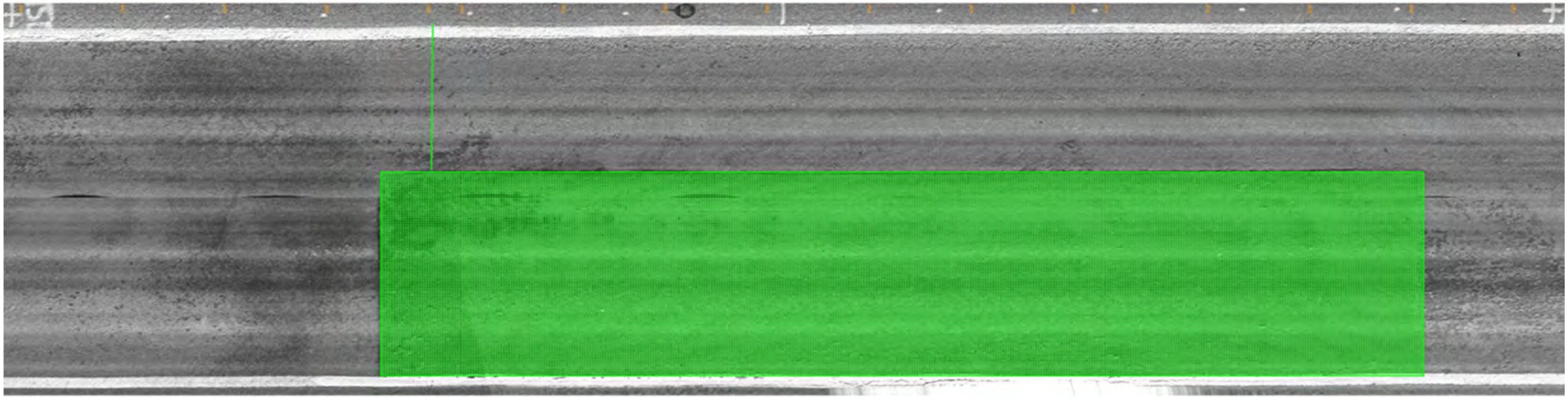


Fugro (Semi Automated)

Section 6 /// Station 150-200



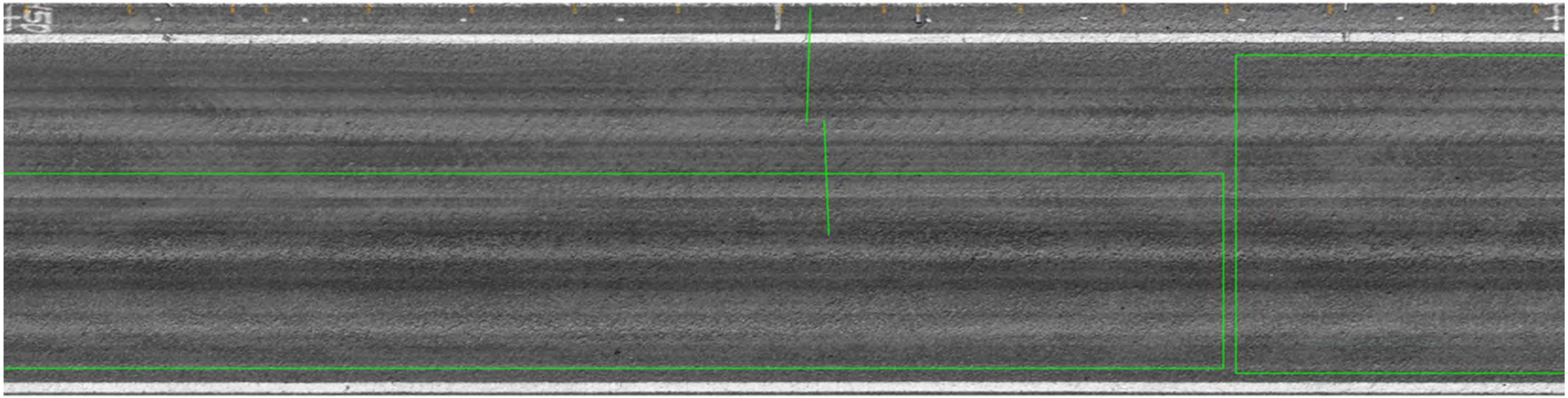
Manual Crack Map



Fugro (Semi Automated)

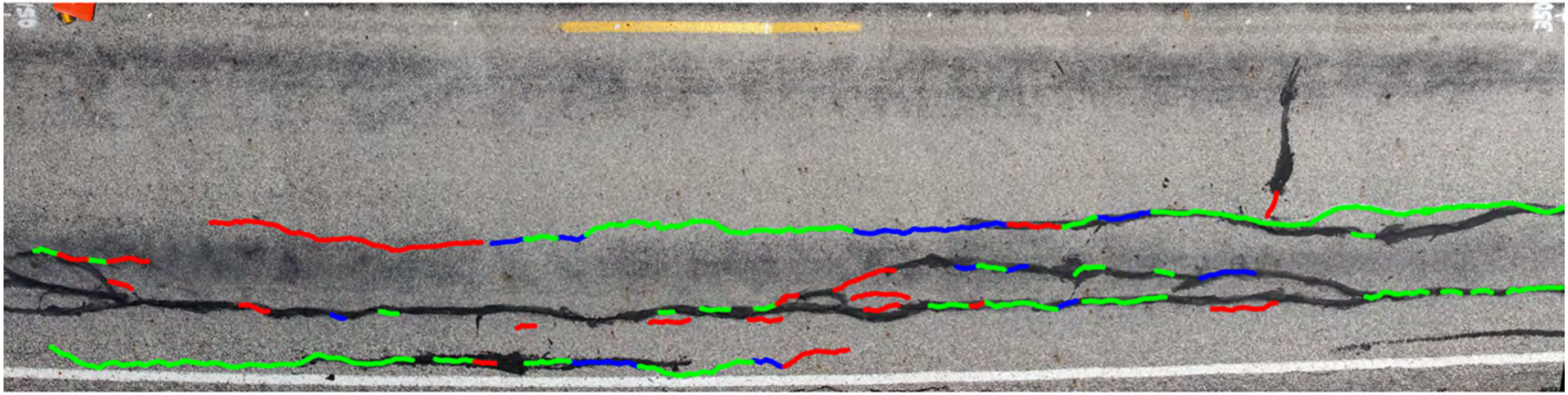
Section 6 /// Station 450-500

Manual Crack Map



Fugro (Semi Automated)

Section 9 /// Station 150-200



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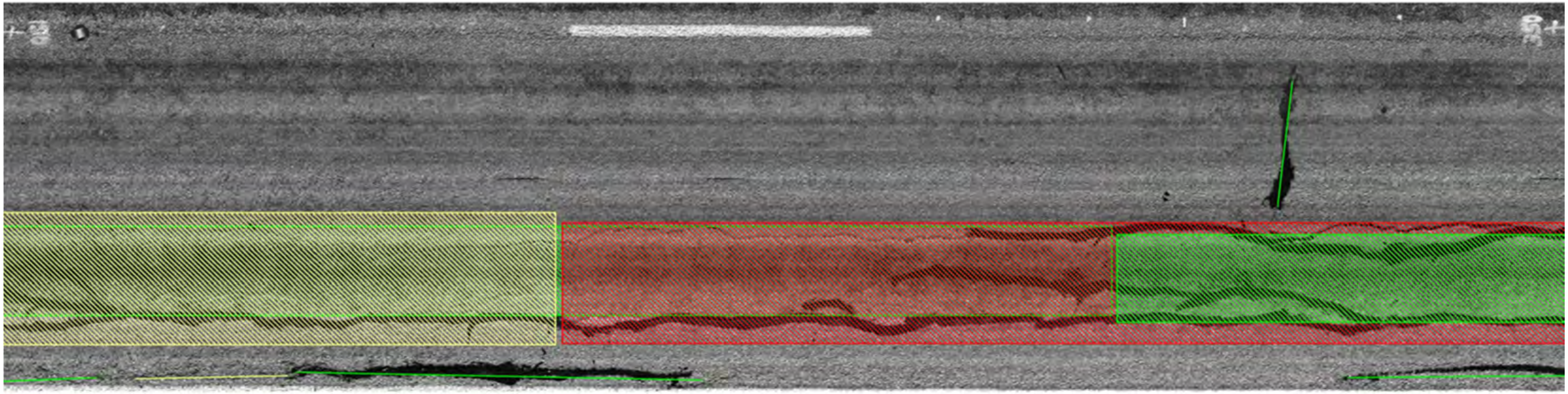
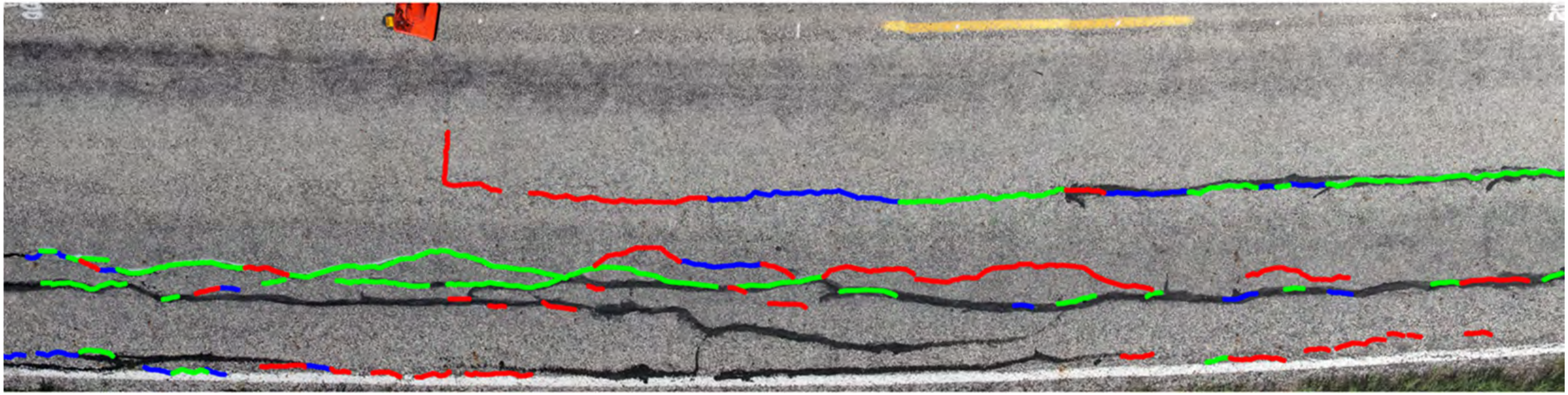


Fugro (Semi Automated)

Section 9 /// Station 300-350



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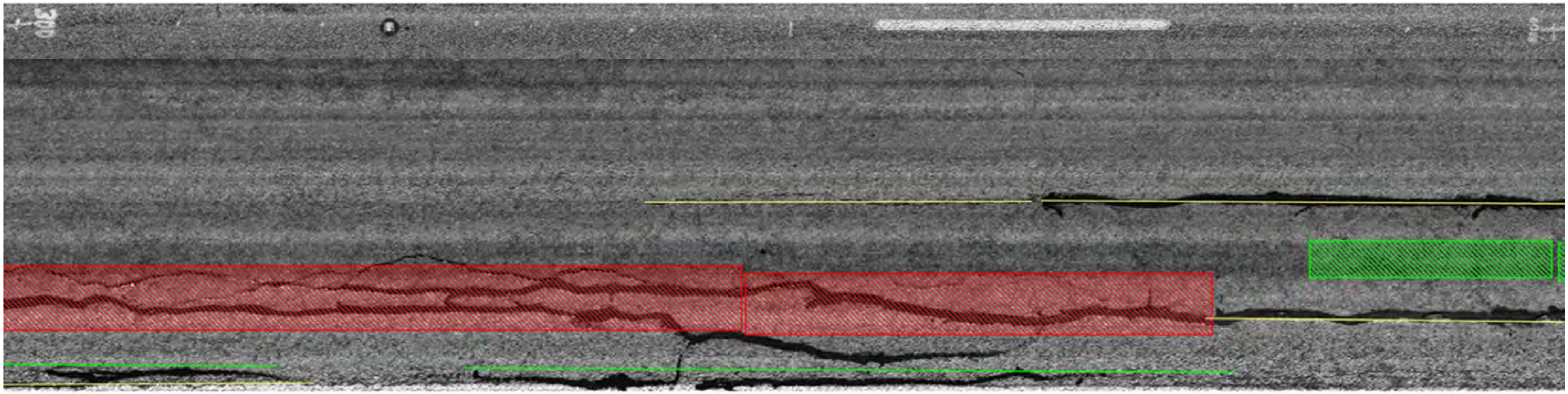
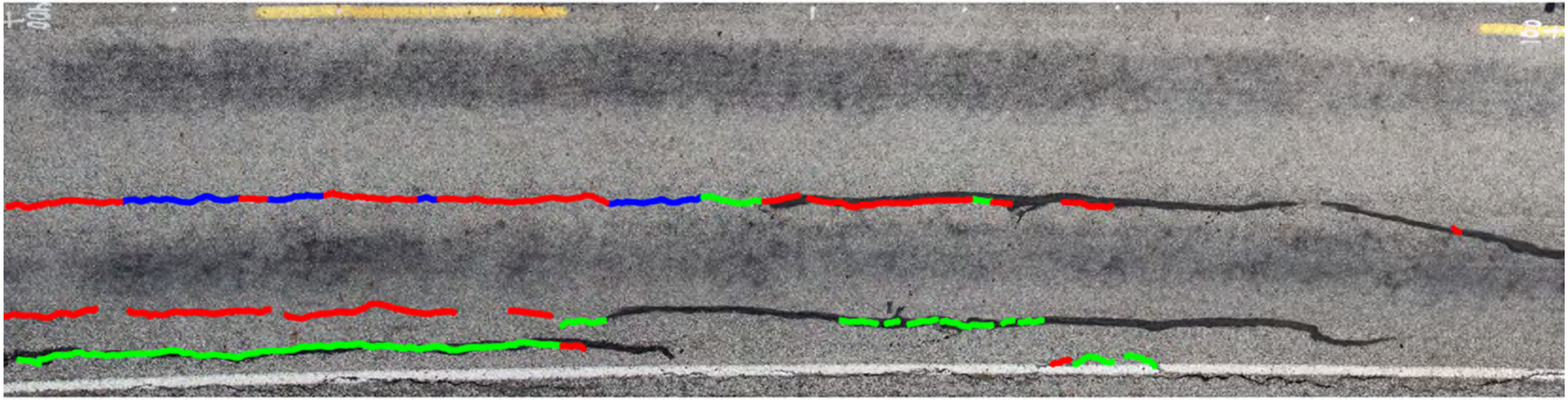


Fugro (Semi Automated)

Section 9 /// Station 400-450



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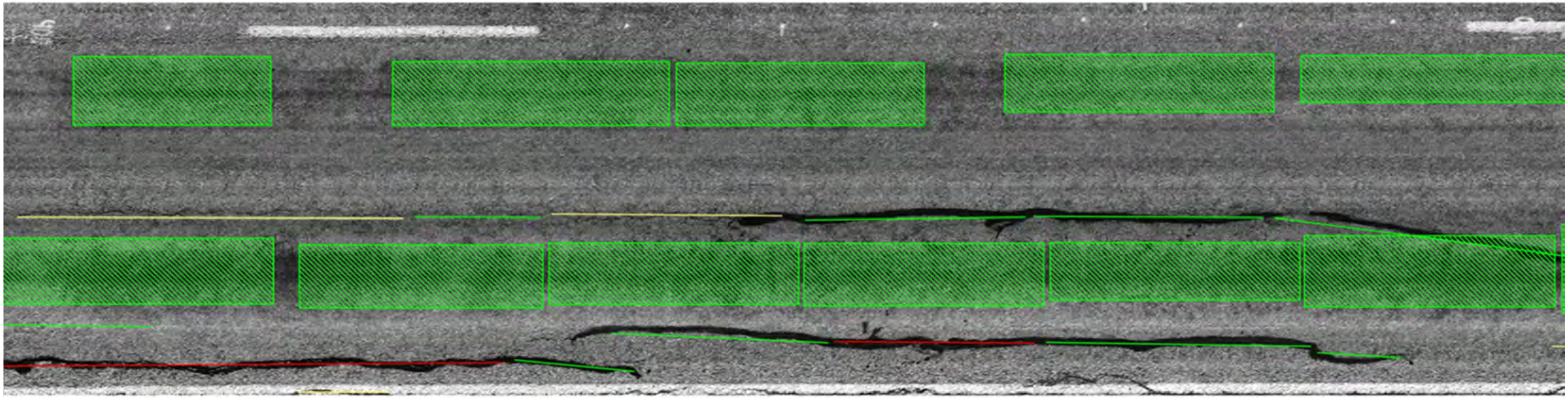
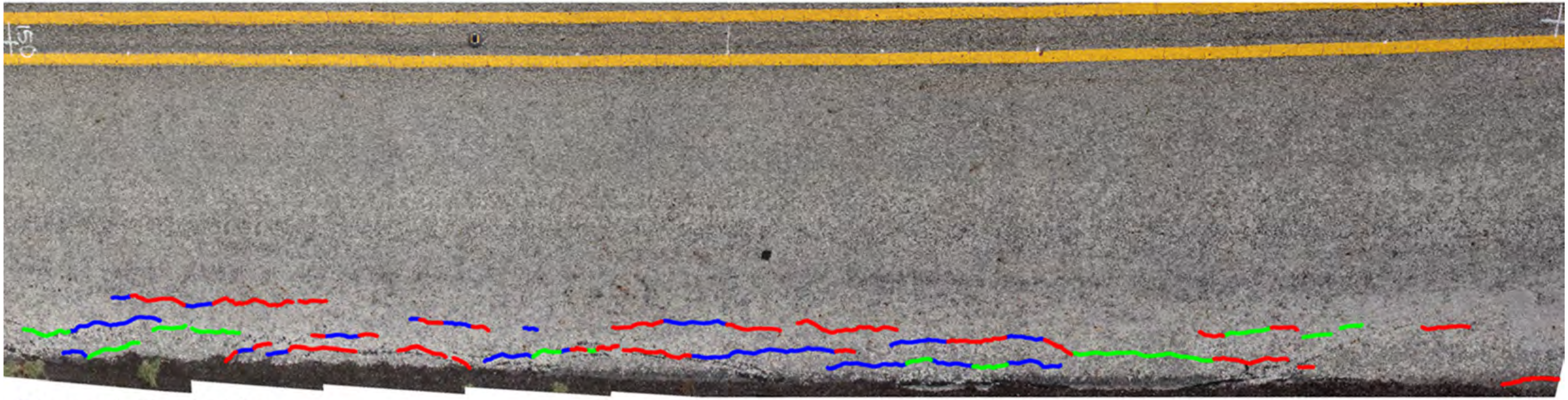


Fugro (Semi Automated)

Section 10/// Station 150-200



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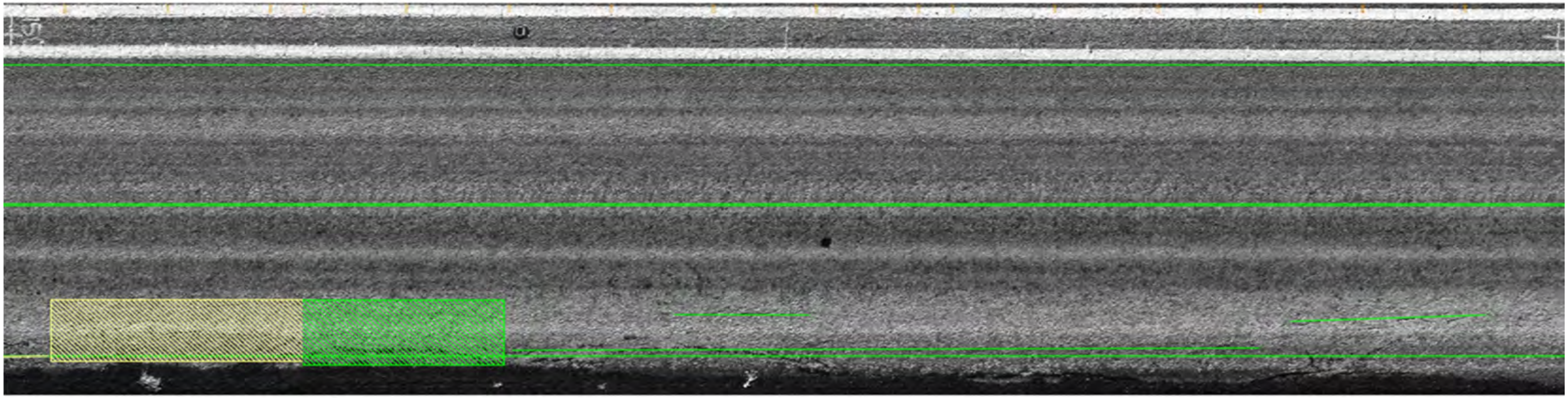
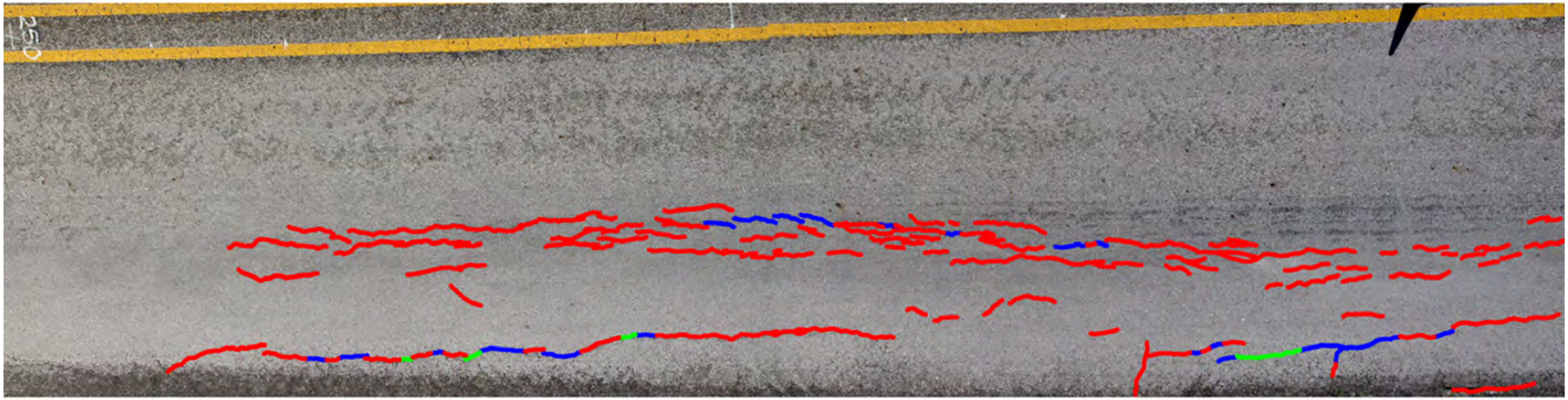


Fugro (Semi Automated)

Section 10/// Station 250-300



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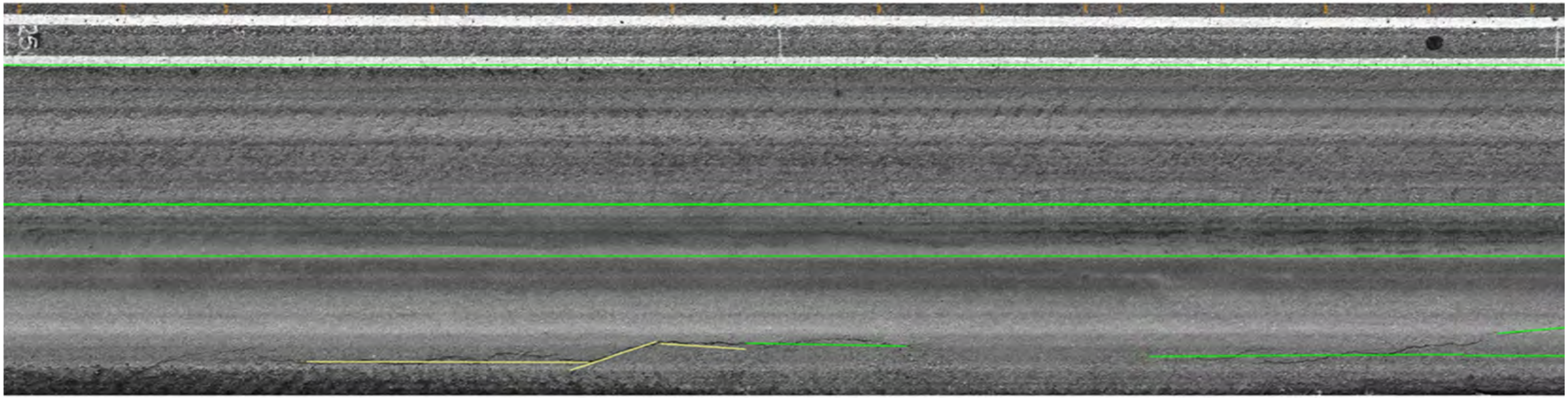
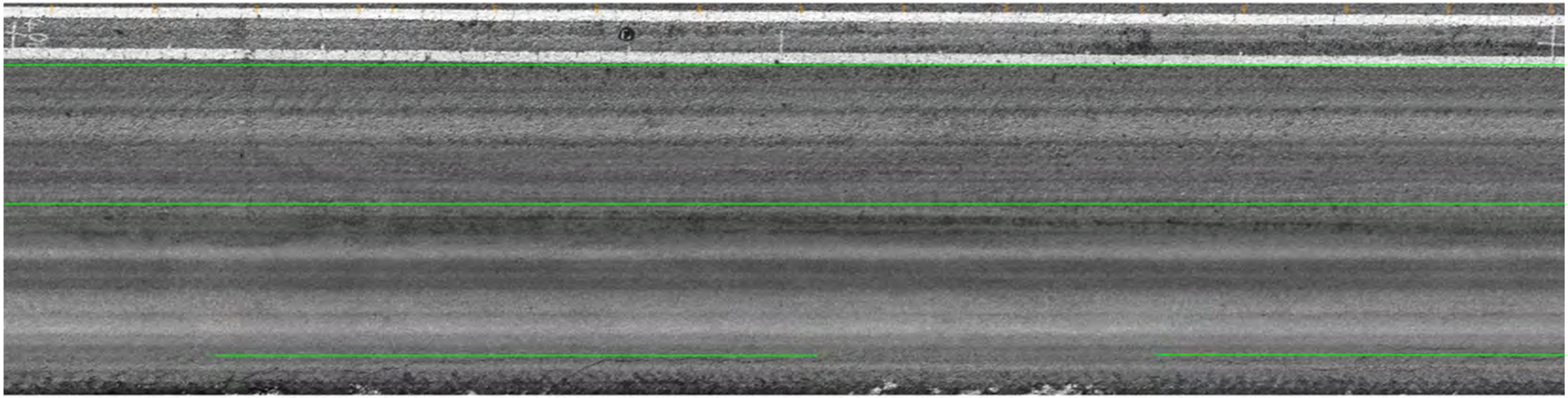


Fugro (Semi Automated)

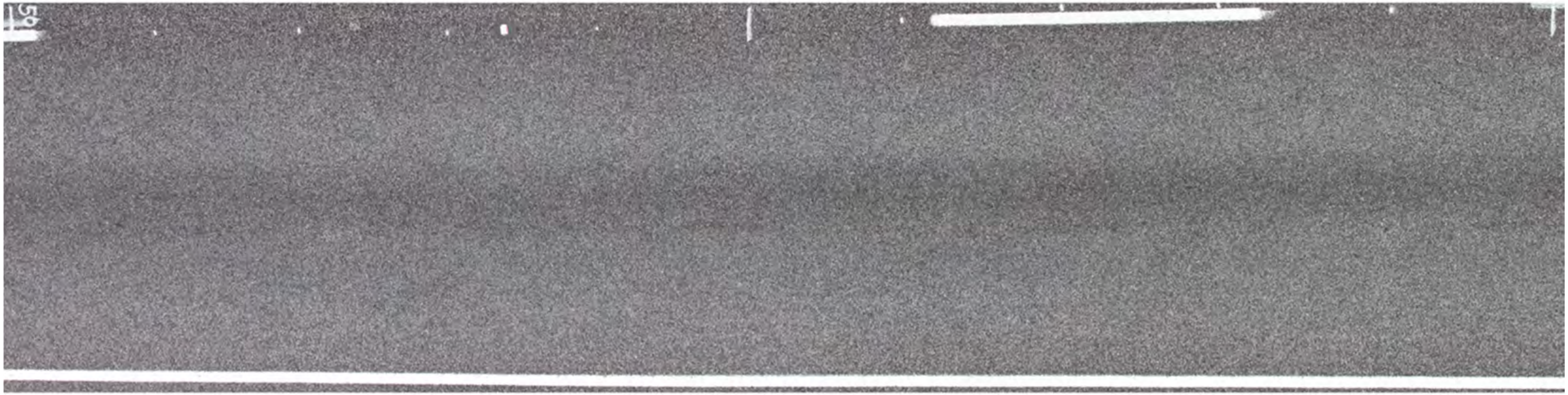
Section 10 /// Station 400-450

Manual Crack Map



Fugro (Semi Automated)

Section 11 /// Station 050-100



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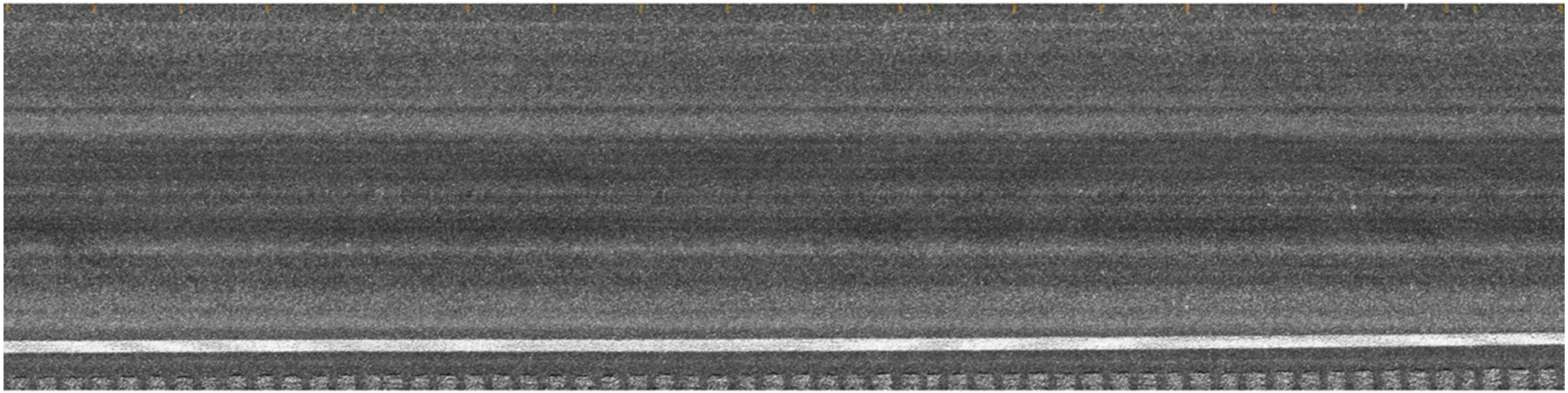
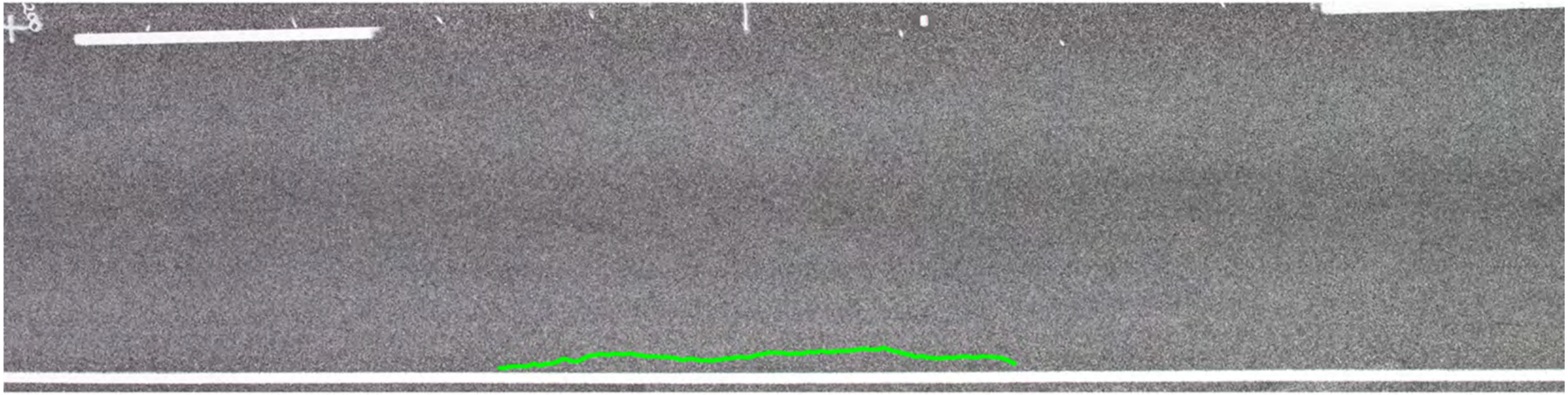


Fugro (Semi Automated)

Section 11 /// Station 200-250



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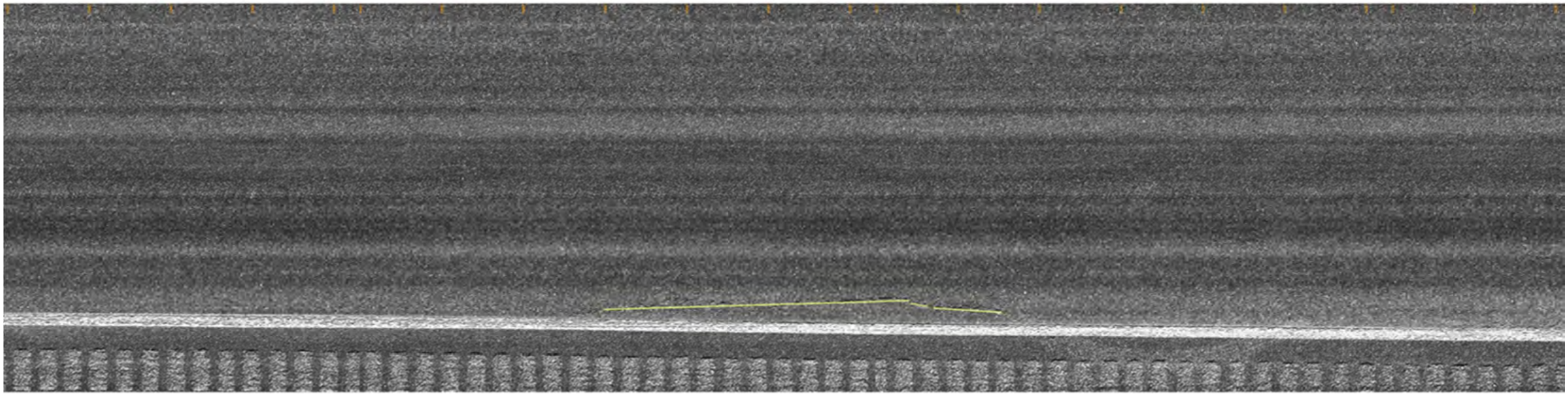

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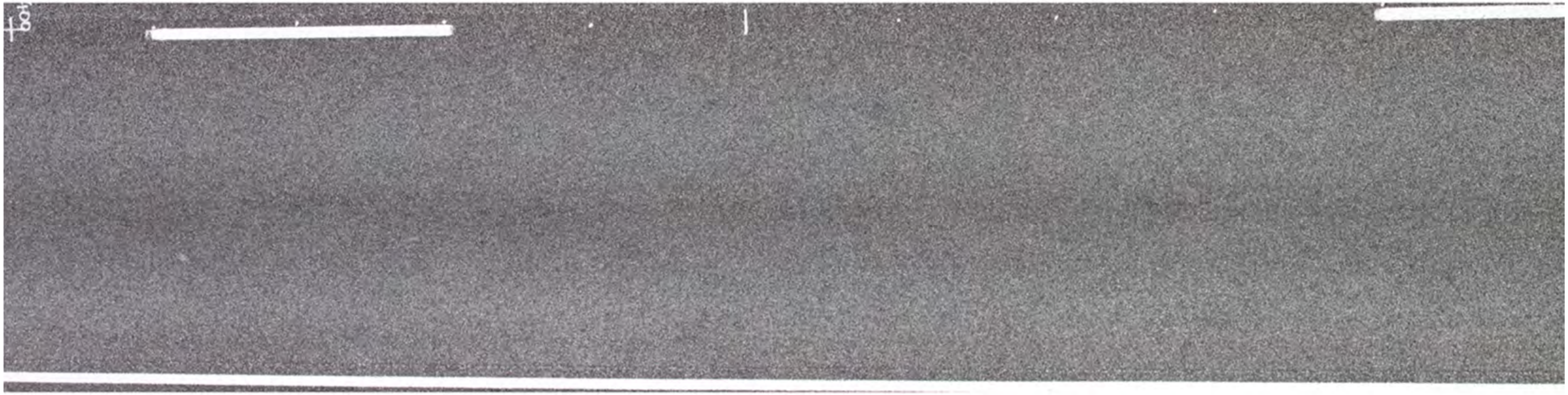
Section 11 /// Station 400-450



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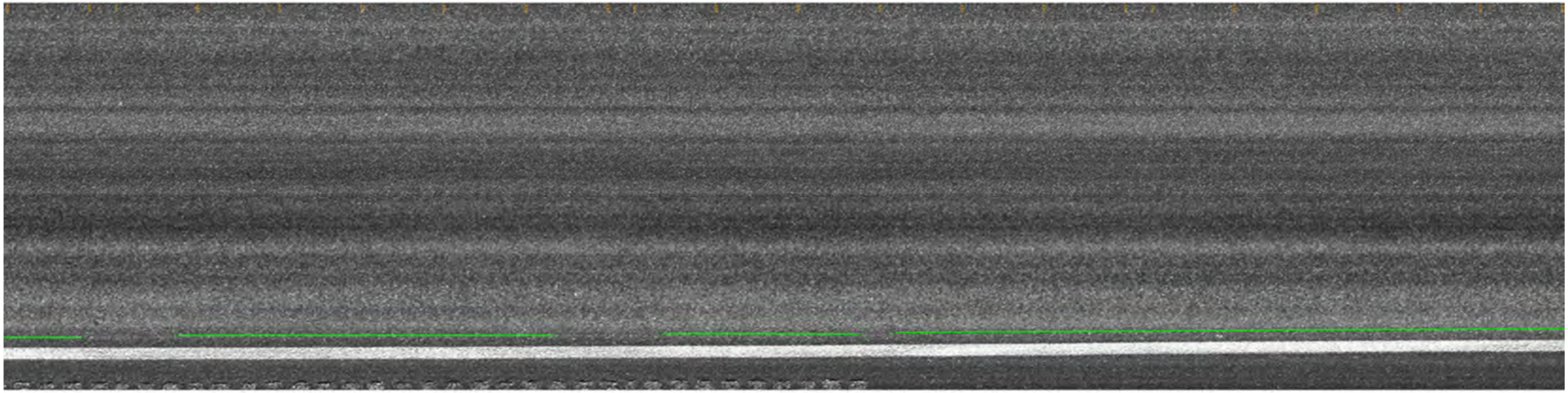

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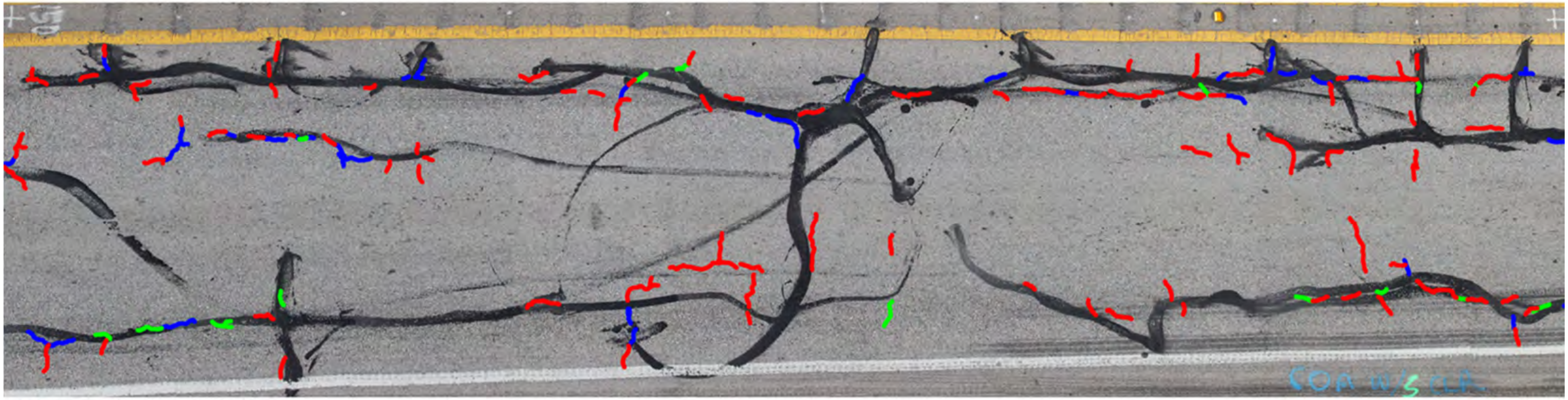
Section 12 /// Station 150-200



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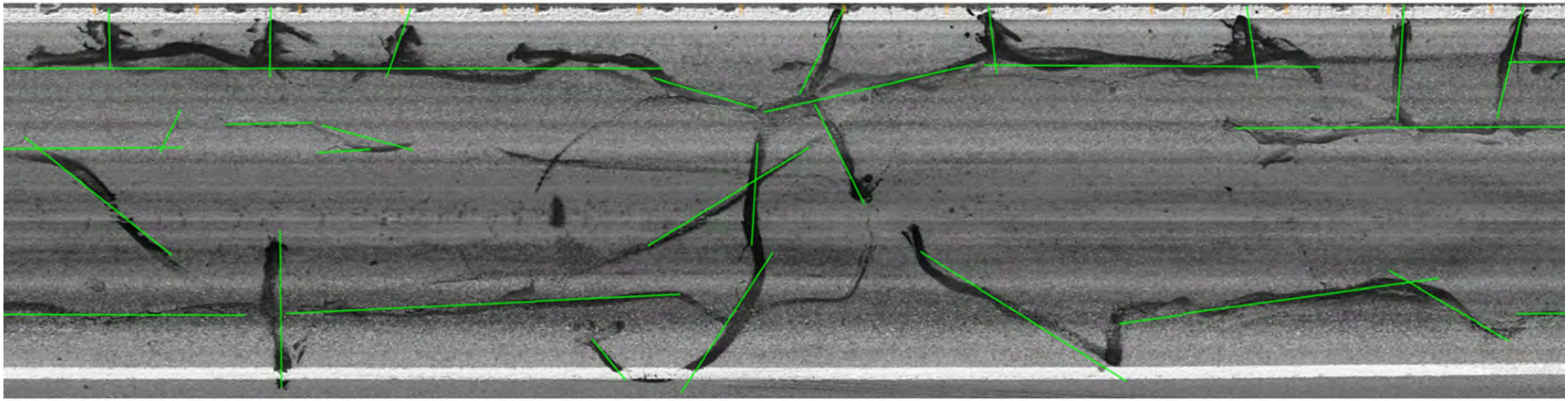
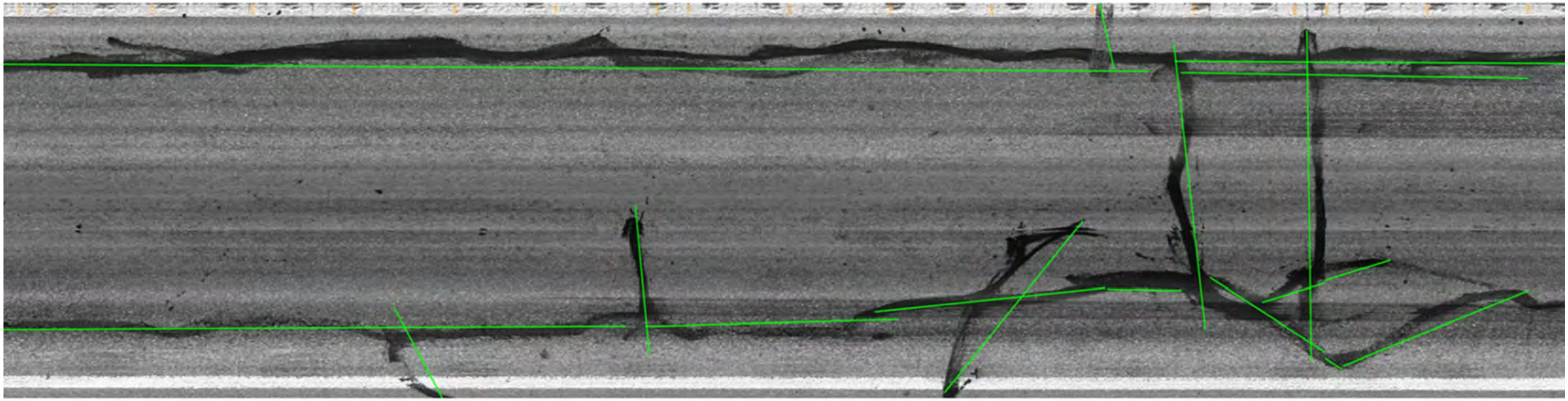


Fugro (Semi Automated)

Section 12 /// Station 250-300

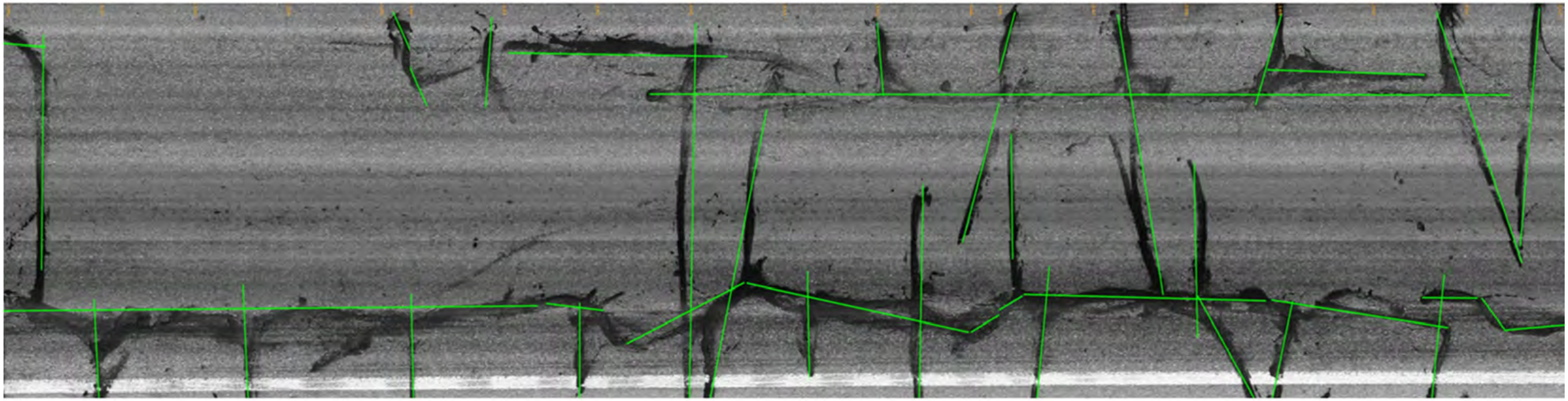
Manual Crack Map



Fugro (Semi Automated)

Section 12 /// Station 450-500

Manual Crack Map



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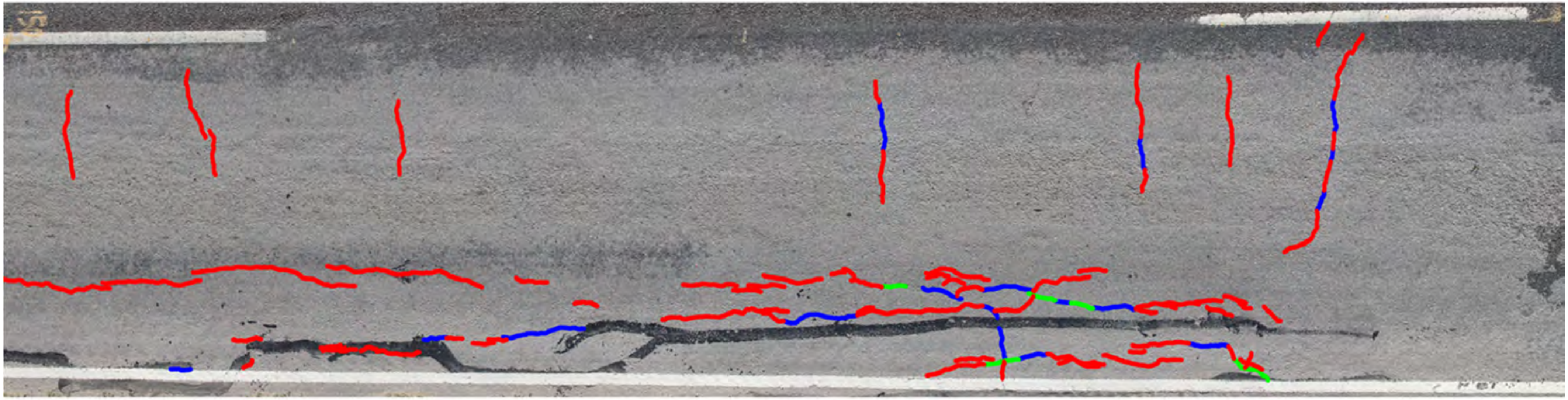
Section 13 /// Station 150-200



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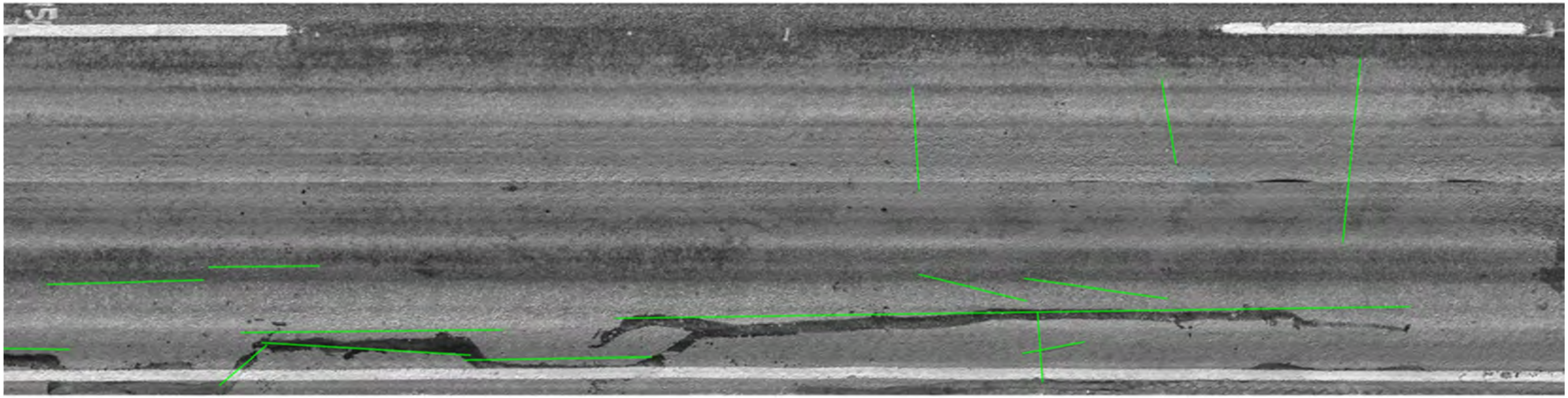
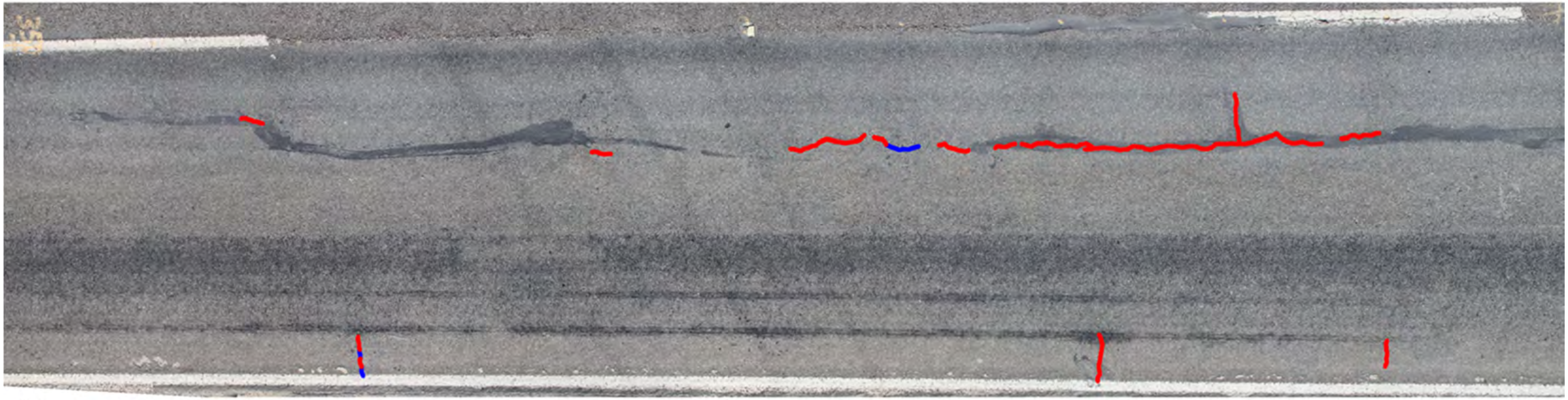


Fugro (Semi Automated)

Section 13 /// Station 350-400



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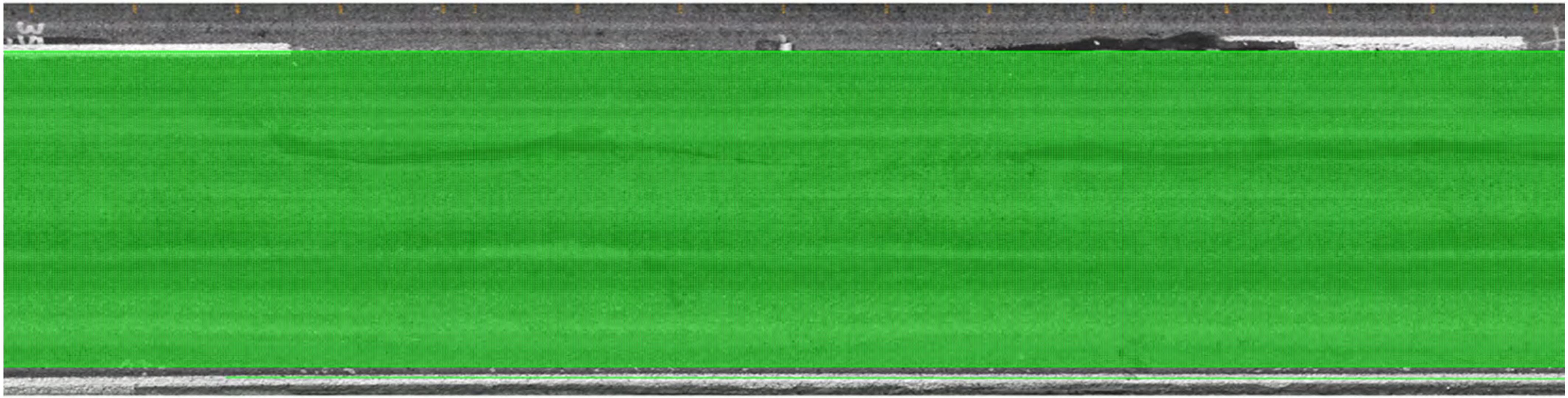

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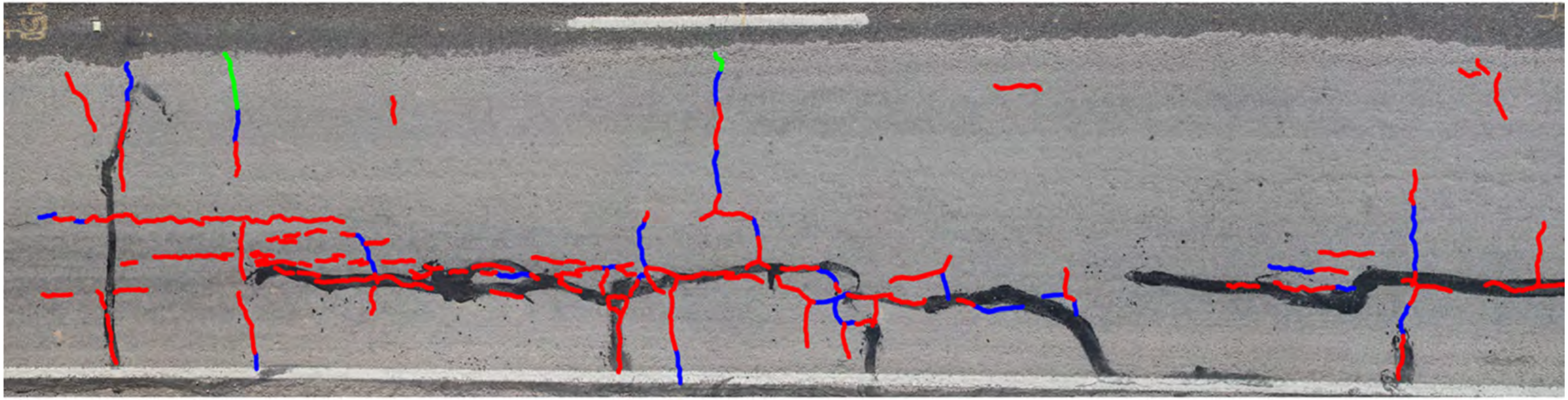
Section 13 /// Station 450-500



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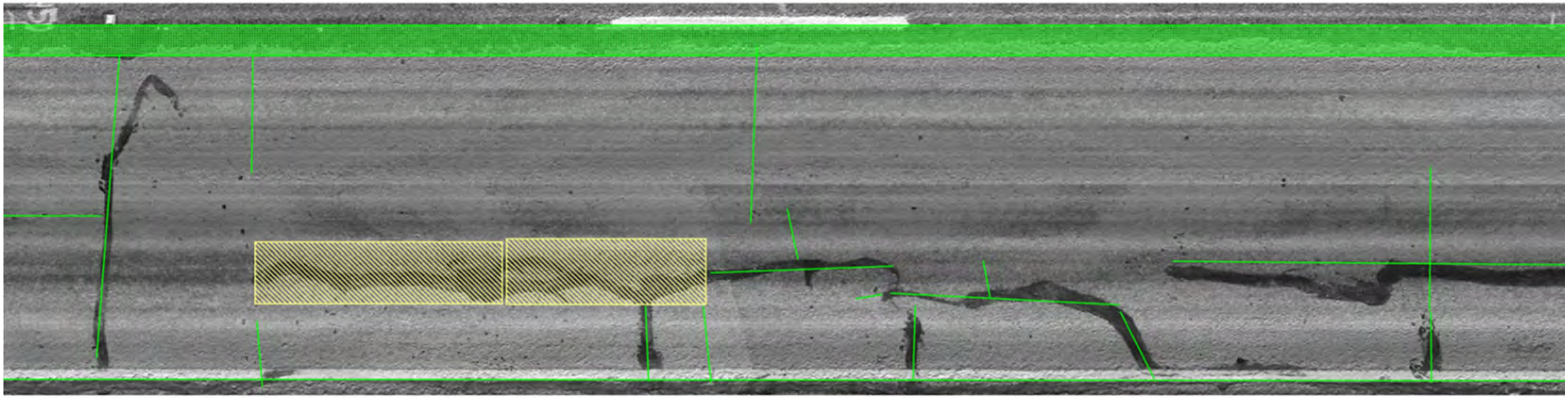

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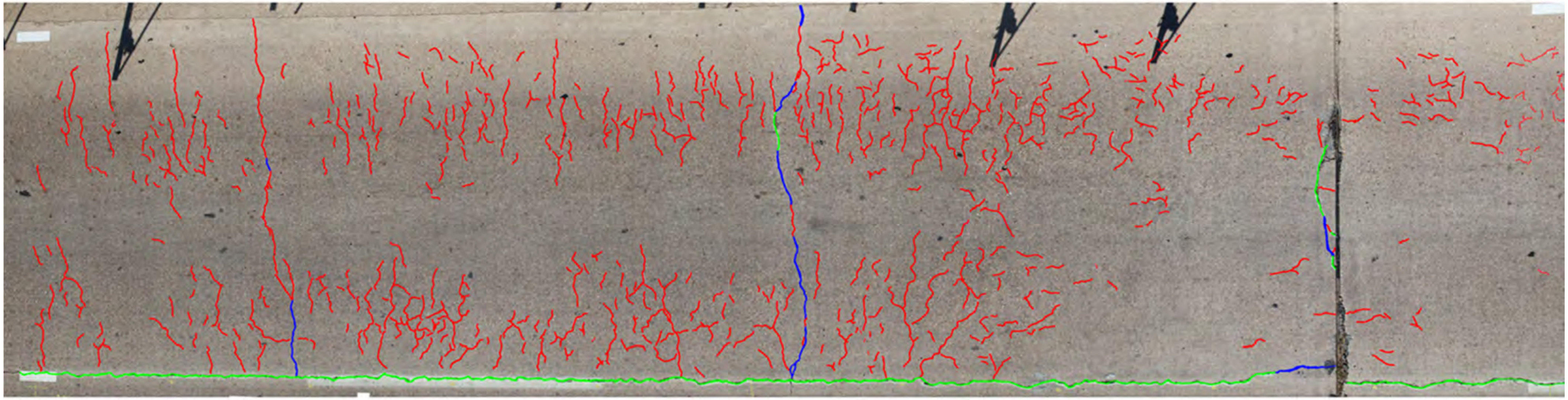
Section 17 /// Station 050-100



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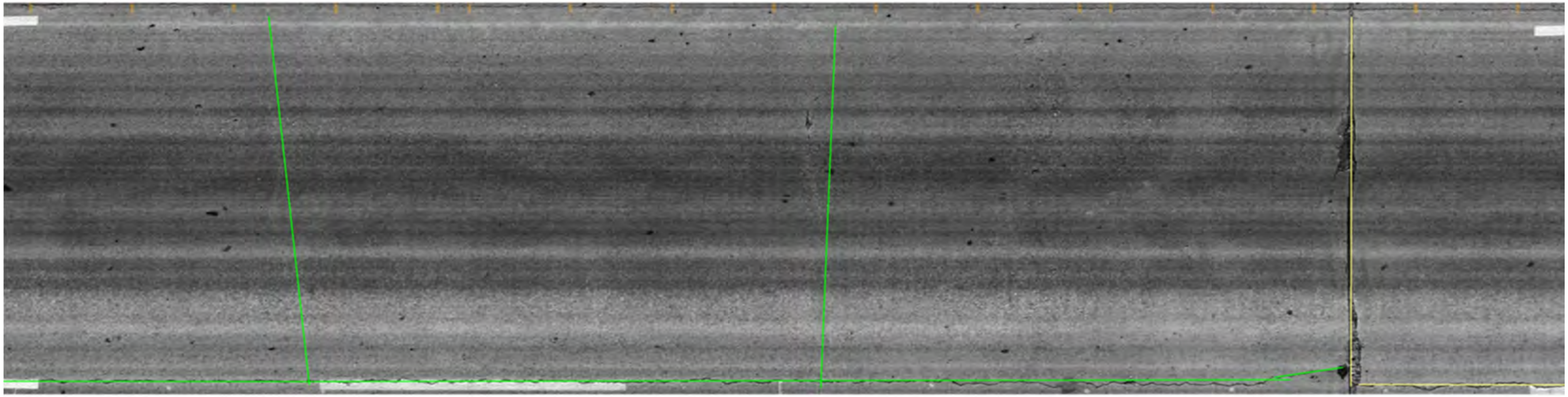
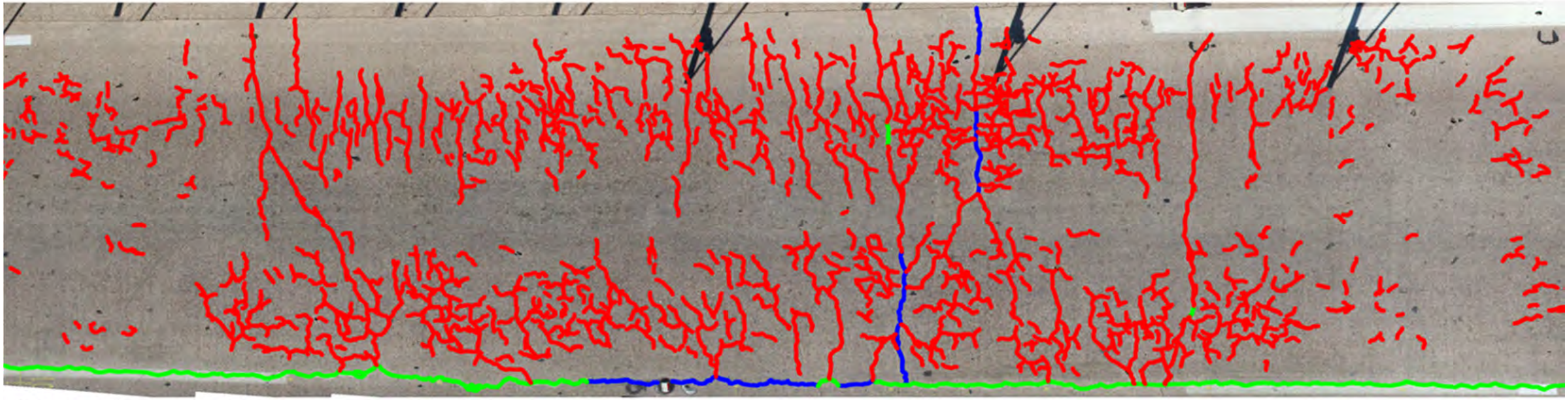
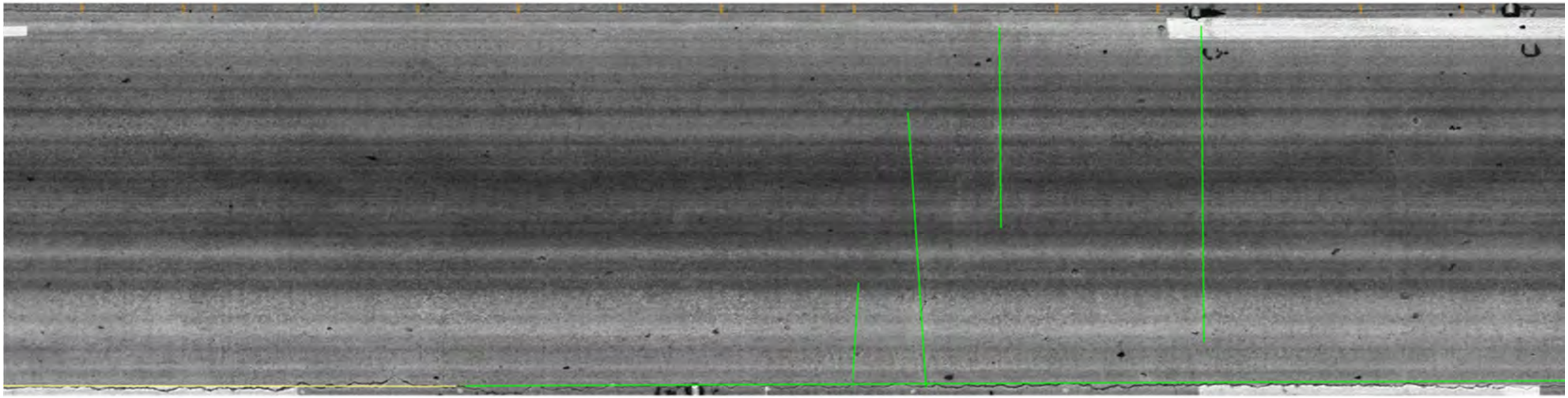


Fugro (Semi Automated)

Section 17 /// Station 100-150

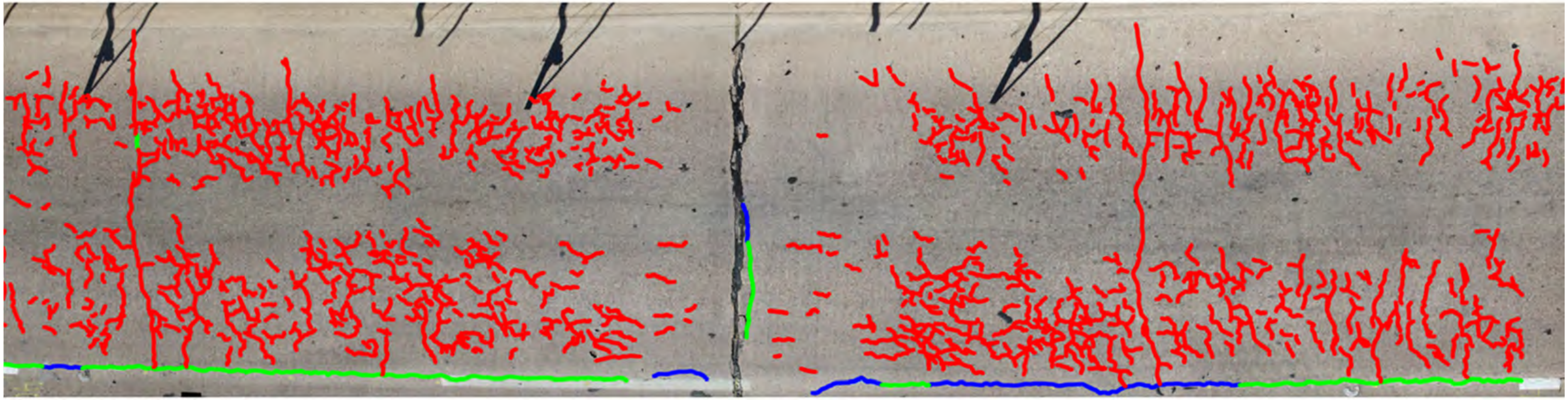


Manual Crack Map

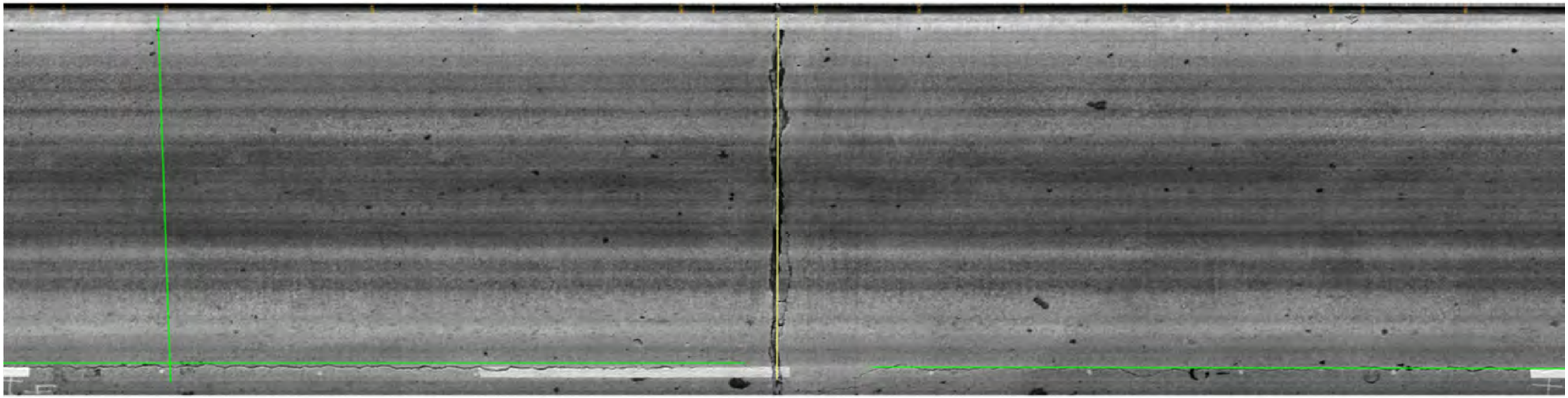


Fugro (Semi Automated)

Section 17 /// Station 400-450

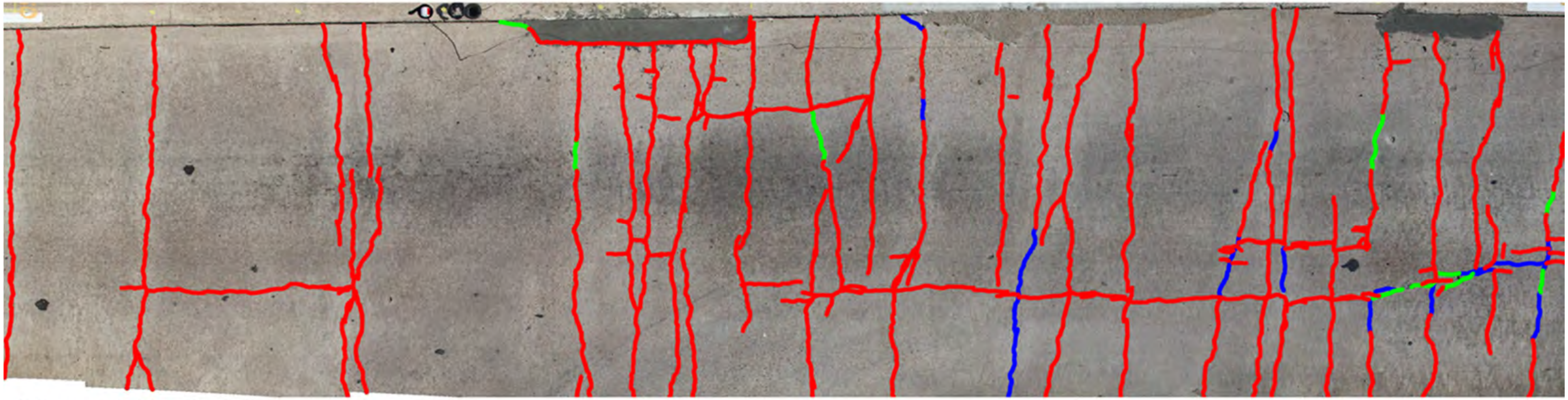


Manual Crack Map

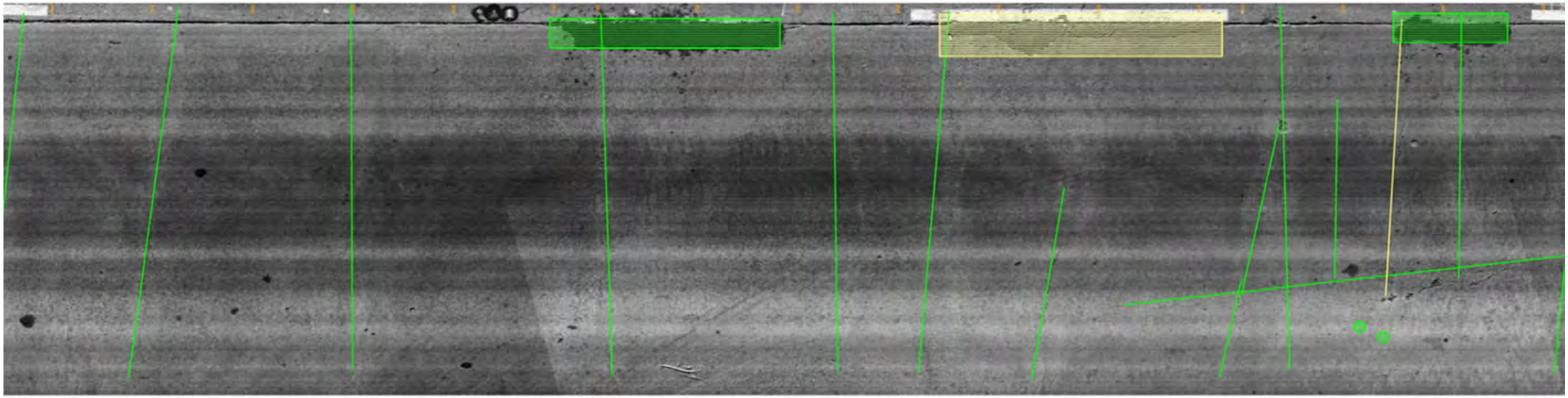


Fugro (Semi Automated)

Section 19 /// Station 150-200



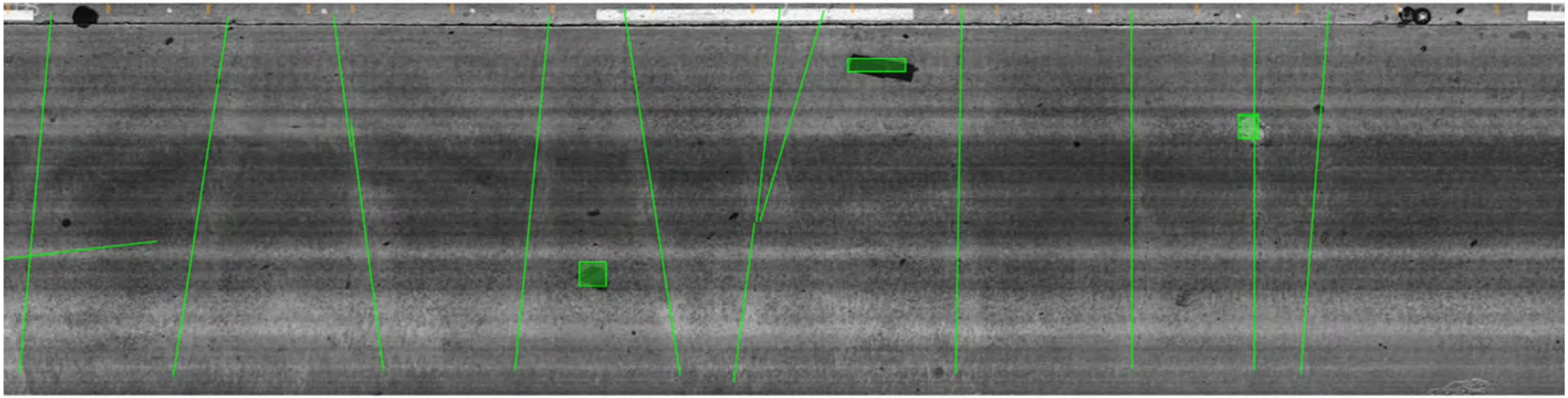
Manual Crack Map



Fugro (Semi Automated)

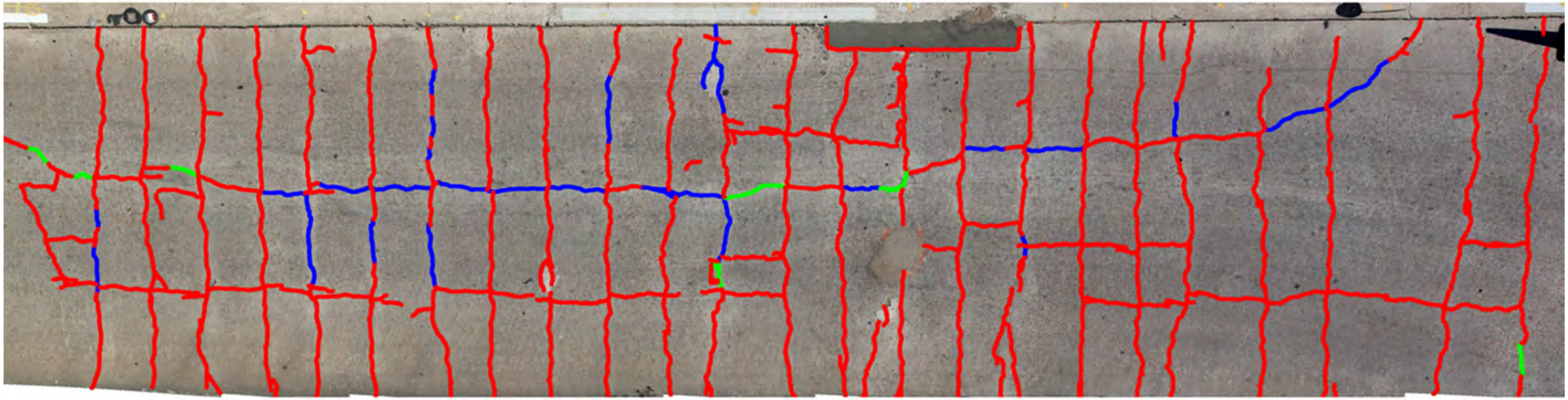
Section 19 /// Station 200-250

Manual Crack Map

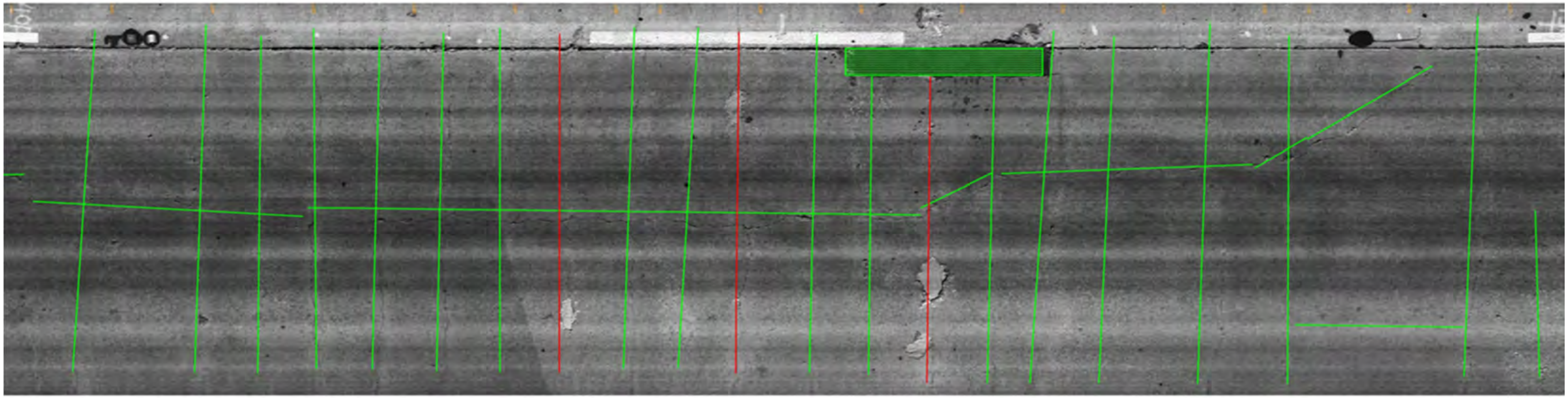


Fugro (Semi Automated)

Section 19 /// Station 400-450



Manual Crack Map



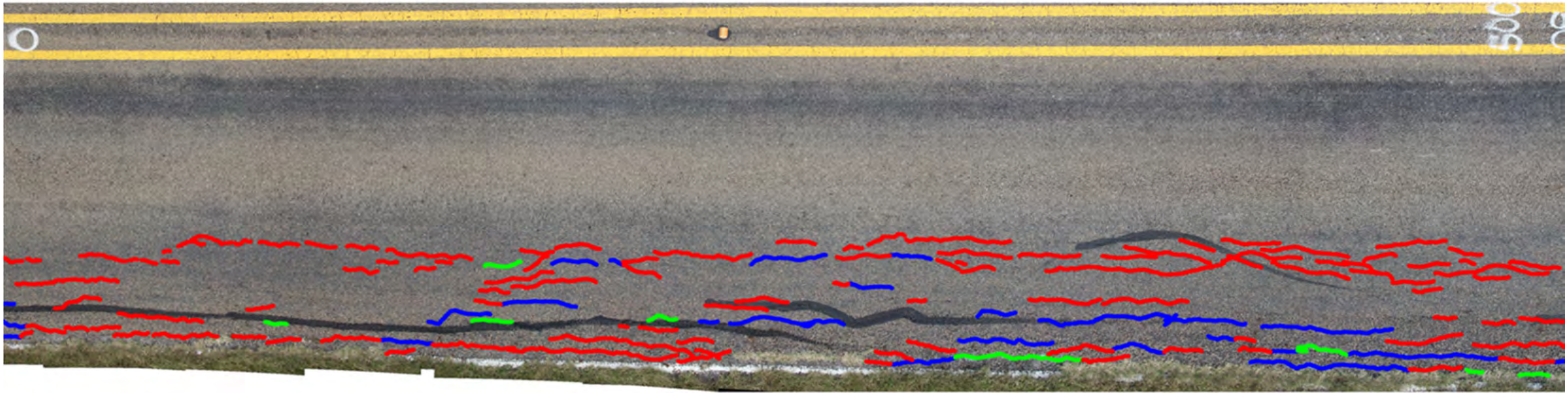
Fugro (Semi Automated)

Appendix A.7

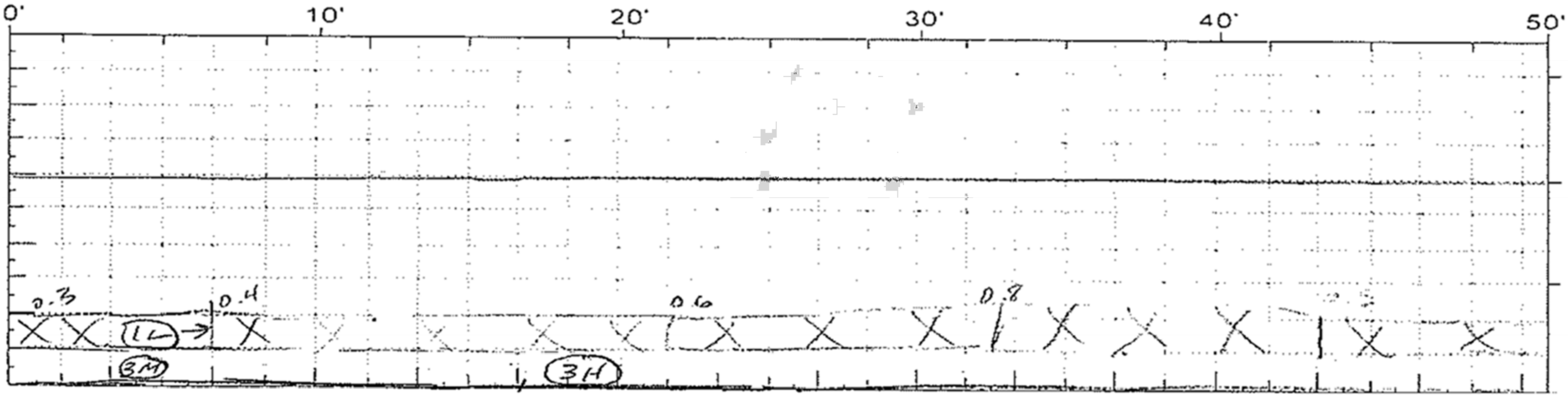
Crack Maps Comparison

LTPP Manual Distress Survey

Section 2 /// Station 000-050



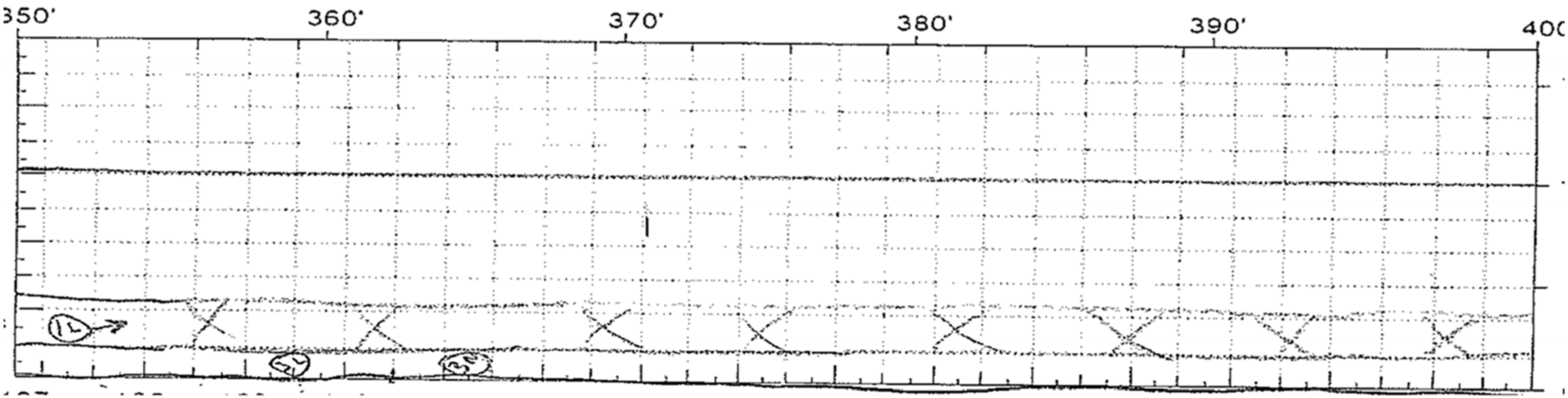
Manual Crack Map



LTPP Manual Distress Survey

Section 2 /// Station 350-400

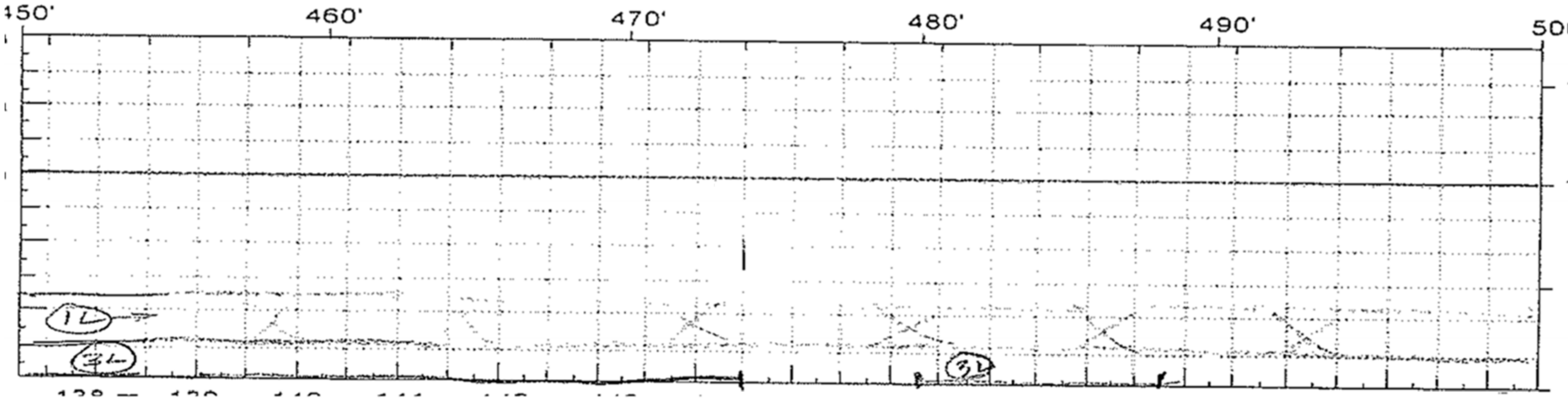
Manual Crack Map



LTPP Manual Distress Survey

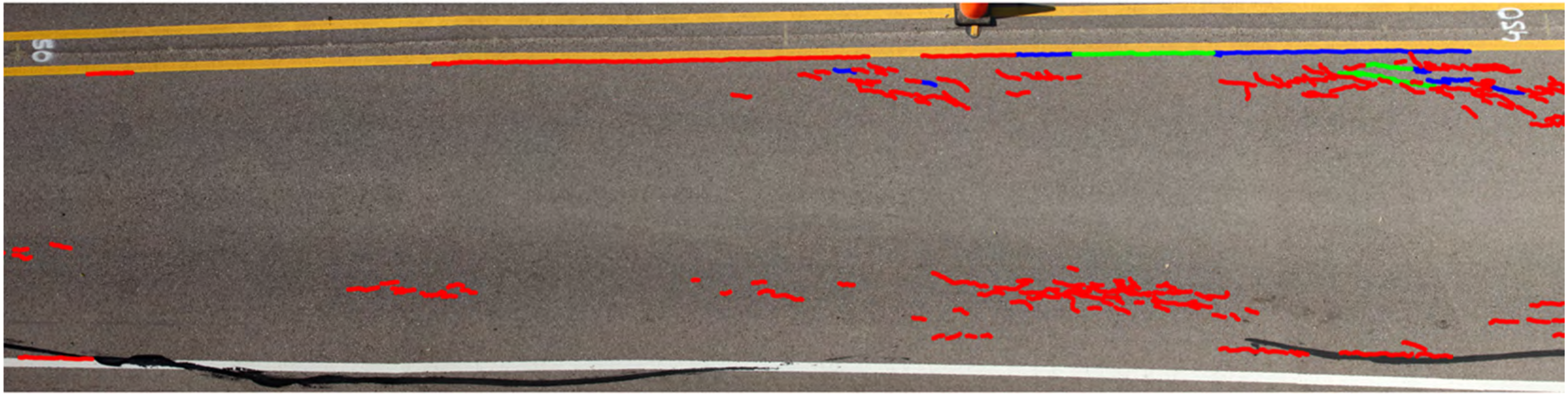
Section 2 /// Station 450-500

Manual Crack Map

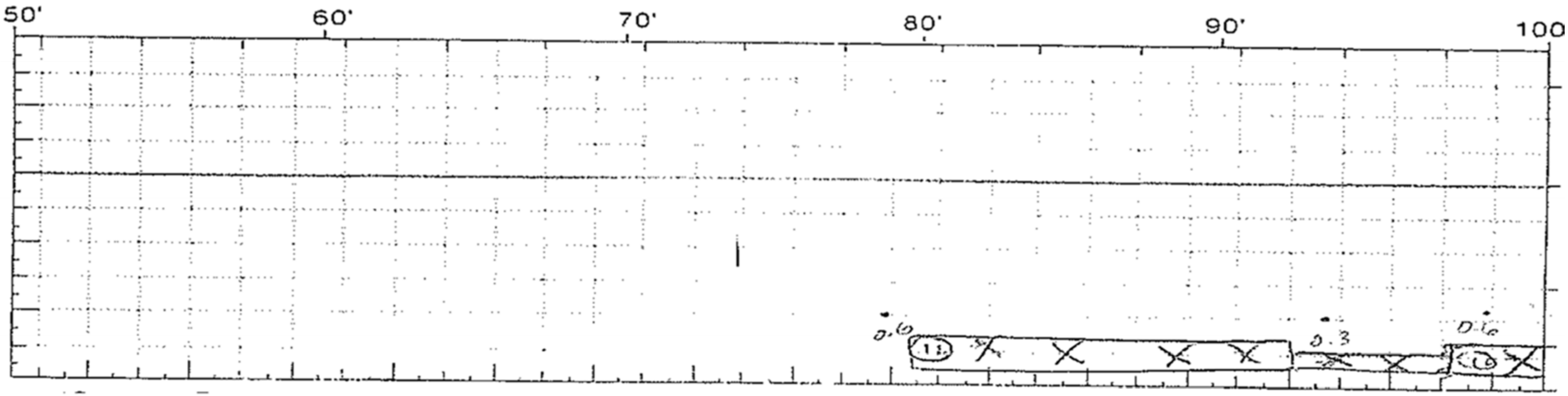


LTPP Manual Distress Survey

Section 4 /// Station 050-100



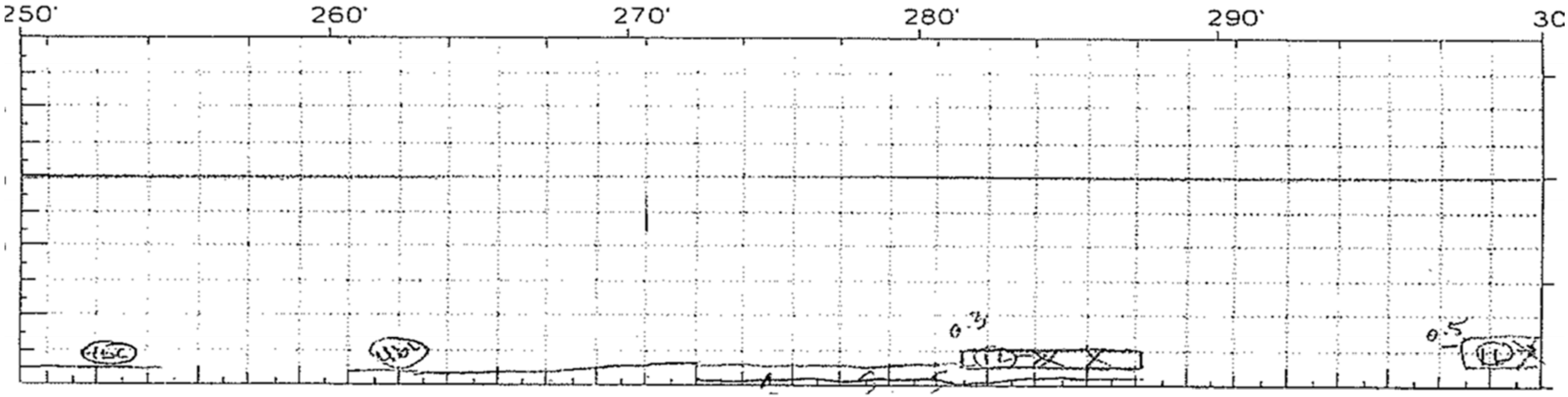
Manual Crack Map



LTPP Manual Distress Survey

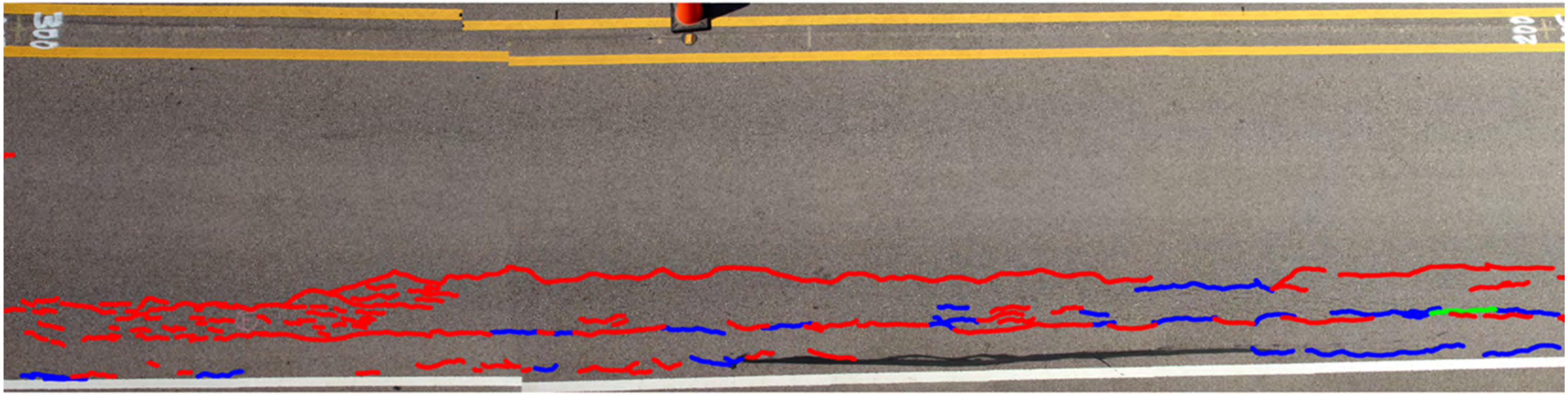
Section 4 /// Station 250-300

Manual Crack Map

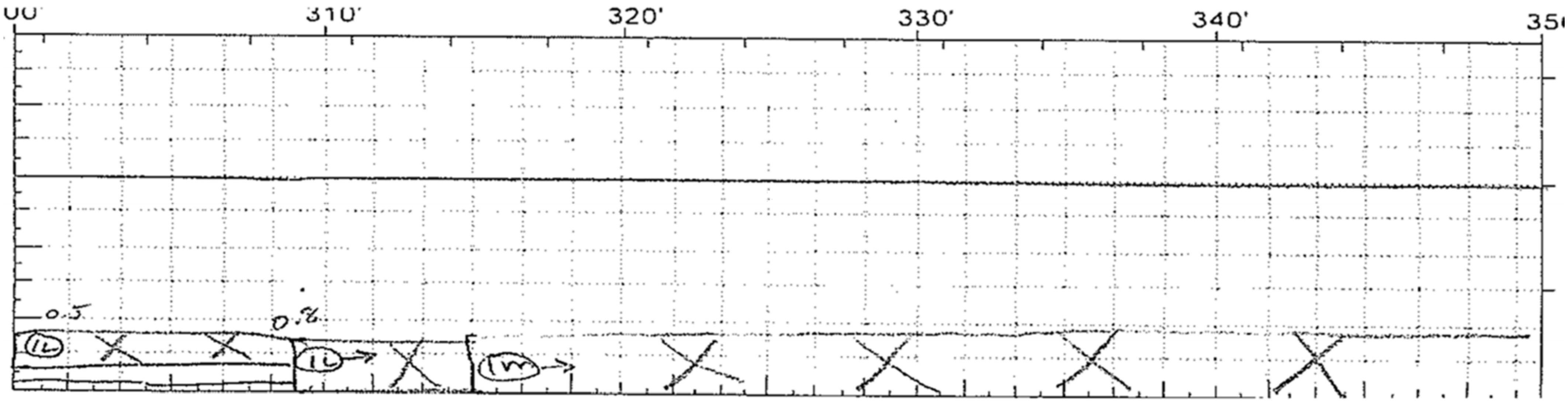


LTPP Manual Distress Survey

Section 4 /// Station 300-350



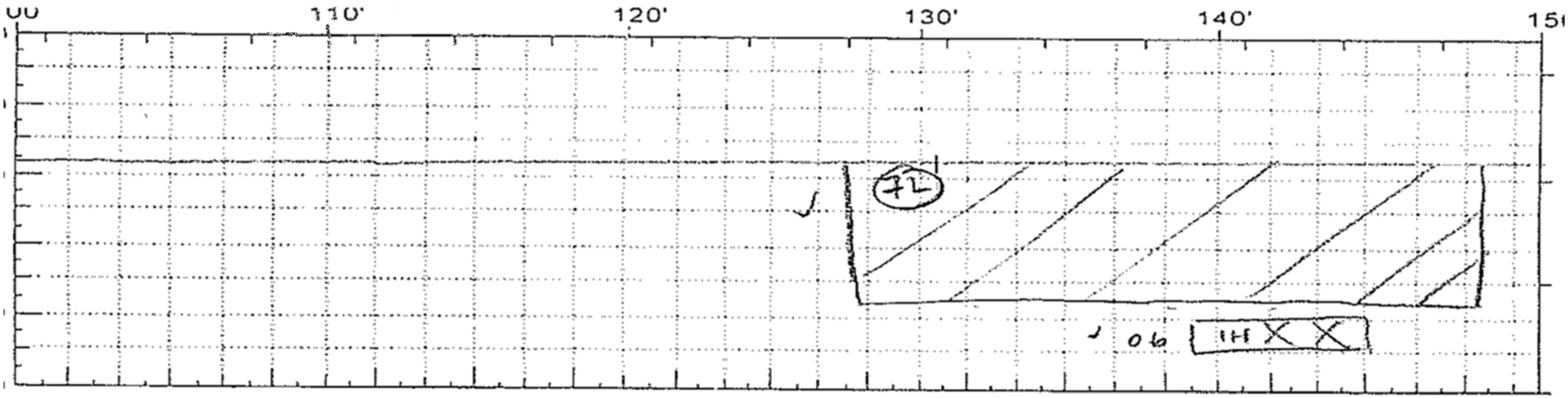
Manual Crack Map



LTPP Manual Distress Survey

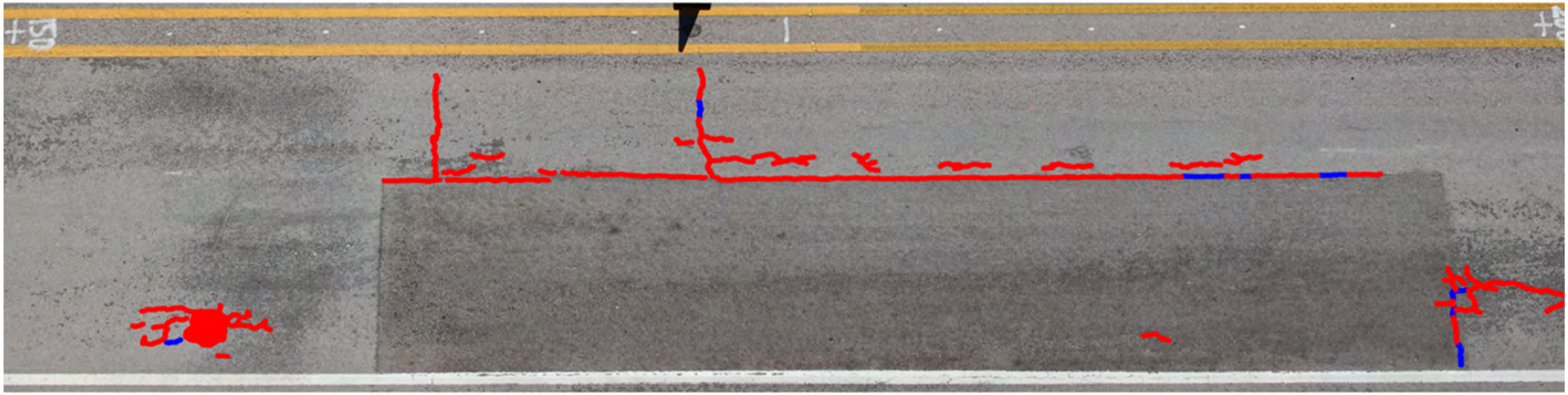
Section 6 /// Station 100-150

Manual Crack Map

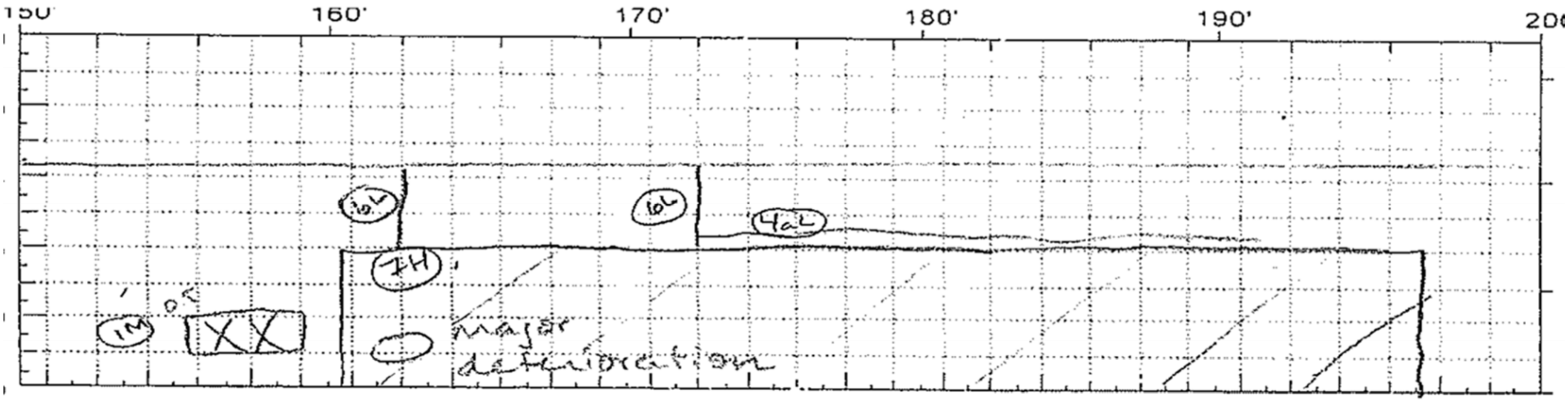


LTPP Manual Distress Survey

Section 6 /// Station 150-200



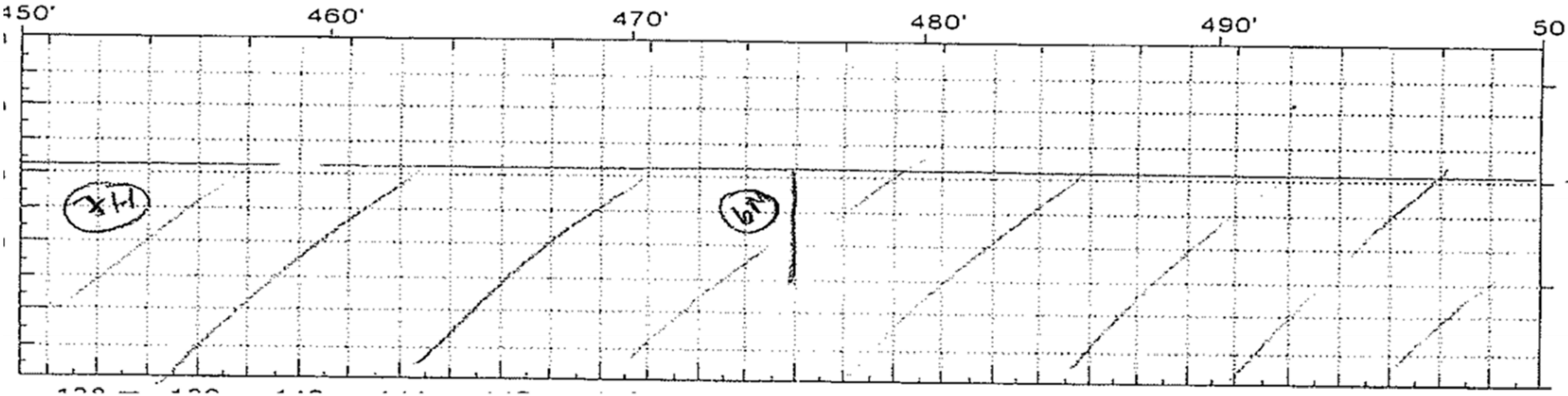
Manual Crack Map



LTPP Manual Distress Survey

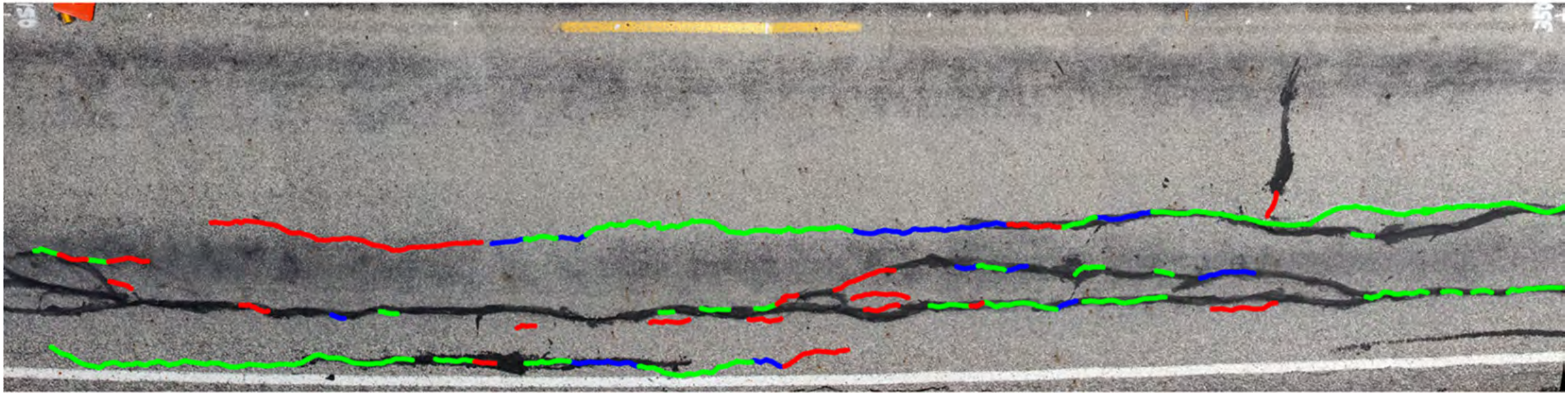
Section 6 /// Station 450-500

Manual Crack Map

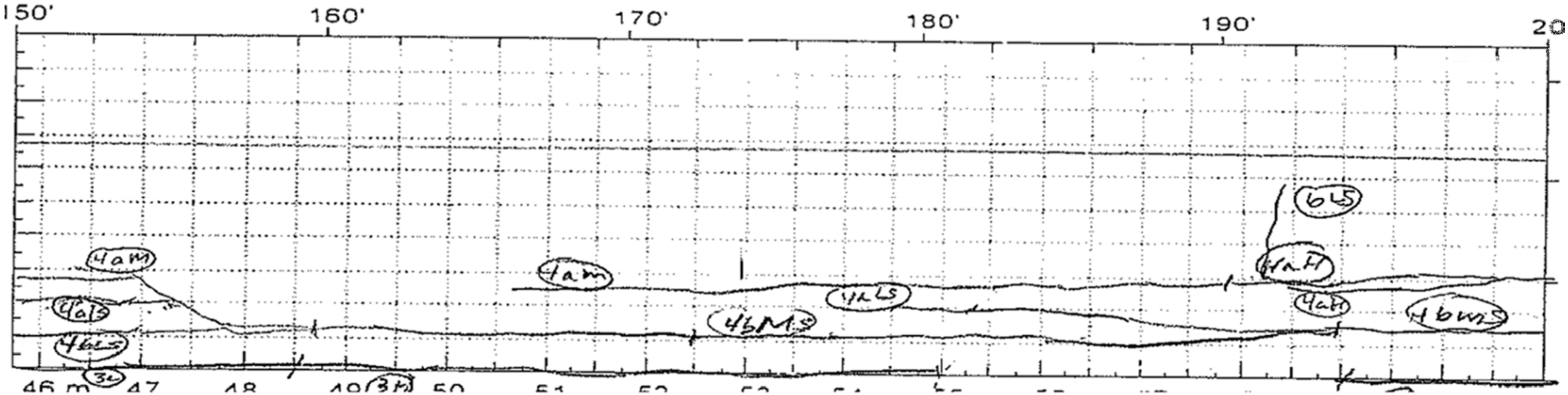


LTPP Manual Distress Survey

Section 9 /// Station 150-200

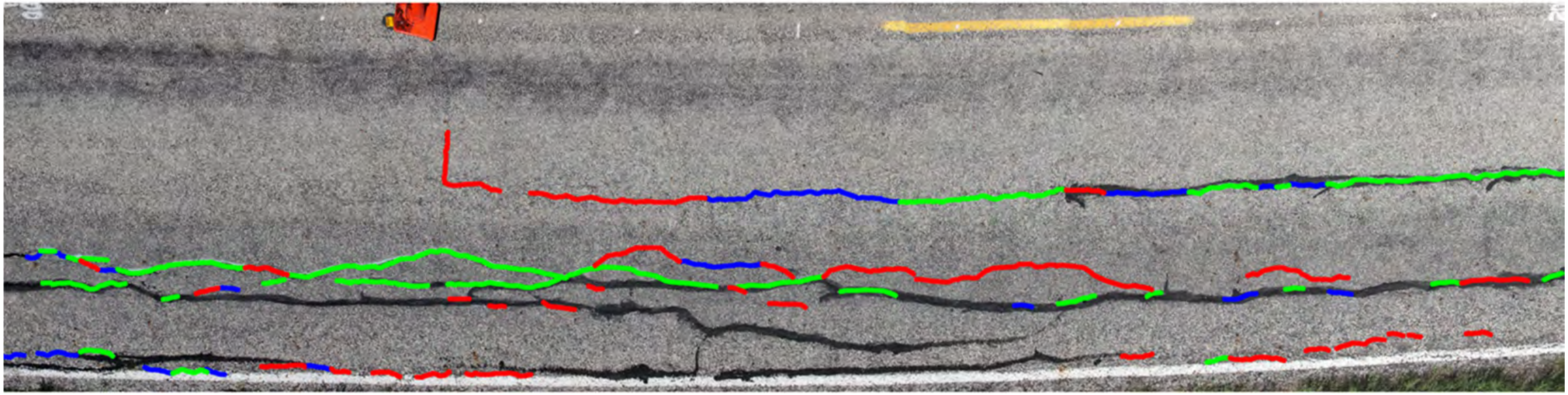


Manual Crack Map

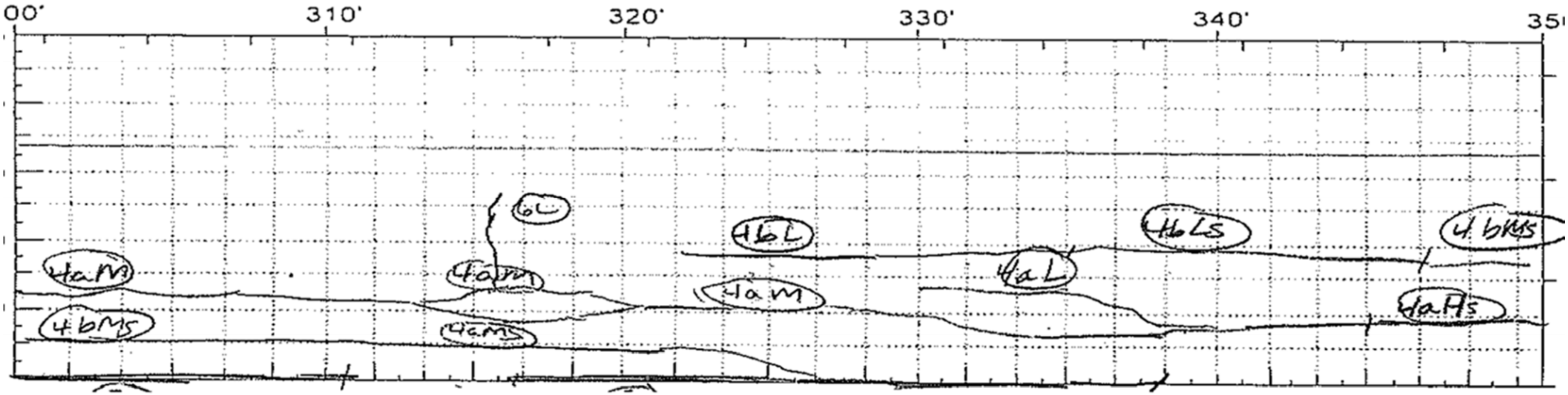


LTPP Manual Distress Survey

Section 9 /// Station 300-350

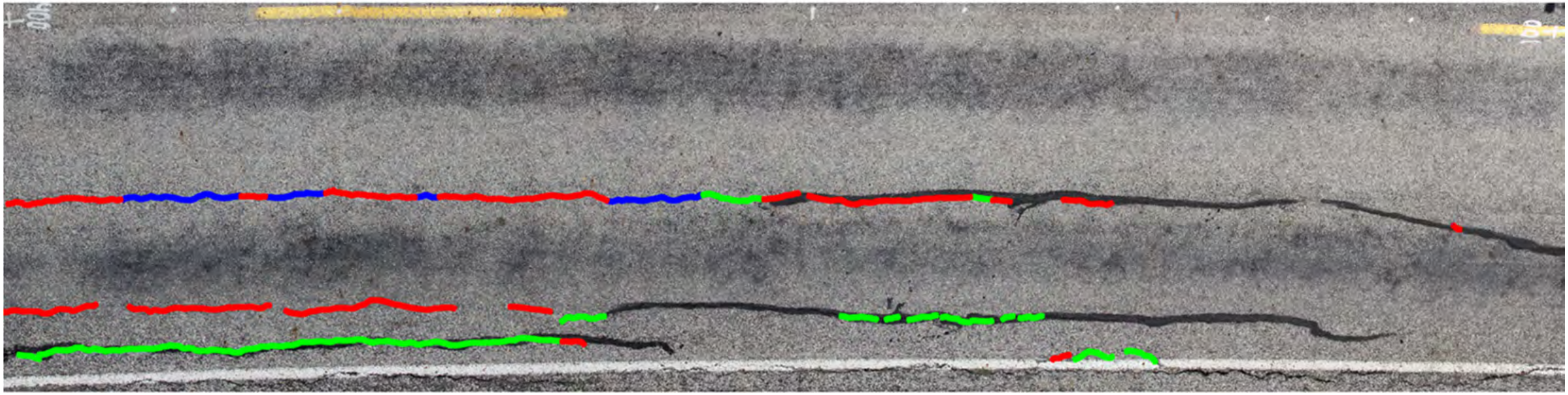


Manual Crack Map

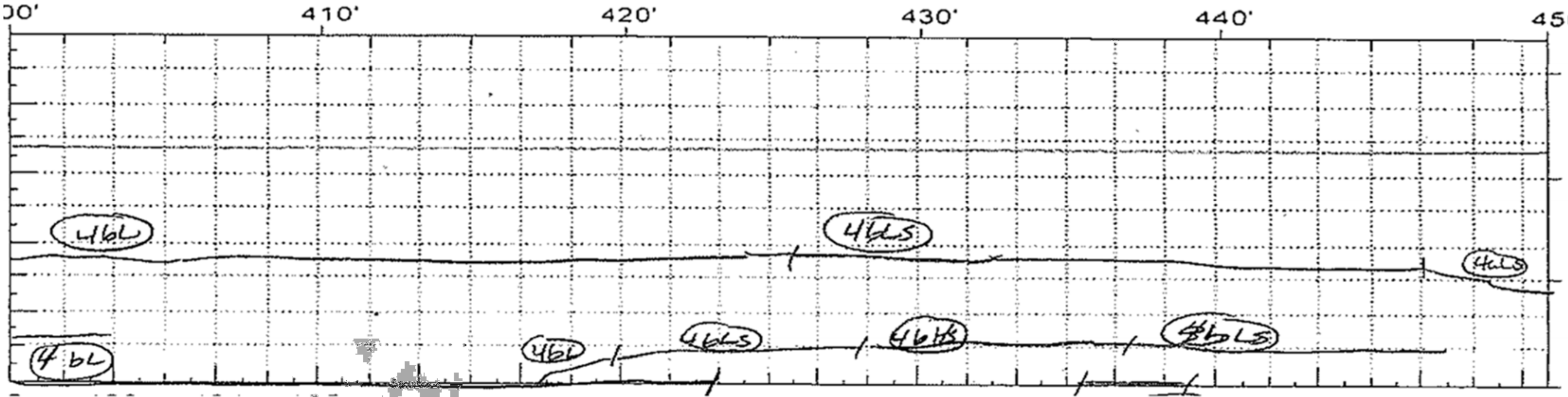


LTPP Manual Distress Survey

Section 9 /// Station 400-450

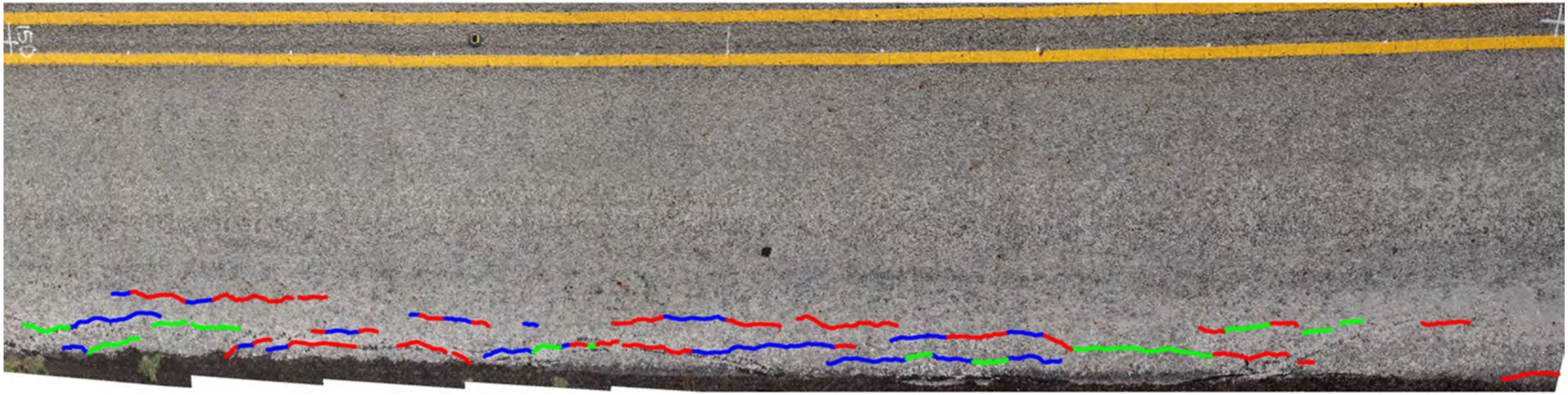


Manual Crack Map

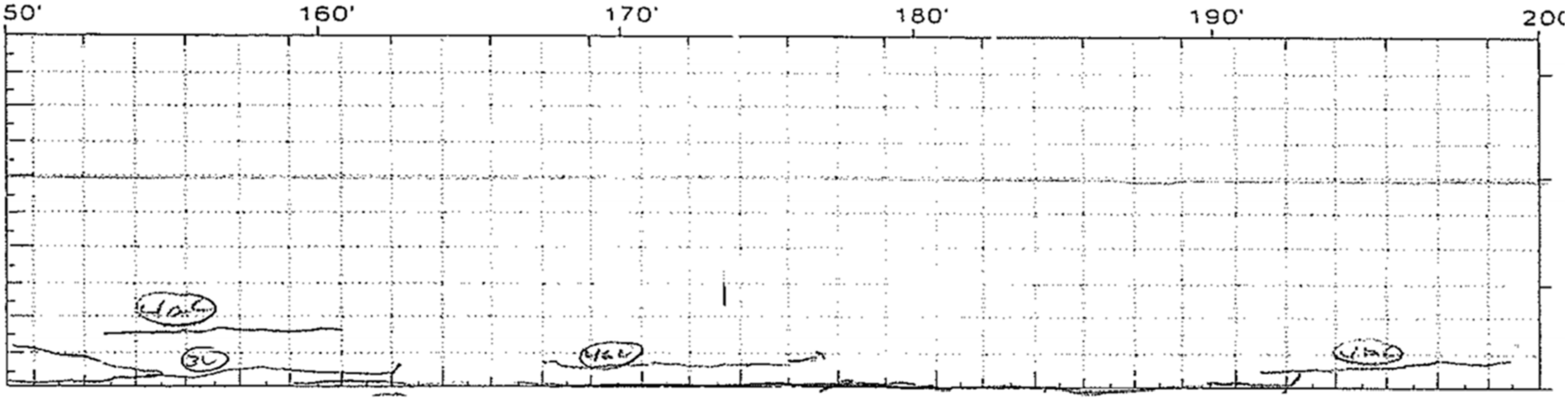


LTPP Manual Distress Survey

Section 10 /// Station 150-200

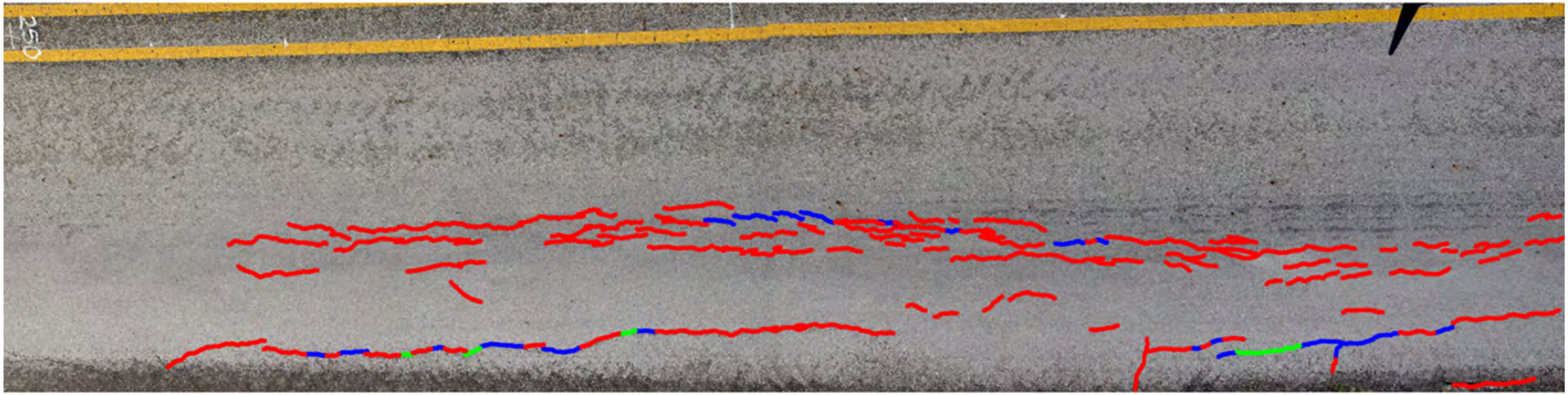


Manual Crack Map

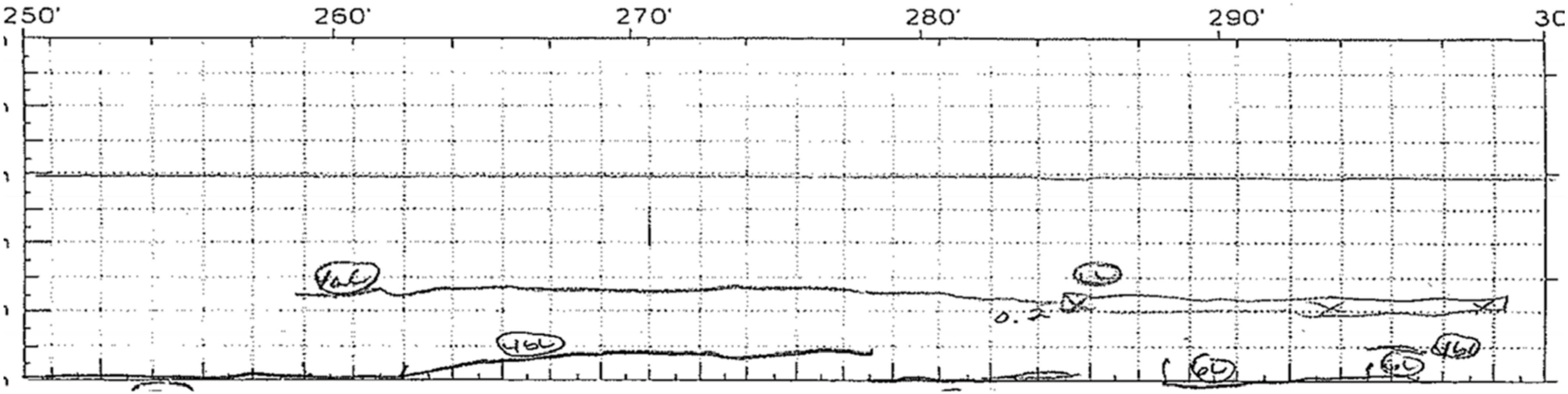


LTPP Manual Distress Survey

Section 10 /// Station 250-300



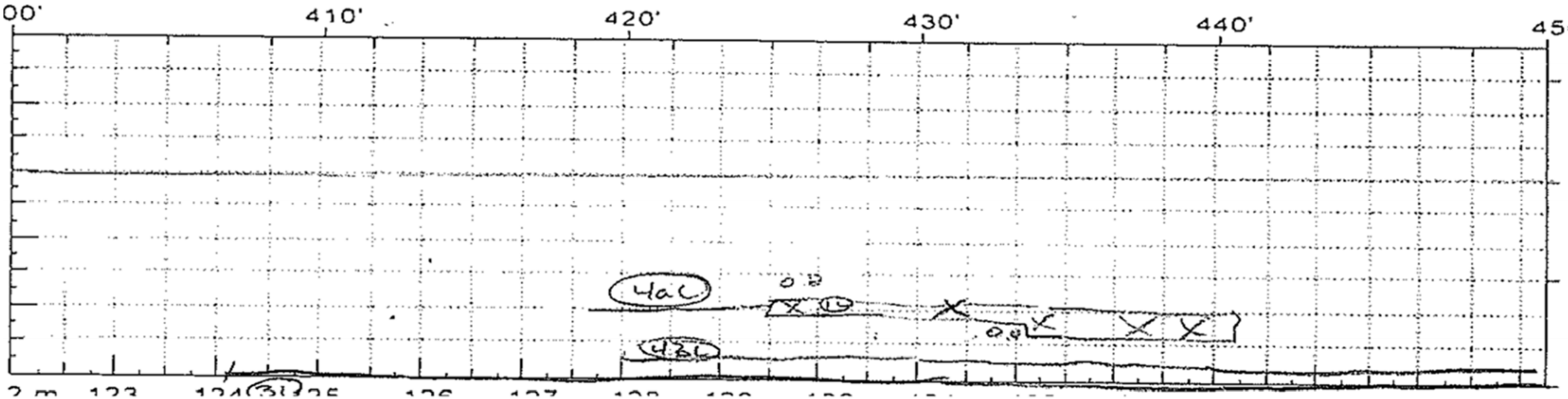
Manual Crack Map



LTPP Manual Distress Survey

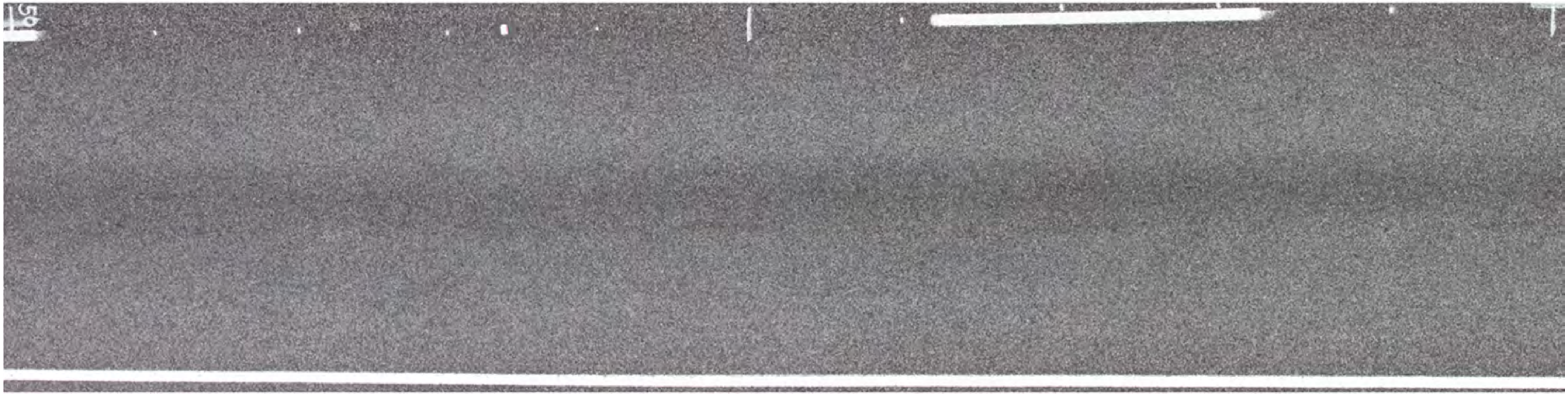
Section 10 /// Station 400-450

Manual Crack Map



LTPP Manual Distress Survey

Section 11 /// Station 050-100



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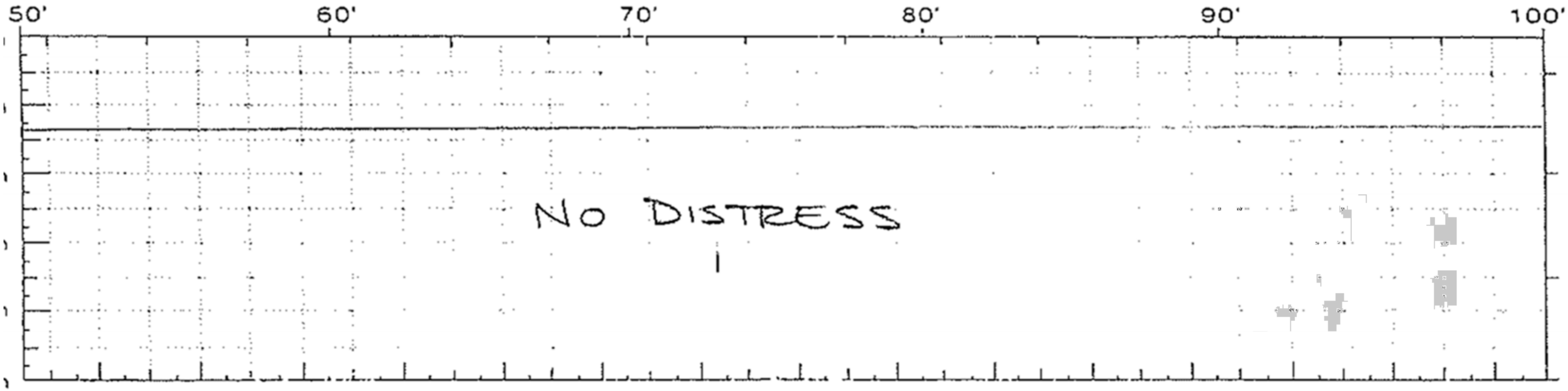
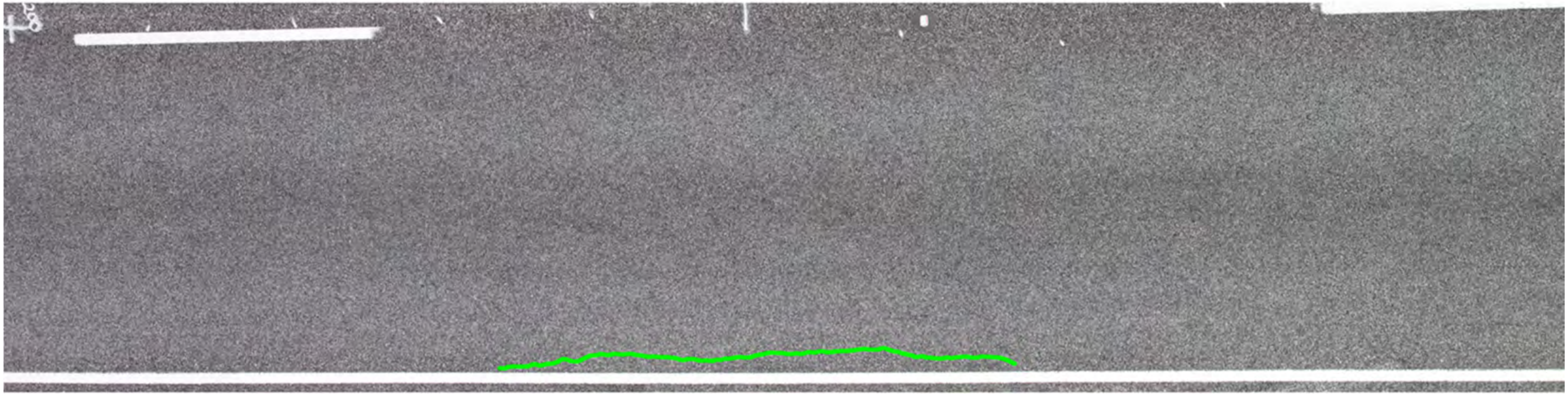
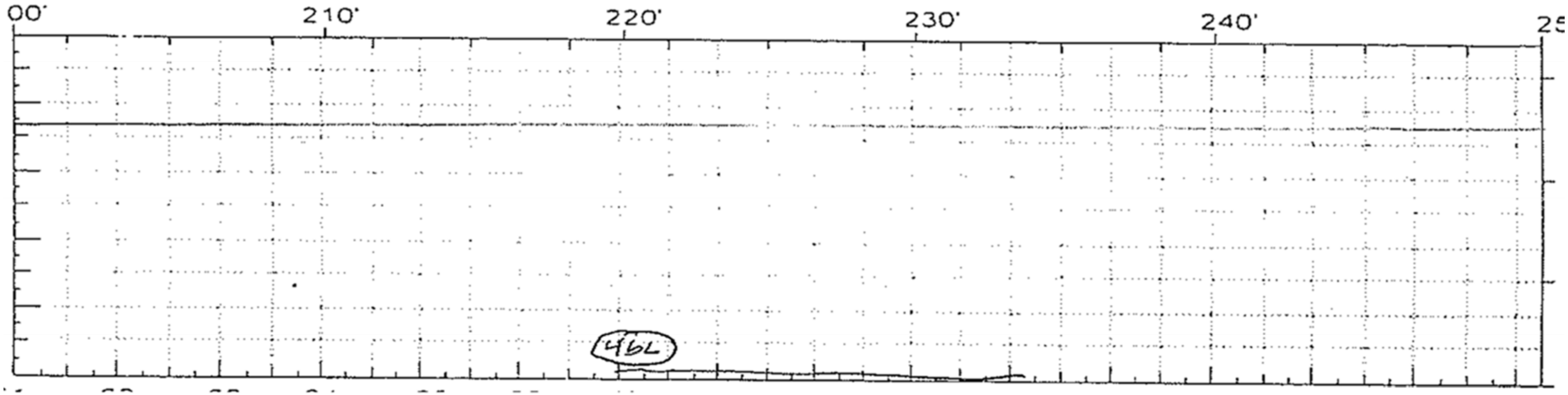


LTPP Manual Distress Survey

Section 11 /// Station 200-250

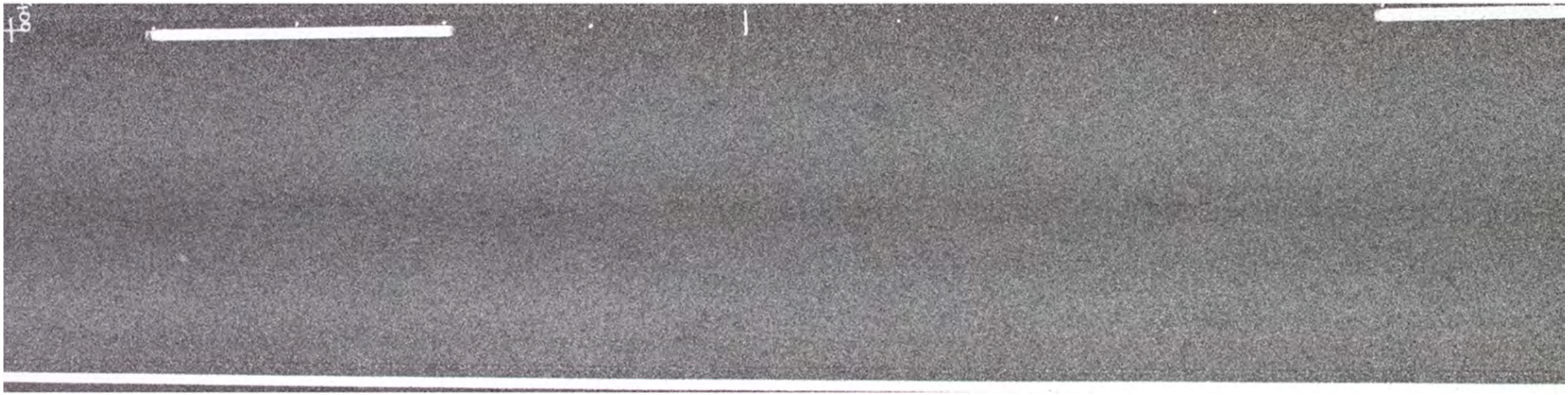


Manual Crack Map



LTPP Manual Distress Survey

Section 11 /// Station 400-450



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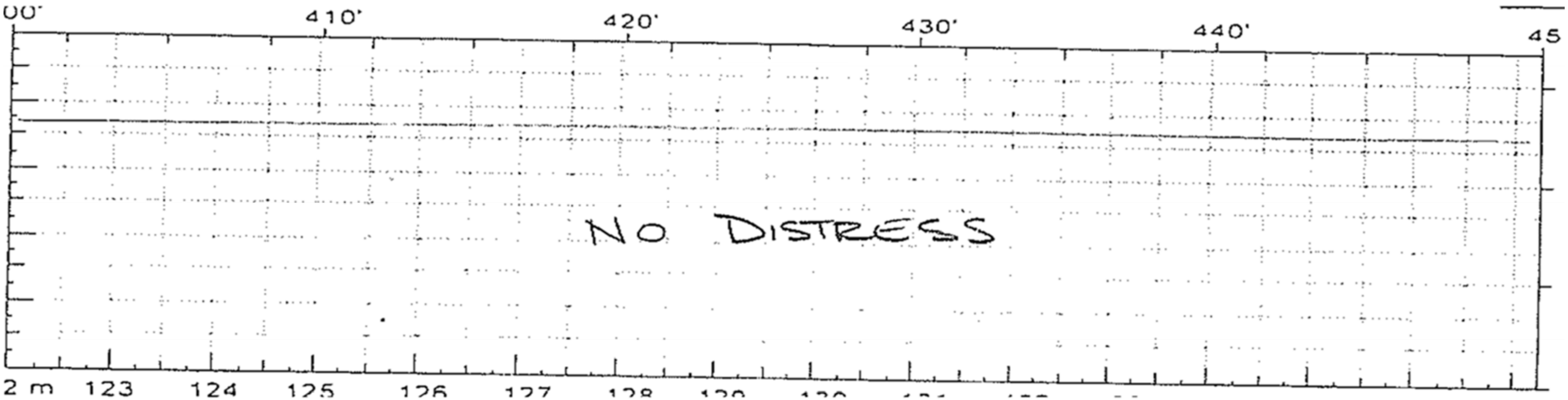
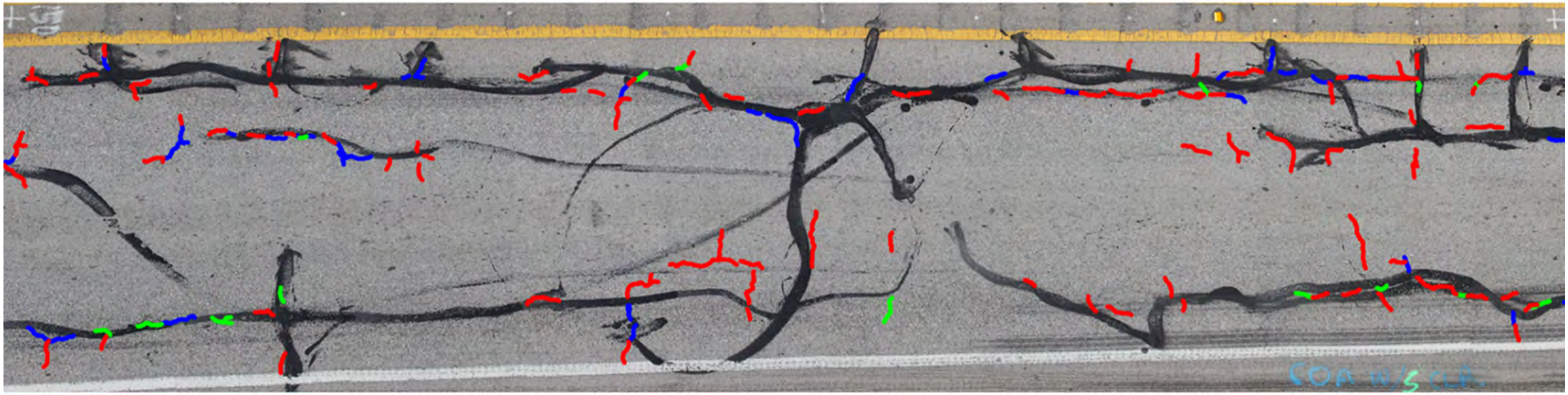


LTPP Manual Distress Survey

Section 12 /// Station 150-200



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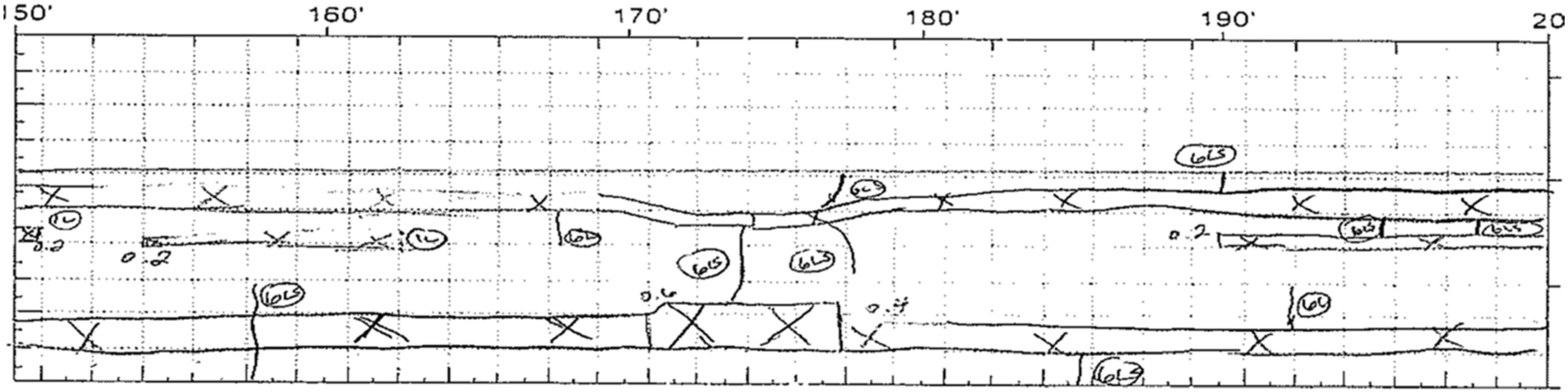
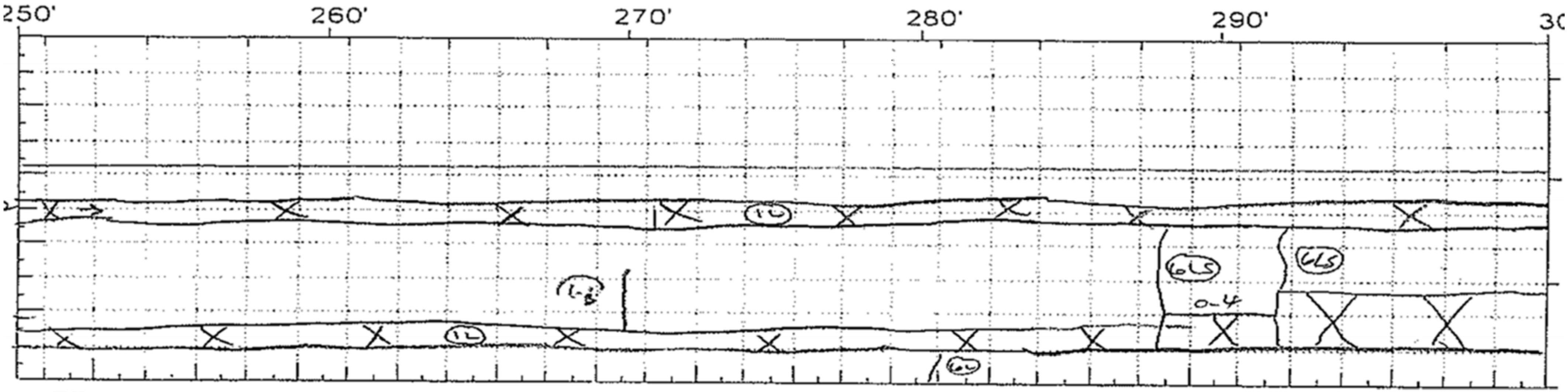


LTPP Manual Distress Survey

Section 12 /// Station 250-300

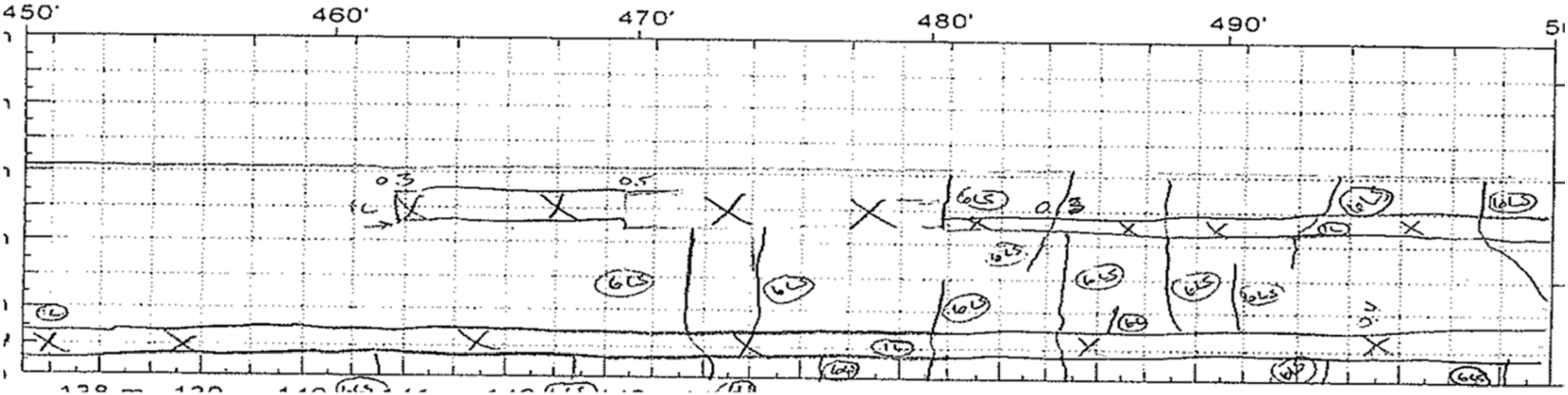
Manual Crack Map



LTPP Manual Distress Survey

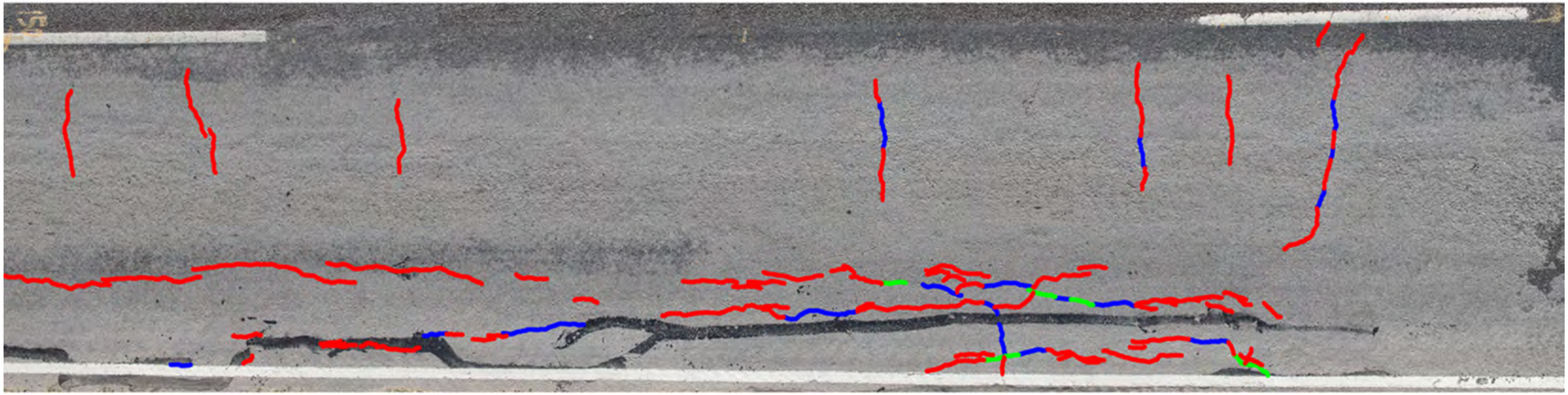
Section 12 /// Station 450-500

Manual Crack Map

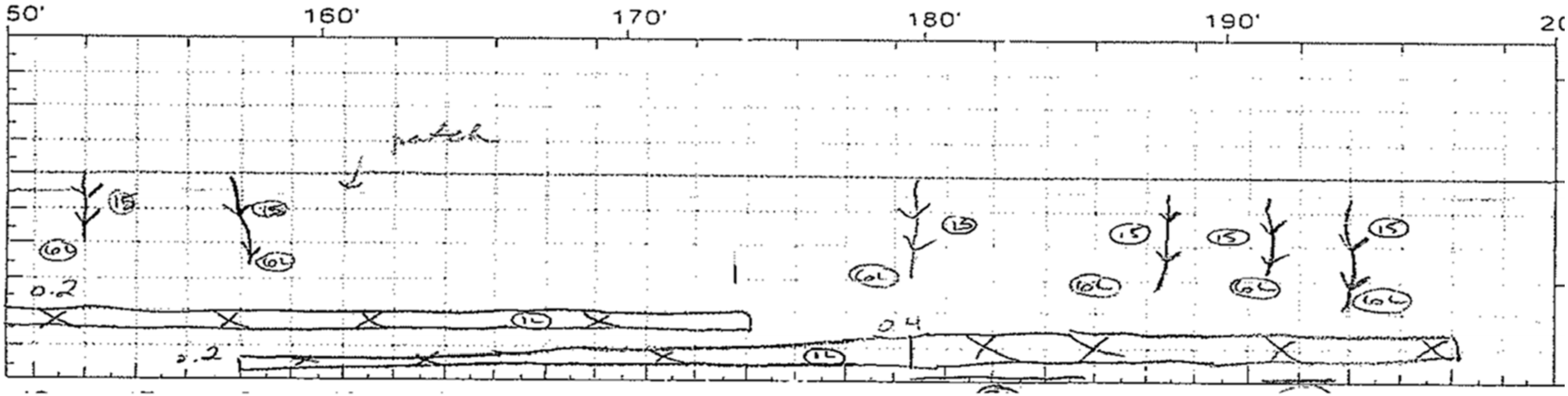


LTPP Manual Distress Survey

Section 13 /// Station 150-200

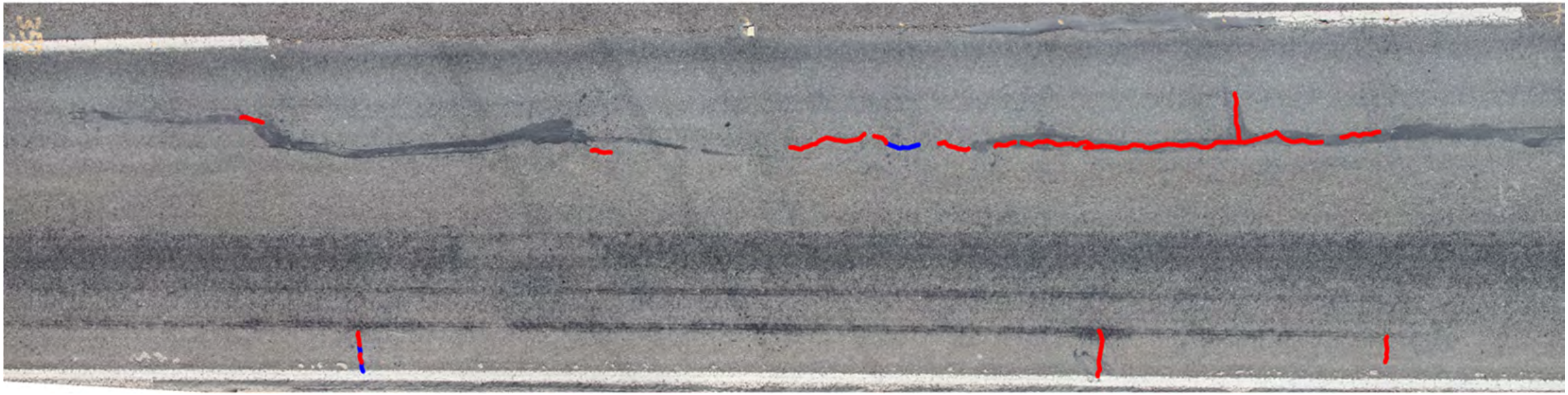


Manual Crack Map

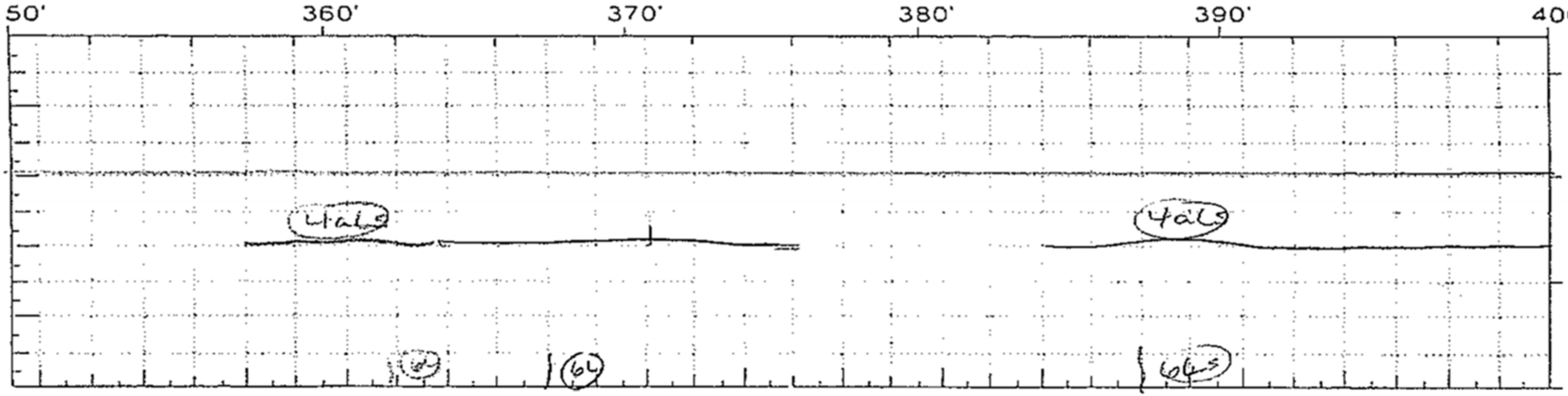


LTPP Manual Distress Survey

Section 13 /// Station 350-400



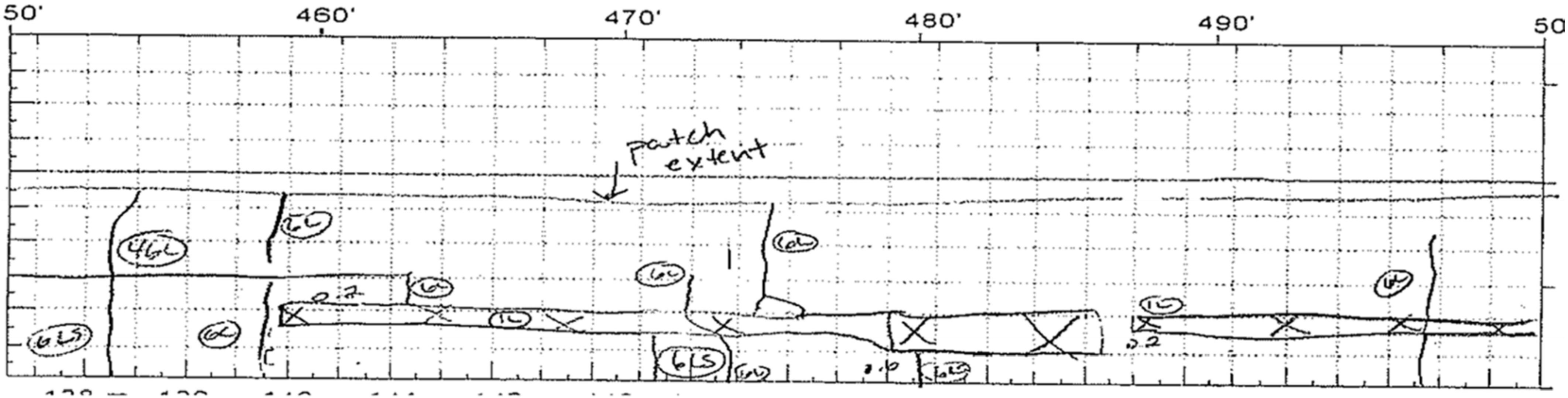
Manual Crack Map



LTPP Manual Distress Survey

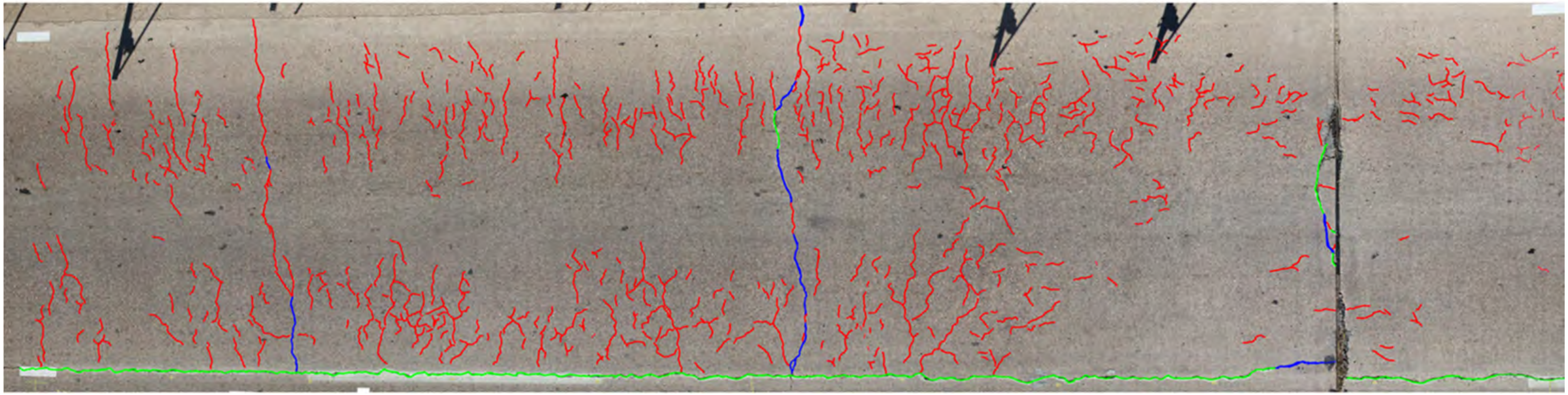
Section 13 /// Station 450-500

Manual Crack Map

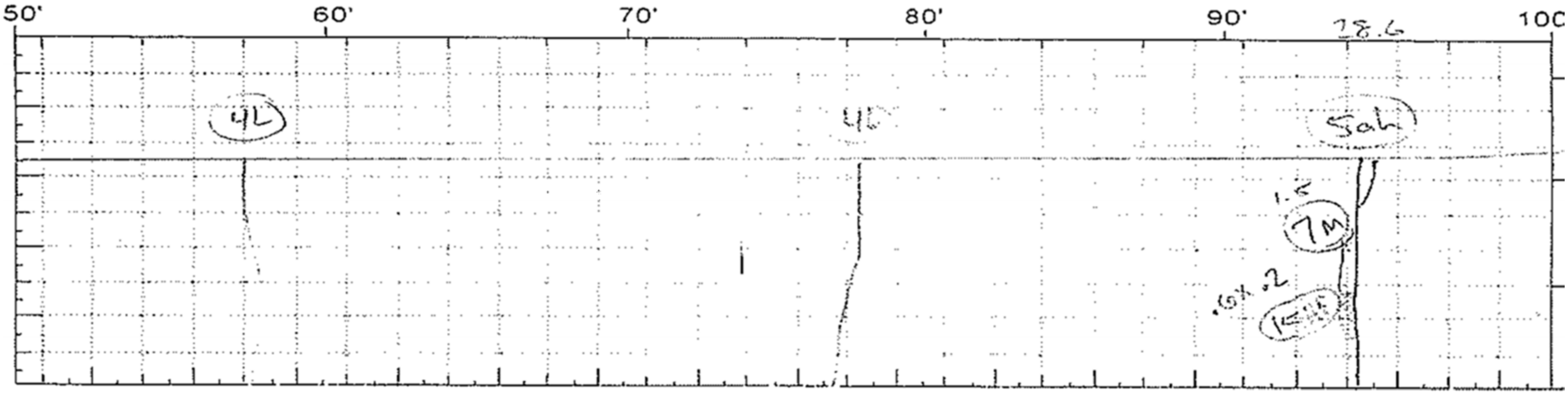


LTPP Manual Distress Survey

Section 17 /// Station 050-100

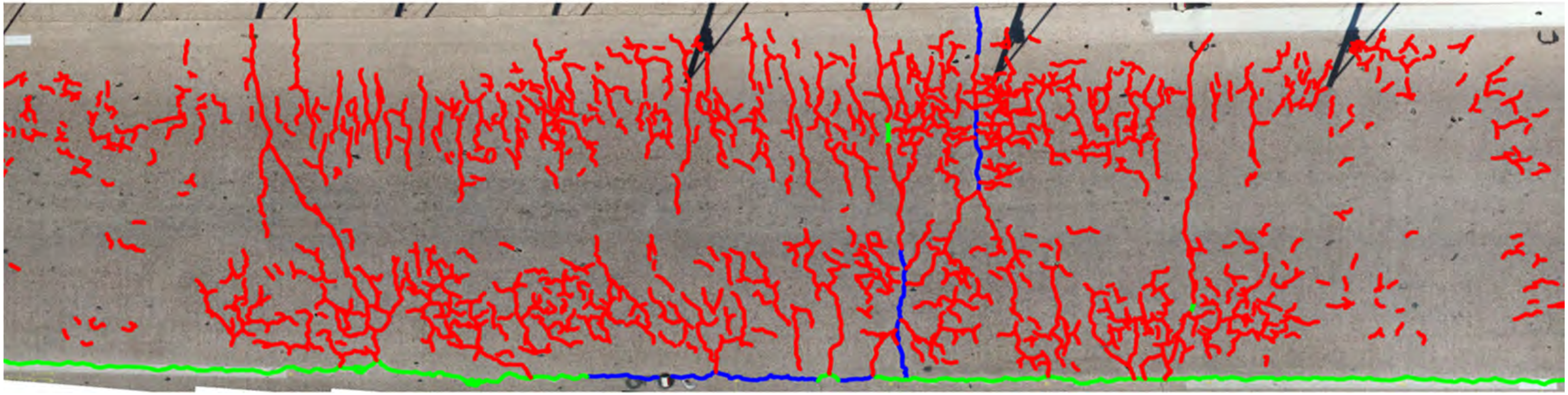


Manual Crack Map

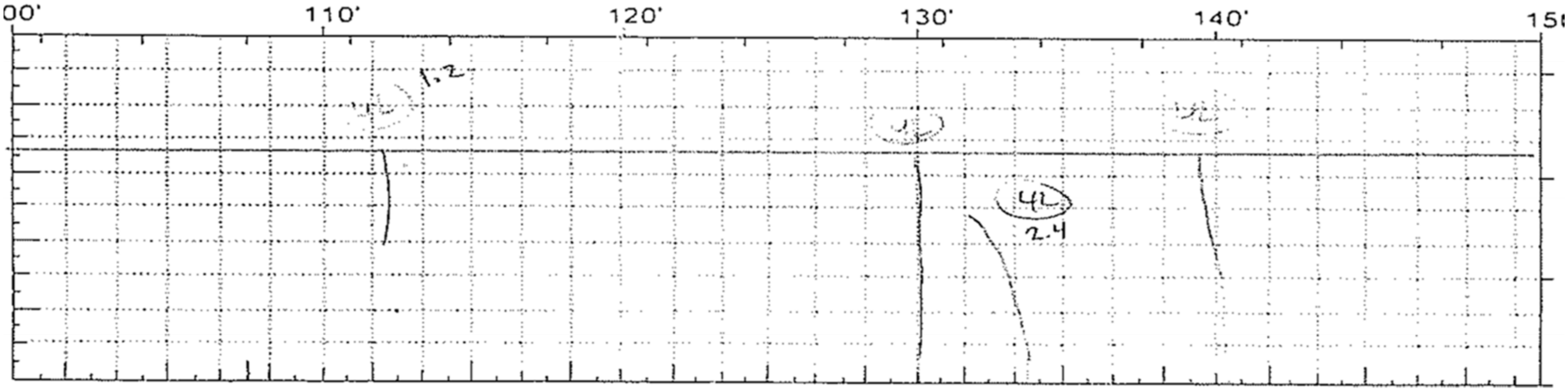


LTPP Manual Distress Survey

Section 17 /// Station 100-150

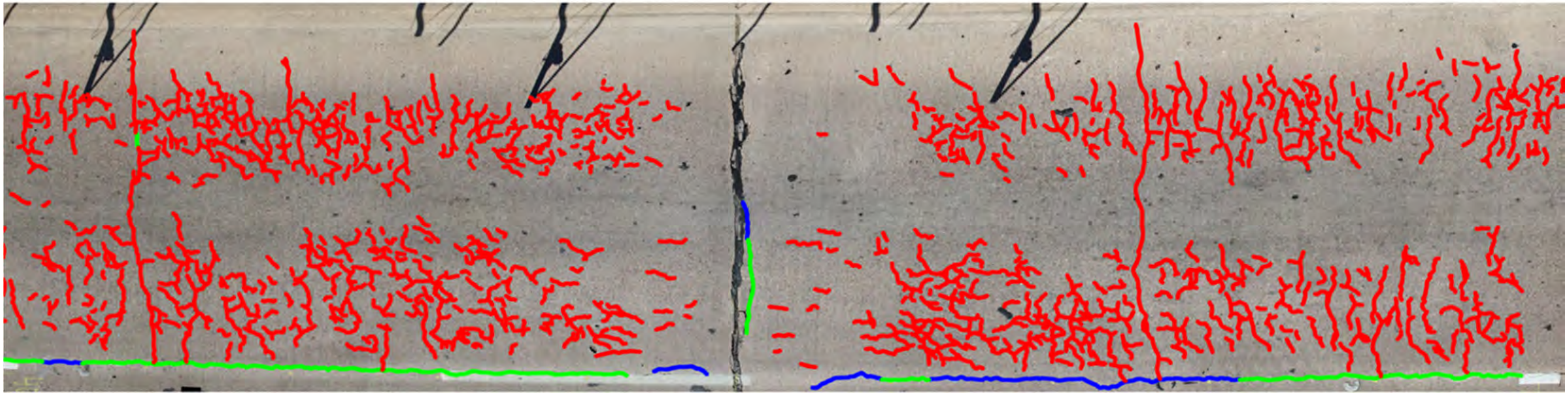


Manual Crack Map

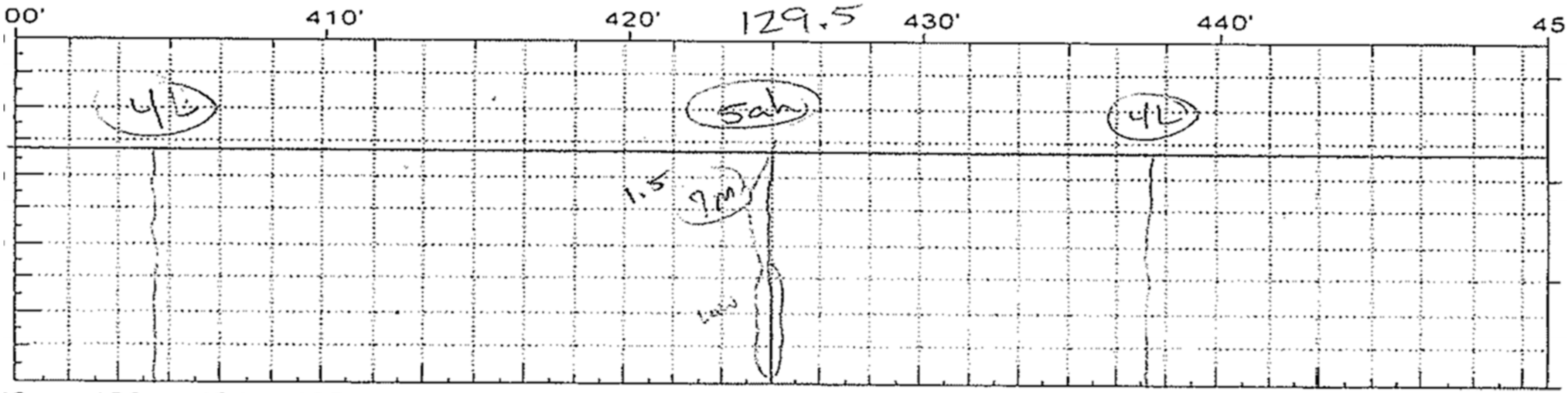


LTPP Manual Distress Survey

Section 17 /// Station 400-450



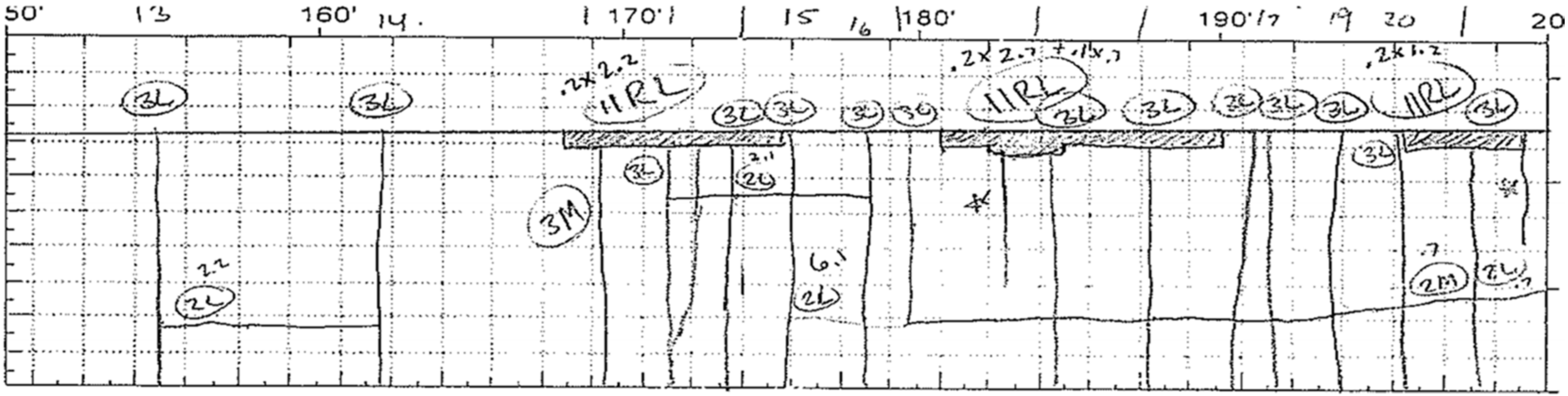
Manual Crack Map



LTPP Manual Distress Survey

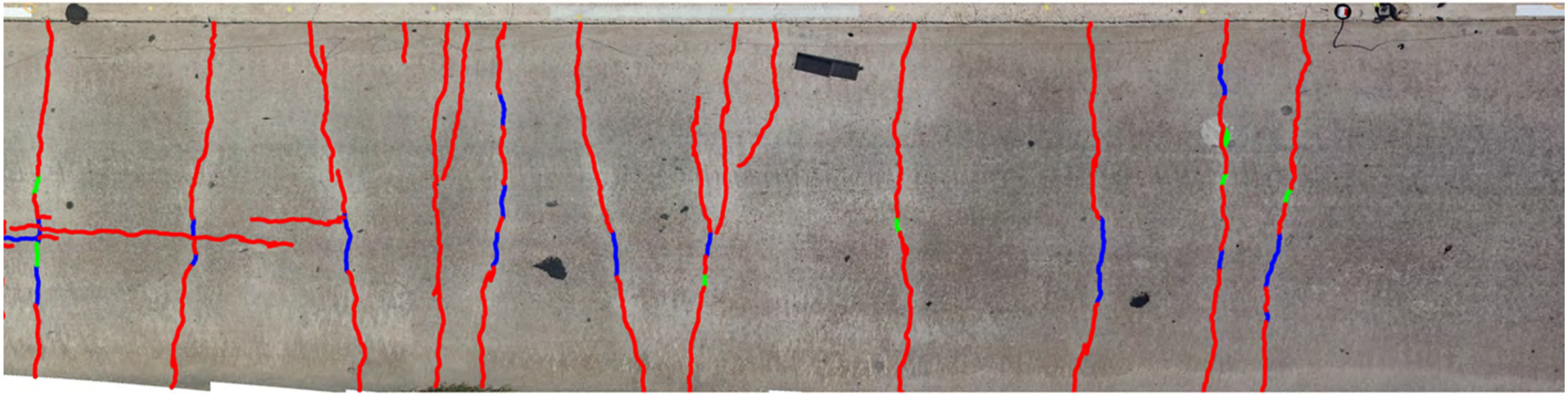
Section 19 /// Station 150-200

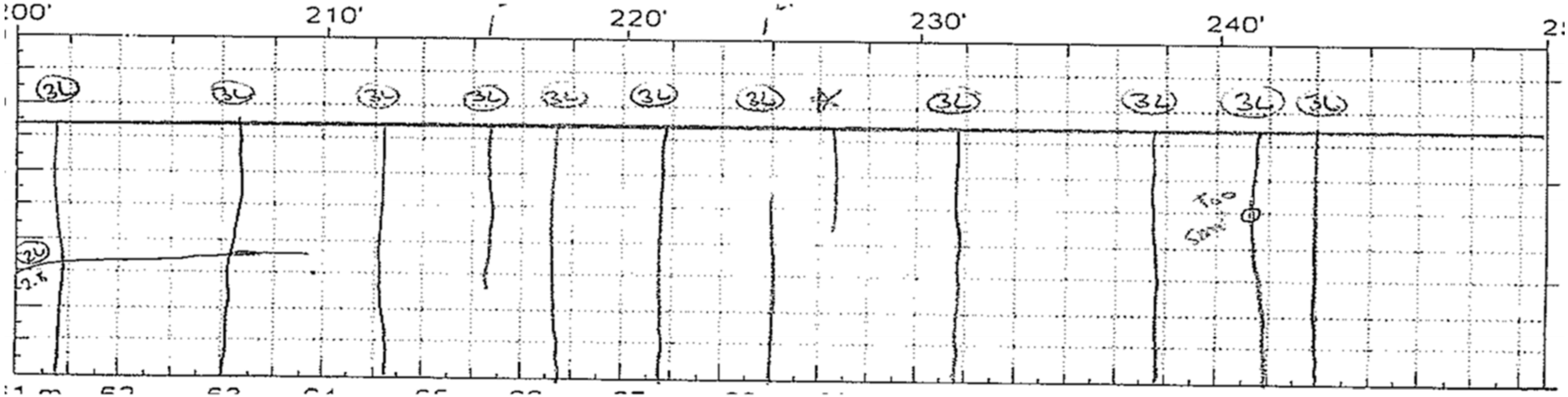
Manual Crack Map



LTPP Manual Distress Survey

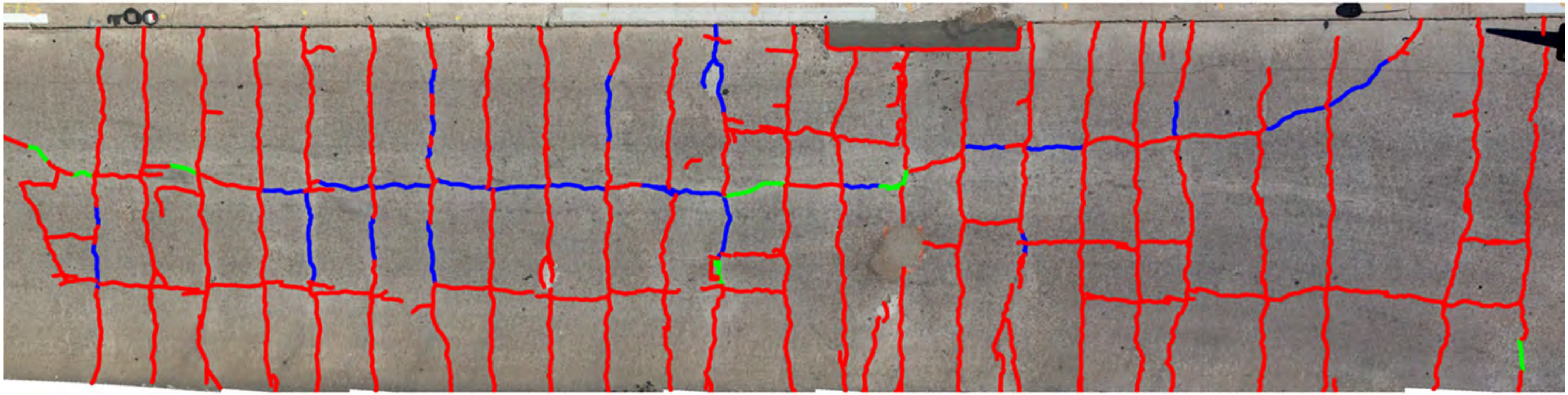
Section 19 /// Station 200-250


Manual Crack Map

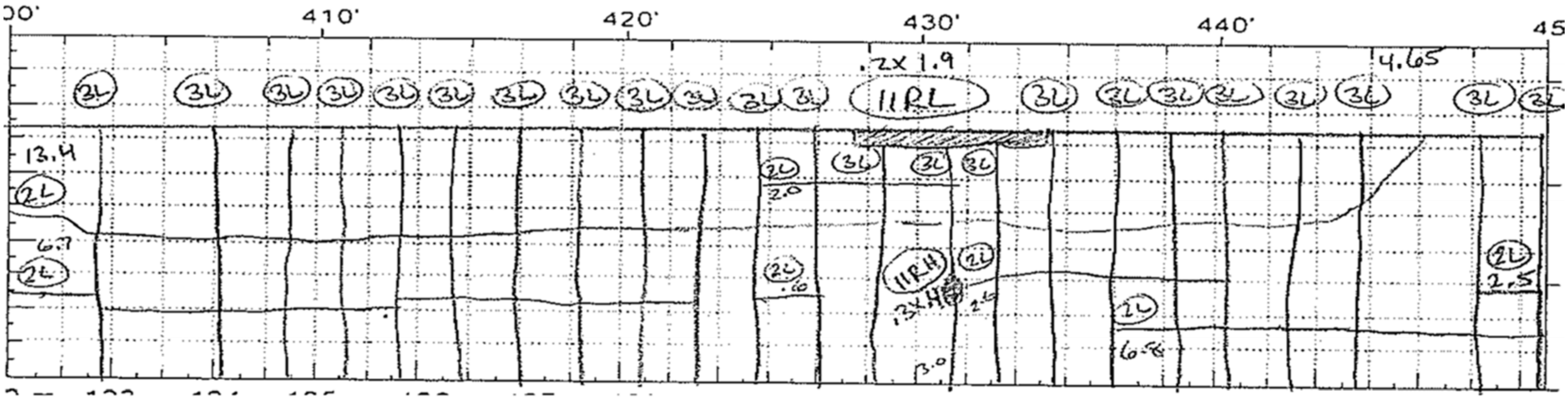


LTPP Manual Distress Survey

Section 19 /// Station 400-450



Manual Crack Map



LTPP Manual Distress Survey

Appendix B.1 – Distresses Statistics for ACP Sections

		Fatigue_Low_m2	Fatigue_Medium__m2	Fatigue_High_m2	Long_WP_Low_m	Long_WP_Medium__m	Long_WP_High_m	Long_Non_WP_Low_m	Long_Non_WP_Medium__m	Long_Non_WP_High_m	Transverse_Low__	Transverse_Low_m	Transverse_Medium__	Transverse_Medium__m	Transverse_High__	Transverse_High_m	Patching_Low__	Patching_Low_m2	Patching_Medium__	Patching_Medium__m2	Patching_High__	Patching_High_m2	Edge_Cracking_Low_m	Edge_Cracking_Medium_m	Edge_Cracking_High_m	Trans_Reflect_Cracking	Bleeding__m2	Raveling__m2
S1	***Manual***	**45.75**	**169.46**	**41.64**	**0.00**	**0.00**	**0.00**	**7.80**	**0.00**	**0.00**	**5.00**	**2.70**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**10.00**	**349.63**	**30.85**	**9.25**	**5.00**	**0.00**	**0.00**	**0.00**
	Fugro_fully_autom	0.28	7.51	46.56	13.01	22.07	1.01	15.98	31.55	2.45	82.08	21.66	41.00	9.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86	12.64	0.00	0.00	0.00
	Fugro_semi_autom	9.02	27.55	70.47	19.77	0.00	0.00	19.77	0.00	0.00	7.00	6.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	49.86	22.32	69.14	0.00	0.00	113.82
	Dynatest_fully_autom	22.06	40.28	10.77	145.90	85.30	25.74	0.00	0.00	0.00	0.00	32.53	0.00	19.05	0.00	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	43.20	47.31	77.55	63.71	16.56	0.08	38.31	24.60	14.38	0.00	14.59	0.00	7.19	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.24
	OSU	2.68	22.02	25.90	2.32	1.31	0.00	32.17	34.77	0.00	25.00	5.37	13.00	4.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S2	***Manual***	**94.55**	**0.00**	**0.00**	**27.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**52.80**	**30.75**	**50.00**	**0.00**	**0.00**	**0.00**
	Fugro_fully_autom	0.80	19.71	10.69	36.12	21.82	0.00	91.66	39.75	0.00	98.26	23.53	22.75	2.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.21	8.52	0.00	0.00	0.00
	Fugro_semi_autom	36.46	31.30	19.30	41.45	0.00	0.00	41.45	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	103.07	60.57	73.47	0.00	0.00	100.11
	Dynatest_fully_autom	33.70	14.30	0.00	204.27	58.94	0.18	0.00	0.00	0.00	0.00	21.39	0.00	6.99	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	65.92	43.89	13.69	40.55	10.35	0.00	127.78	31.91	0.17	0.00	17.90	0.00	6.61	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	1.05	1.88	0.00	79.93	0.00	0.00	278.97	13.27	0.00	2.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S3	***Manual***	**63.05**	**0.00**	**0.00**	**30.00**	**0.00**	**0.00**	**6.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**90.00**	**35.50**	**0.00**	**0.00**	**0.00**	**0.00**
	Fugro_fully_autom	0.48	2.29	0.01	30.06	13.42	0.00	73.61	38.80	0.00	114.40	28.22	22.00	4.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.30	0.47	0.00	0.00	0.00
	Fugro_semi_autom	0.00	0.00	0.00	100.98	0.00	0.00	100.98	0.00	0.00	2.00	1.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.80	109.81	0.00	0.00	49.41	190.66
	Dynatest_fully_autom	17.34	4.57	0.00	257.55	41.41	0.00	0.00	0.00	0.00	0.00	18.83	0.00	6.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	108.94	3.69	0.00	19.79	0.69	0.00	154.07	9.46	0.00	0.00	5.18	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	3.61	0.00	0.00	47.56	0.00	0.00	139.63	98.12	68.27	2.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S4	***Manual***	**19.66**	**11.40**	**0.00**	**0.00**	**0.00**	**0.00**	**21.25**	**2.75**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Fugro_fully_autom	0.00	0.00	0.00	1.55	0.00	0.00	3.74	1.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	0.00	0.00	0.00	60.58	0.00	0.00	60.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_fully_autom	0.00	0.00	0.00	58.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	13.26	0.00	0.00	36.24	0.00	0.00	11.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	0.13	0.00	0.00	0.00	0.00	0.00	3.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S5	***Manual***	**8.60**	**0.00**	**0.00**	**27.00**	**0.00**	**0.00**	**11.30**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Fugro_fully_autom	0.00	0.00	0.00	4.46	0.00	0.00	2.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	0.00	0.00	0.00	0.00	0.00	60.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.58	0.00	0.00	0.00
	Dynatest_fully_autom	0.00	0.00	0.00	55.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	0.00	0.00	0.00	45.32	0.00	0.00	18.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	0.16	0.00	0.00	0.00	0.00	0.00	3.71	0.00	0.00	1.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S6	***Manual***	**0.00**	**0.64**	**1.95**	**7.50**	**0.00**	**0.00**	**4.00**	**0.00**	**0.00**	**6.00**	**7.90**	**1.00**	**1.60**	**0.00**	**0.00**	**1.00**	**12.03**	**0.00**	**0.00**	**7.00**	**204.72**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Fugro_fully_autom	0.00	1.47	0.00	3.53	10.57	0.22	5.51	16.10	0.31	31.89	8.54	28.00	9.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	0.00	0.00	0.89	0.00	0.00	0.00	0.00	0.00	0.00	7.00	11.78	0.00	0.00	0.00	0.00	2.00	35.87	0.00	0.00	2.00	34.79	0.00	0.00	0.00	0.00	0.00	118.28
	Dynatest_fully_autom	0.90	1.27	0.00	10.42	18.90	1.40	0.00	0.00	0.00	0.00	8.96	0.00	5.47	0.00	0.28	0.00	61.05	0.00	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	0.27	0.00	0.74	4.18	4.49	0.20	3.42	9.19	0.20	0.00	8.33	0.00	4.15	0.00	0.28	0.00	64.53	0.00	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	1.24	1.00	0.60	3.00	2.98	0.00	0.00	4.00	8.83	1.00	3.53	0.00	0.00	0.00	0.00	0.00	0.00
S7	***Manual***	**93.27**	**86.83**	**0.00**	**18.00**	**42.50**	**1.25**	**25.25**	**1.25**	**0.00**	**9.00**	**8.50**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**68.35**	**33.25**	**0.00**	**0.00**	**0.00**	**87.45**
	Fugro_fully_autom	0.44	25.22	19.14	5.82	83.53	0.00	8.44	108.56	0.00	96.00	25.96	74.18	23.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	1.89	0.00	0.00	0.00
	Fugro_semi_autom	0.00	257.23	113.38	0.00	0.00	0.00	0.00	4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.68	0.00	0.00	0.00	0.00	40.03
	Dynatest_fully_autom	147.73	29.35	0.00	109.69	115.03	2.26	0.00	0.00	0.00	0.00	31.70	0.00	19.52	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	71.19	261.80	9.87	29.24	15.57	0.15	56.41	30.38	0.96	0.00	13.07	0.00	9.50	0.00	0.14	0.00	7.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	4.73	9.47	0.00	14.56	29.13	0.00	1.21	2.26	0.00	5.00	1.79	3.00	1.68	1.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S8	***Manual***	**0.00**	**0.00**	**0.00**	**10.80**	**1.00**	**38.10**	**5.75**	**8.25**	**31.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.00**	**2.75**	**0.00**	**0.00**	**35.85**	**2.00**	**41.50**	**0.00**	**167.75**	**0.00**
	Fugro_fully_autom	0.54	7.58	0.03	3.09	50.25	8.20	5.69	50.03	13.15	39.00	6.91	16.00	2.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.65	1.10	0.00	0.00	0.00
	Fugro_semi_autom	12.19	90.03	6.10	8.25	7.17	6.32	8.25	1.18	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.37	13.40	9.07	0.00	110.56	0.00
	Dynatest_fully_autom	9.66	7.58	0.37	44.59	72.27	17.44	0.00	0.00	0.00	0.00	6.23	0.00	6.30	0.00	1.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	80.32	85.90	13.26	3.31	5.58	1.26	11.06	34.58	6.33	0.00	2.97	0.00	2.63	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	2.53	1.78	0.00	3.00	4.12	2.81	16.07	21.65	13.19	1.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

		Fatigue_Low_m2	Fatigue_Medium__m2	Fatigue_High_m2	Long_WP_Low_m	Long_WP_Medium__m	Long_WP_High_m	Long_Non_WP_Low_m	Long_Non_WP_Medium__m	Long_Non_WP_High_m	Transverse_Low__	Transverse_Low_m	Transverse_Medium___	Transverse_Medium__m	Transverse_High__	Transverse_High_m	Patching_Low__	Patching_Low_m2	Patching_Medium___	Patching_Medium__m2	Patching_High__	Patching_High_m2	Edge_Cracking_Low_m	Edge_Cracking_Medium_m	Edge_Cracking_High_m	Trans_Reflect_Cracking	Bleeding__m2	Raveling__m2
S9	Manual	0.00	0.00	0.00	6.50	29.75	18.75	13.50	0.00	0.00	2.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.05	10.25	23.50	0.00	247.13	0.00
	Fugro_fully_autom	0.01	4.85	5.78	5.45	57.94	0.00	34.85	111.25	0.00	135.41	27.23	52.00	10.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.83	9.46	0.00	0.00	0.00
	Fugro_semi_autom	44.88	32.16	32.02	10.43	12.67	9.39	10.43	24.84	13.92	3.00	5.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.47	23.72	7.24	0.00	142.70	0.00
	Dynatest_fully_autom	5.99	17.28	0.55	75.83	117.75	11.22	0.00	0.00	0.00	0.00	22.02	0.00	9.34	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	27.46	90.08	26.92	35.47	20.76	3.81	62.91	44.47	1.06	0.00	22.95	0.00	5.56	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	0.00	0.00	0.00	0.65	7.28	21.22	30.19	18.16	56.42	0.00	0.00	2.00	2.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S10	Manual	2.16	0.00	0.00	35.60	4.00	0.00	47.05	0.00	0.00	2.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	117.00	3.50	0.00	0.00	0.00	413.63
	Fugro_fully_autom	0.00	0.54	0.00	8.98	13.64	0.00	30.77	24.32	0.00	37.08	9.82	23.00	7.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.41	0.00	0.00	0.00
	Fugro_semi_autom	1.36	1.61	0.00	3.07	2.31	0.00	3.07	9.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.19	9.67	0.00	0.00	0.00	319.98
	Dynatest_fully_autom	6.40	8.86	4.70	97.85	73.42	5.34	0.00	0.00	0.00	0.00	21.39	0.00	21.84	0.00	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	50.00	2.57	0.26	17.89	21.21	0.04	24.44	15.48	0.62	0.00	14.59	0.00	16.21	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	11.34	106.03	28.65	0.00	0.00	0.00
	OSU	0.00	0.00	0.00	1.68	1.83	0.00	30.41	20.17	4.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S11	Manual	0.00	0.00	0.00	0.00	0.00	0.00	4.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_fully_autom	0.00	0.00	0.00	0.00	0.00	0.00	0.74	4.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	1.36	1.61	0.00	3.07	2.31	0.00	3.07	9.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.19	9.67	0.00	0.00	0.00	319.98
	Dynatest_fully_autom	0.00	0.00	0.00	0.43	3.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	0.00	0.00	0.00	0.38	1.82	0.00	0.05	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S12	Manual	112.11	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	21.00	11.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_fully_autom	0.00	0.00	0.00	19.07	0.23	0.00	8.32	0.00	0.00	22.00	9.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	4.36	0.00	0.00	16.58	3.33	0.00	16.58	0.00	0.00	129.00	170.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.93	0.00	0.00	0.00	0.00	0.00
	Dynatest_fully_autom	0.00	0.00	0.00	292.17	15.26	0.00	0.00	0.00	0.00	0.00	114.75	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	0.00	0.00	0.00	261.92	0.30	0.00	68.07	9.90	0.00	0.00	124.60	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	3.27	1.04	0.00	3.52	3.16	0.00	3.45	2.08	0.00	6.00	1.82	8.00	3.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S13	Manual	35.36	6.00	20.45	0.00	0.00	0.00	5.75	0.00	0.00	54.00	46.30	1.00	1.00	0.00	0.00	3.00	99.69	0.00	0.00	4.00	171.56	2.50	0.00	0.00	0.00	0.00	48.63
	Fugro_fully_autom	0.02	0.00	0.00	4.76	1.25	0.00	6.35	17.12	0.00	40.21	18.12	4.00	1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	3.51	2.78	0.00	20.25	0.00	0.00	20.25	0.00	0.00	51.00	56.89	0.00	0.00	0.00	0.00	5.00	243.27	0.00	0.00	0.00	0.00	95.81	0.00	0.00	0.00	2.55	0.00
	Dynatest_fully_autom	1.73	0.00	0.00	112.18	18.94	0.08	0.00	0.00	0.00	0.00	37.90	0.00	0.86	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	20.34	0.00	0.00	73.69	8.24	0.03	34.96	11.75	0.05	0.00	43.08	0.00	0.61	0.00	0.10	0.00	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	0.44	1.22	1.70	0.00	0.00	0.00	15.13	18.47	3.29	1.00	0.36	18.00	10.79	17.00	10.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S14	Manual	0.00	0.00	0.00	32.20	0.00	0.00	0.00	0.00	0.00	5.00	8.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.33	0.00
	Fugro_fully_autom	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	0.00	0.00	0.00	157.36	0.00	0.00	157.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.36	0.00	0.00
	Dynatest_fully_autom	0.00	0.00	0.00	40.76	0.40	0.00	0.00	0.00	0.00	0.00	137.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	0.00	0.00	0.00	77.11	0.40	0.00	29.14	0.00	0.00	0.00	137.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	0.00	0.00	0.00	0.00	0.00	0.00	5.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S15	Manual	0.00	0.00	0.00	0.00	0.00	0.00	15.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_fully_autom	0.00	0.00	0.00	0.56	0.00	0.00	0.94	0.49	0.00	10.00	3.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	0.00	0.00	0.00	129.98	0.00	0.00	129.98	31.39	0.00	3.00	11.10	0.00	0.00	0.00	0.00	1.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_fully_autom	0.00	0.07	0.00	36.41	5.17	0.14	0.00	0.00	0.00	0.00	12.49	0.00	2.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	0.00	0.00	0.00	0.78	0.04	0.00	70.52	4.10	0.00	0.00	15.08	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	0.00	0.00	0.00	0.00	0.00	0.00	90.23	37.59	7.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

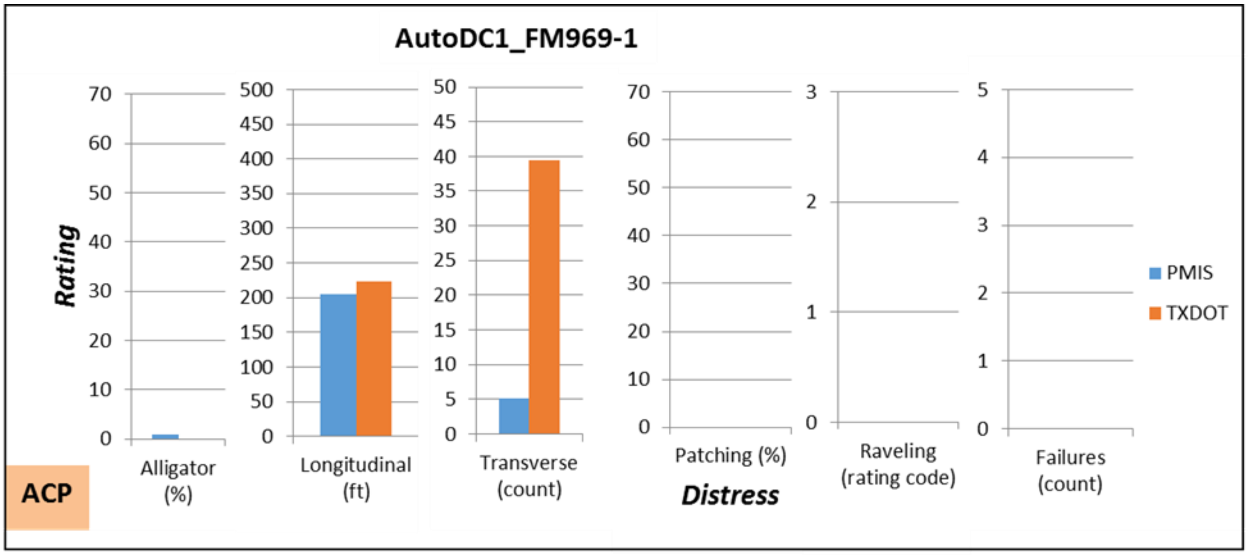
Appendix B.2 – Distresses Statistics for JCP Sections

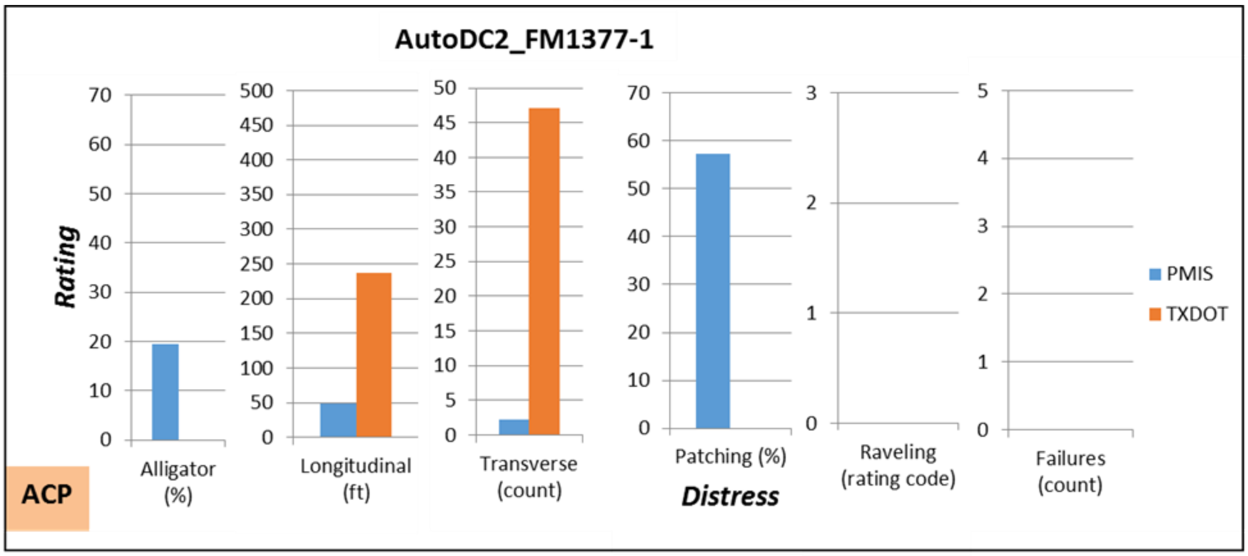
		Longitudinal_Low_m	Longitudinal_Medium__m	Longitudinal_High_m	Transverse_Low__	Transverse_Low_m	Transverse_Medium___	Transverse_Medium__m	Transverse_High__	Transverse_High_m	Spalling_of_Longitudinal_Joints_Low_m	Spalling_of_Longitudinal_Joints_Medium__m	Spalling_of_Longitudinal_Joints_High_m	Spalling_of_Transverse_Joints_Low__	Spalling_of_Transverse_Joints_Low_m	Spalling_of_Transverse_Joints_Medium___	Spalling_of_Transverse_Joints_Medium__m	Spalling_of_Transverse_Joints_High__	Spalling_of_Transverse_Joints_High_m	Patching_Low__	Patching_Low_m2	Patching_Medium___	Patching_Medium__m2	Map_Cracking___
S16	Manual	14.15	8.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	3.50	19.45	4.00	4.80	3.00	1.60	14.00	26.95	13.00	19.95	0.00	0.00	0.00
	Fugro_fully_autom	1.23	24.37	0.00	11.00	8.83	14.00	7.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	0.00	16.73	4.36	0.00	0.00	0.00	3.98	0.00	8.03	7.21	0.00	0.00	8.00	29.00	3.00	11.85	8.00	25.45	11.00	14.58	9.00	17.31	2.00
	Dynatest_fully_autom	21.86	33.00	0.00	4.00	1.17	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.21	0.00	0.00	0.00
	Dynatest_semi_autom	24.91	22.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.35	2.44	0.00	0.00	25.67	0.00	20.30	0.00	0.70	0.00	26.58	0.00	3.48	0.00
	OSU	386.72	409.93	195.89	0.00	0.00	0.00	0.00	4.00	15.28	10.03	0.00	0.00	26.00	13.41	3.00	2.39	0.00	0.00	4.00	1.61	5.00	8.53	0.00
S17	Manual	1.30	0.00	0.00	23.00	75.90	5.00	18.25	0.00	0.00	0.00	0.00	0.00	2.00	3.30	6.00	14.35	1.00	0.80	0.00	0.00	0.00	0.00	12.00
	Fugro_fully_autom	12.08	32.00	0.00	33.00	29.03	17.00	13.42	2.00	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	5.57	0.00	0.00	0.00	45.45	0.00	0.00	0.00	0.00	148.55	6.35	0.00	0.00	0.00	9.00	33.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_fully_autom	29.65	36.72	27.40	19.00	28.57	2.00	3.36	1.00	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	0.70	0.00	0.00	26.00	65.13	0.00	0.00	0.00	0.00	88.48	14.17	3.78	0.00	0.00	0.00	5.76	0.00	19.97	0.00	0.00	0.00	0.00	0.00
	OSU	47.40	109.93	0.00	11.00	5.99	21.00	21.62	14.00	18.11	3.28	0.34	0.00	3.00	1.19	3.00	3.22	2.00	3.35	0.00	0.00	0.00	0.00	0.00

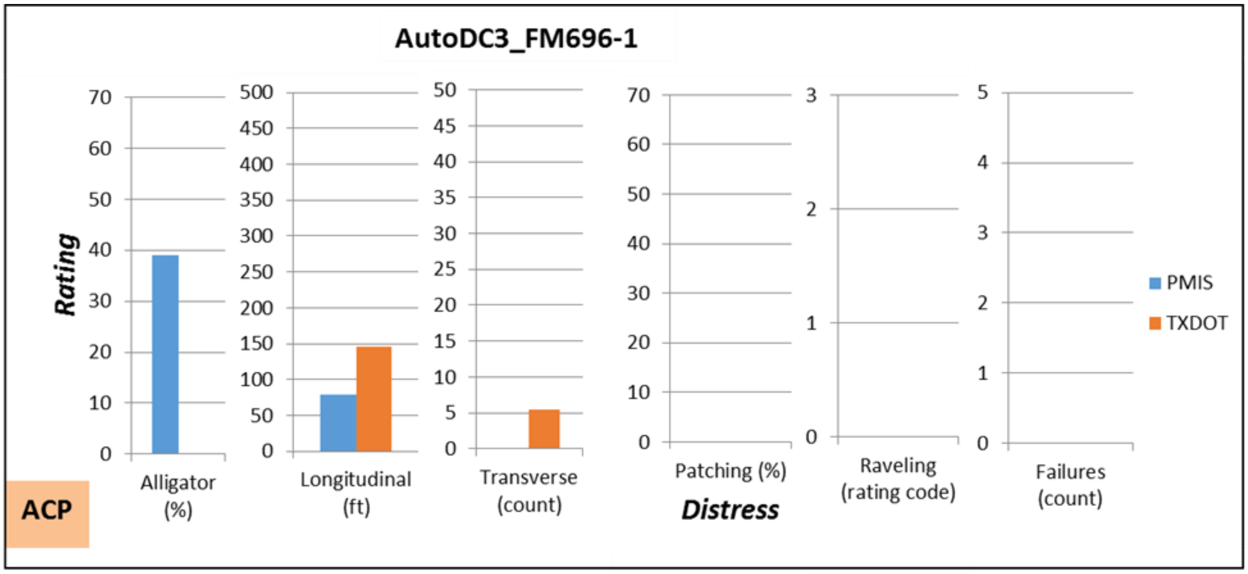
Appendix B.3 – Distresses Statistics for CRCP Sections

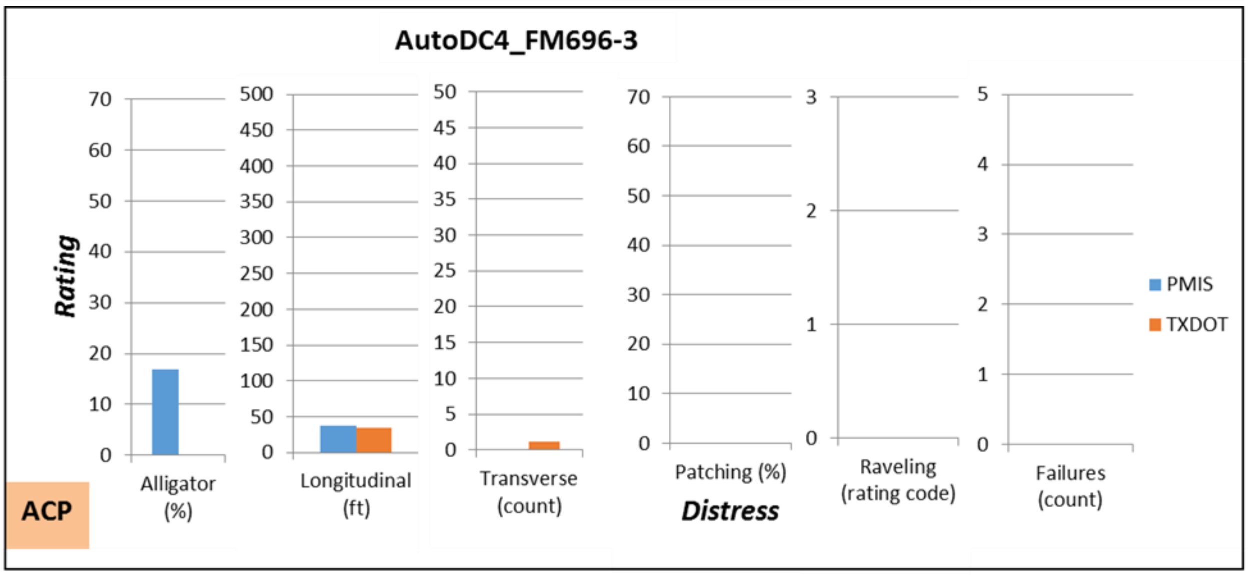
		Longitudinal_Low_m	Longitudinal_Medium__m	Longitudinal_High_m	Transverse_Low___	Transverse_Low_m	Transverse_Medium___	Transverse_Medium__m	Transverse_High___	Transverse_High_m	Patching_Low___	Patching_Low_m2	Patching_Medium___	Patching_Medium__m2	Patching_High___	Patching_High_m2	Punchouts_Low___	Punchouts_Medium___	Punchouts_High___	Spalling_of_Longitudinal_Joints_Low_m	Spalling_of_Longitudinal_Joints_Medium__m	Spalling_of_Longitudinal_Joints_High_m	Map_Cracking___	Map_Cracking__m2	Scaling___	Scaling__m2	Polished_Aggregate__m2	Trans_Const_Joint_Deterioration_Low___	Longitudinal_Joint_Seal_Damage___	Longitudinal_Joint_Seal_Damage__m
S18	Manual	90.70	0.00	0.00	90.00	304.70	0.00	0.00	0.00	0.00	6.00	2.18	0.00	0.00	2.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00	3.00	13.21	0.00	0.00	0.00	0.00	5.00	74.50
	Fugro_fully_autom	0.00	107.61	41.65	35.00	19.29	3.00	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	63.62	0.00	0.00	53.00	147.13	2.00	7.84	0.00	0.00	9.00	8.39	3.00	325.98	0.00	0.00	2.00	1.00	1.00	53.29	9.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	36.22
	Dynatest_fully_autom	123.53	53.97	6.11	71.00	80.88	0.00	5.46	6.00	0.94	0.00	12.06	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	46.13	8.54	0.54	70.00	132.83	8.00	4.76	3.00	0.61	0.00	4.21	0.00	0.95	0.00	0.00	8.00	0.00	0.00	27.71	28.97	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	81.21	19.24	3.28	66.00	112.24	1.00	1.89	0.00	0.00	7.00	1.95	1.00	0.57	0.00	0.00	20.00	2.00	0.00	53.95	6.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S19	Manual	141.80	6.40	0.00	143.00	513.20	4.00	15.40	1.00	3.35	10.00	41.61	2.00	0.79	5.00	3.42	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	1.00	0.18	0.00	3.00	11.00	167.75
	Fugro_fully_autom	1.54	57.35	5.73	48.00	27.96	2.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	79.99	0.83	0.00	140.00	423.68	6.00	17.12	5.00	18.17	16.00	45.97	3.00	1.55	1.00	1.65	5.00	1.00	1.00	6.36	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_fully_autom	57.01	16.78	0.66	92.00	172.88	0.00	13.44	5.00	2.36	0.00	7.11	21.00	7.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	46.75	11.63	0.66	134.00	317.45	19.00	18.30	5.00	2.36	0.00	7.50	0.00	12.52	0.00	0.00	11.00	0.00	0.00	36.55	32.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	23.09	28.25	15.27	10.00	7.64	65.00	60.77	49.00	85.28	9.00	2.49	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3.86	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S20	Manual	88.70	2.70	0.00	122.00	442.45	4.00	14.60	0.00	0.00	1.00	0.16	3.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.00	612.29	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_fully_autom	0.62	26.59	0.00	9.00	9.70	2.00	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fugro_semi_autom	53.63	0.00	0.00	124.00	432.97	3.00	11.62	0.00	0.00	0.00	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_fully_autom	31.00	0.69	5.31	140.00	345.53	0.00	1.54	2.00	0.54	0.00	1.23	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dynatest_semi_autom	75.84	0.12	5.31	159.00	436.45	11.00	15.56	2.00	0.54	0.00	1.62	0.00	0.00	0.00	0.00	11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OSU	36.91	7.78	0.00	95.00	61.76	136.00	167.12	43.00	67.48	0.00	0.00	0.00	0.00	0.00	0.00	13.00	1.00	0.00	5.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

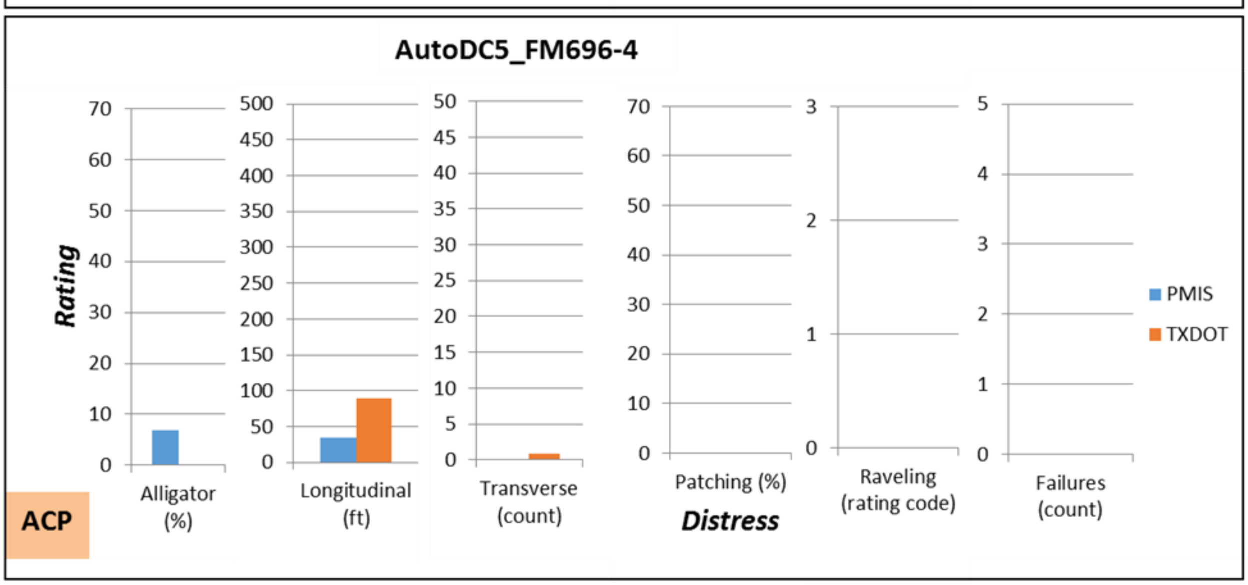
Appendix C – Comparative Analysis of Surface Distresses Statistics between Manual Rating and TxDOT 3D System Measurements

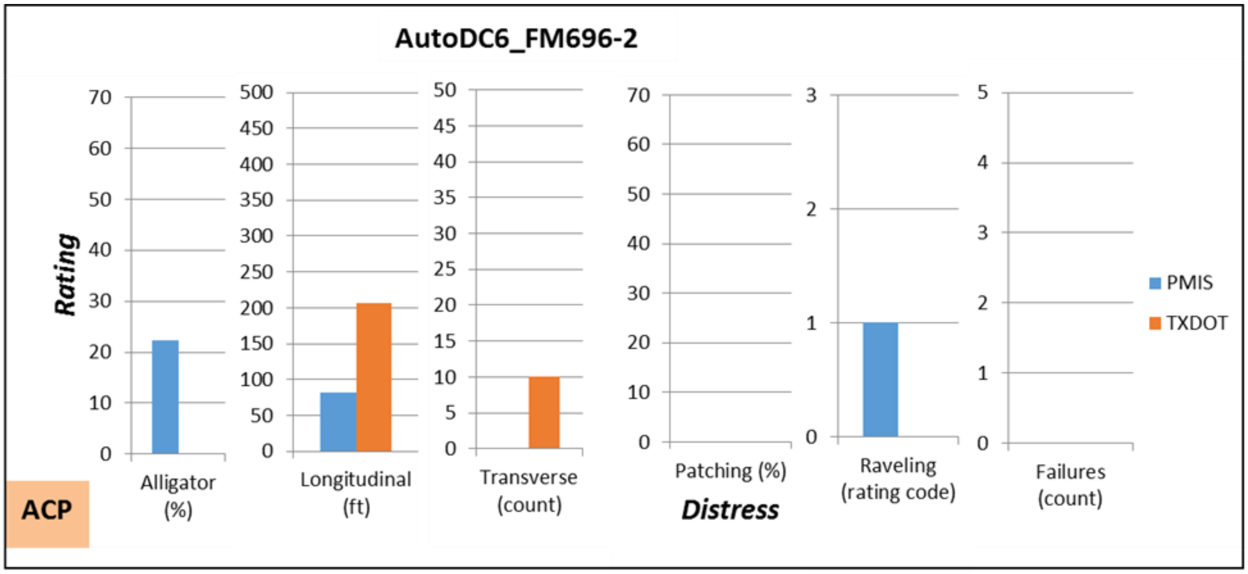

AutoDC1_FM969-1
Rating
ACP
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Raveling (rating code)
Failures (count)
PMIS
TXDOT


AutoDC2_FM1377-1
Rating
ACP
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Raveling (rating code)
Failures (count)
PMIS
TXDOT

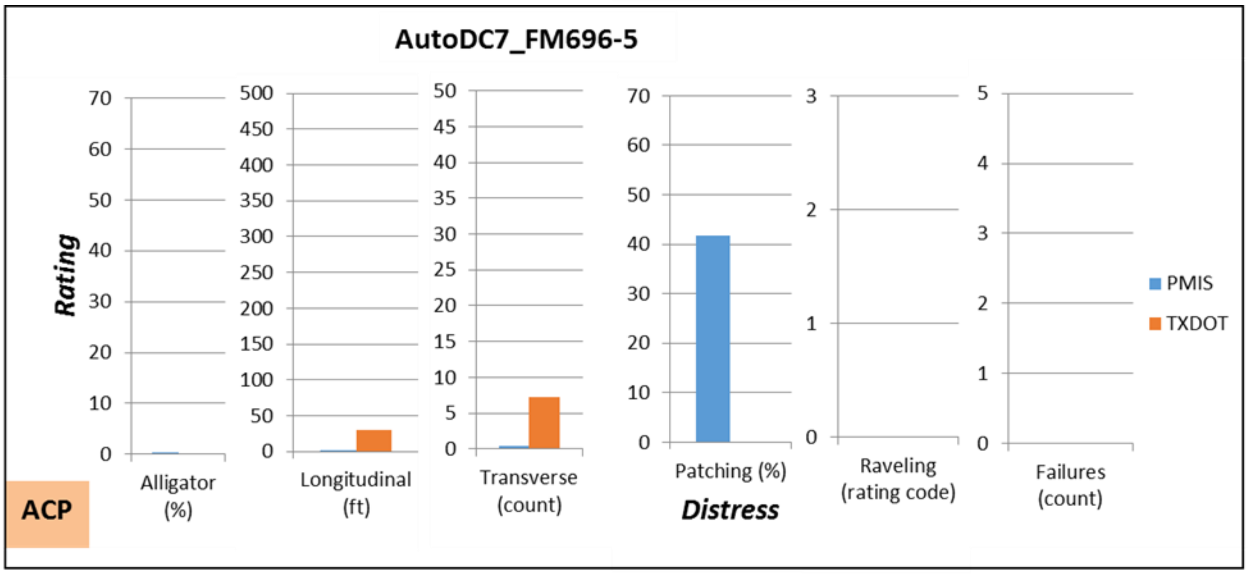

AutoDC3_FM696-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Raveling (rating code)
Failures (count)
PMIS
TXDOT
ACP


AutoDC4_FM696-3
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Raveling (rating code)
Failures (count)
PMIS
TXDOT
ACP

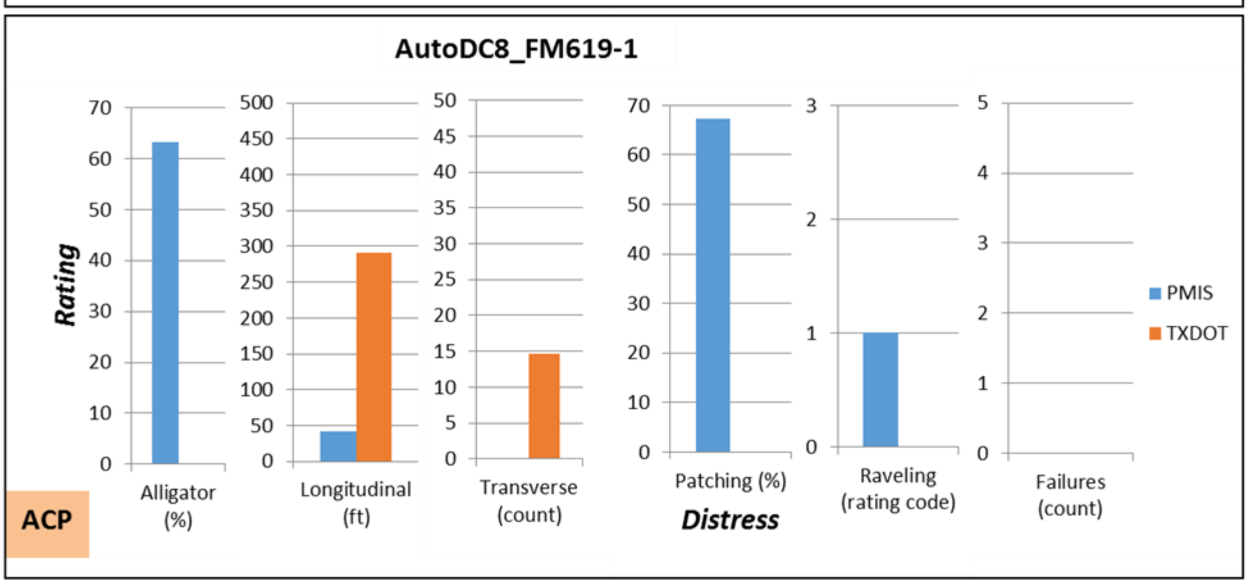

AutoDC5_FM696-4
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Raveling (rating code)
Failures (count)
PMIS
TXDOT
ACP



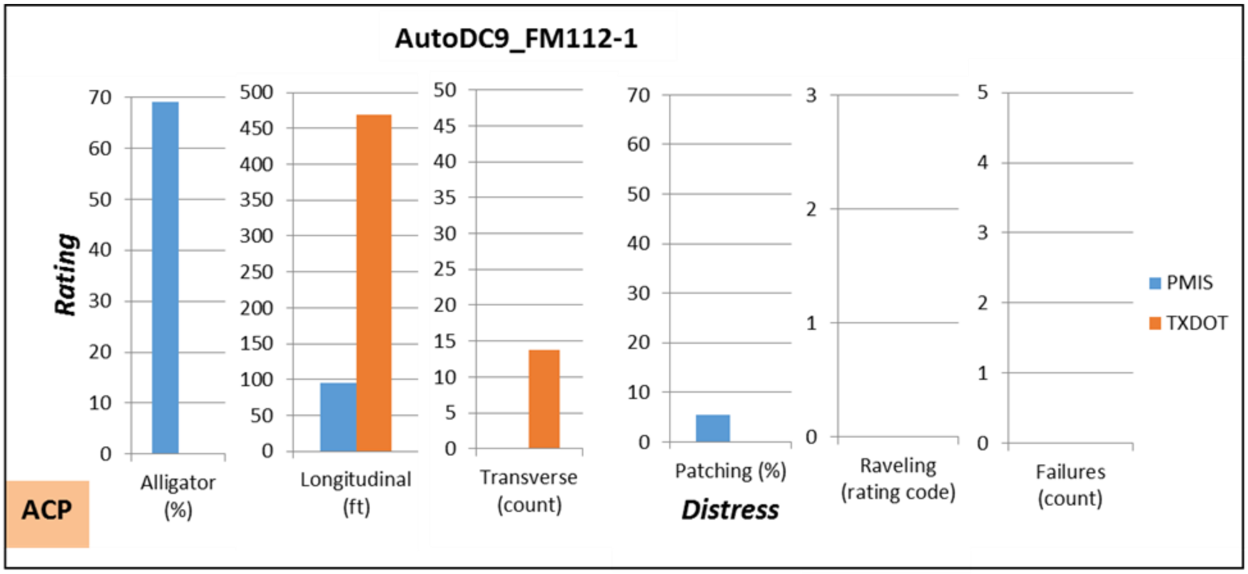
AutoDC6_FM696-2
Rating
70
60
50
40
30
20
10
0
Alligator (%)
500
450
400
350
300
250
200
150
100
50
0
Longitudinal (ft)
50
45
40
35
30
25
20
15
10
5
0
Transverse (count)
Patching (%)
Raveling (rating code)
Failures (count)
Distress
PMIS
TXDOT
ACP

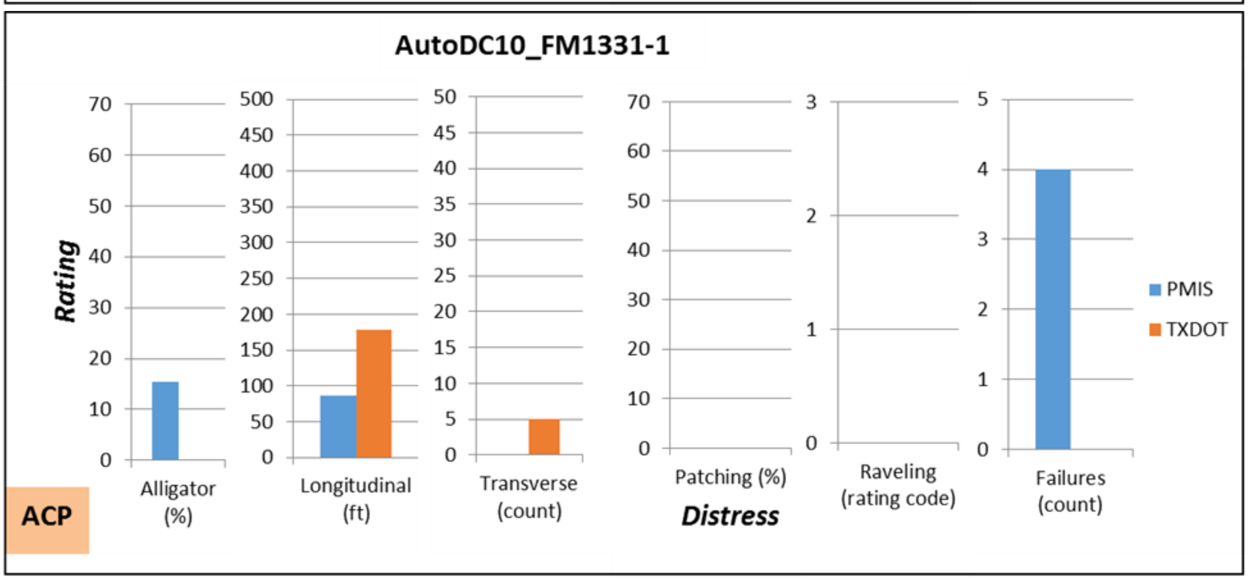


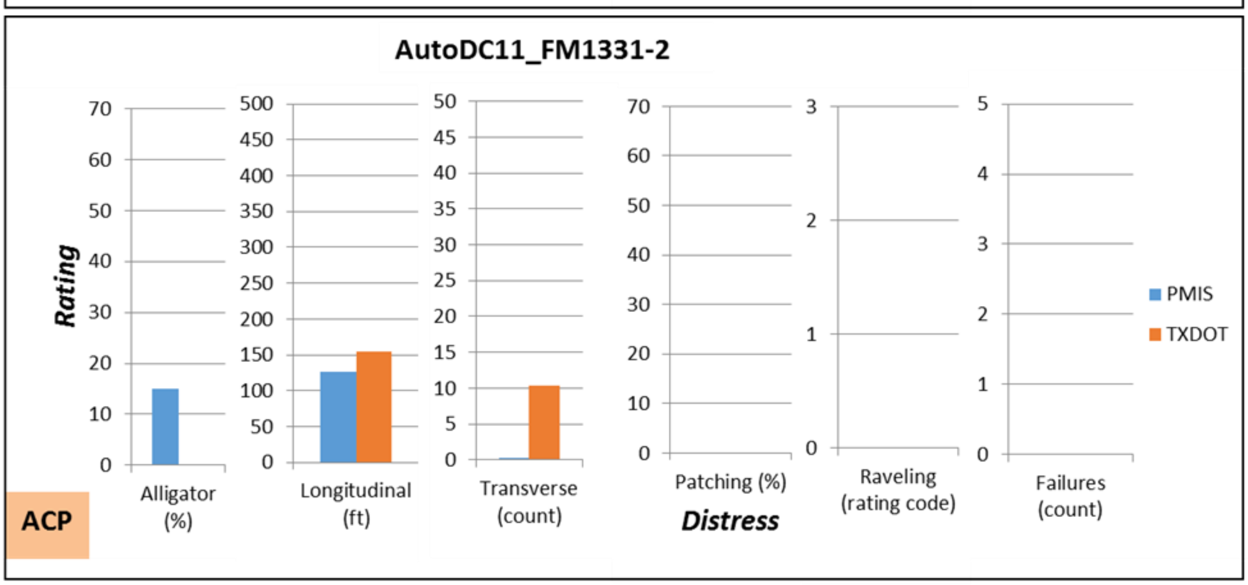
AutoDC7_FM696-5
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Raveling (rating code)
Failures (count)
Distress
PMIS
TXDOT
ACP

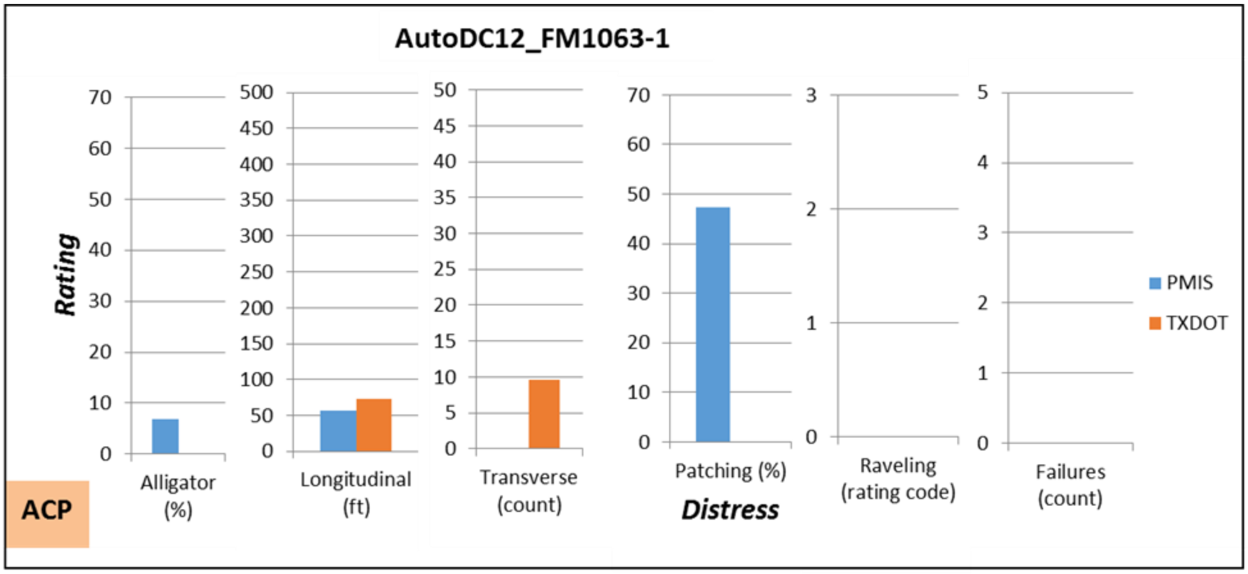


AutoDC8_FM619-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Raveling (rating code)
Failures (count)
Distress
PMIS
TXDOT
ACP

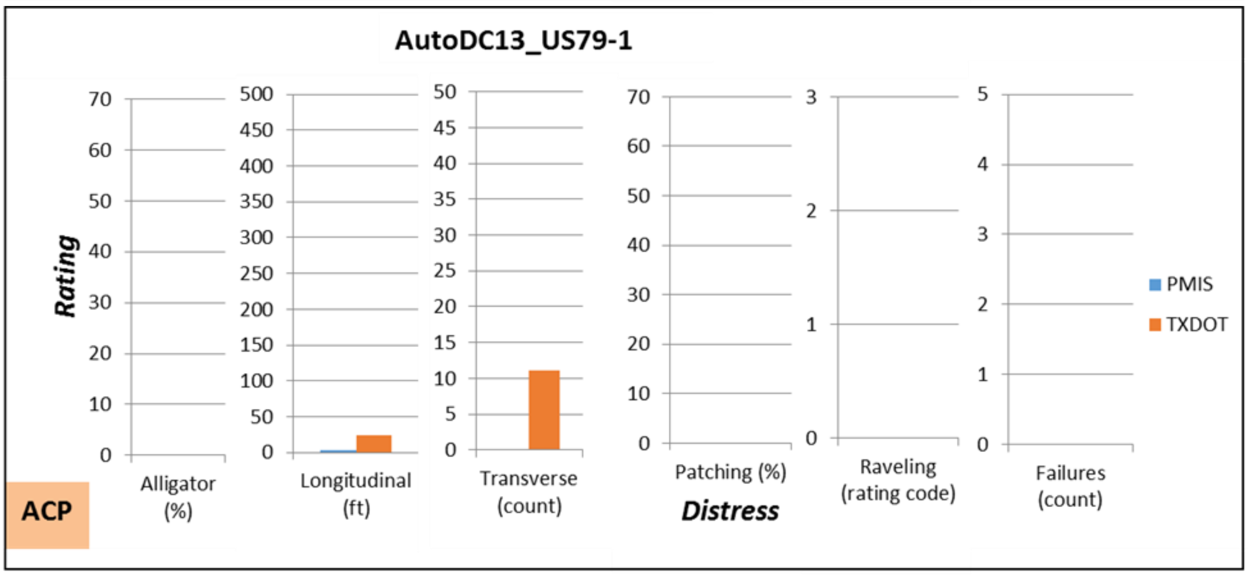

AutoDC9_FM112-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Raveling (rating code)
Failures (count)
Distress
ACP
PMIS
TXDOT


AutoDC10_FM1331-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Raveling (rating code)
Failures (count)
Distress
ACP
PMIS
TXDOT

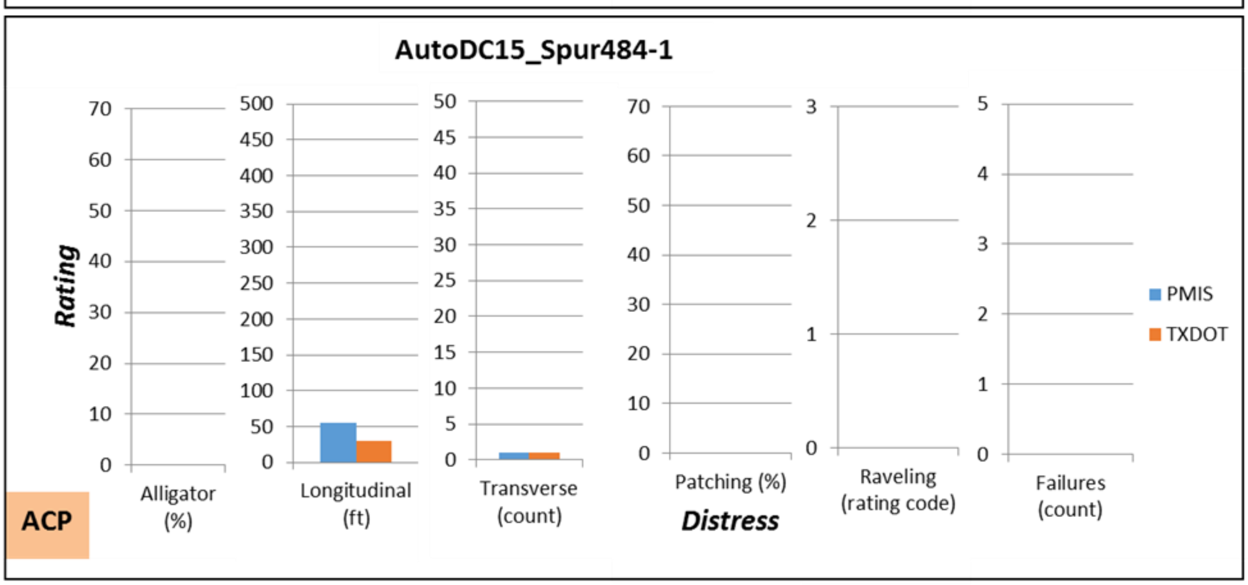

AutoDC11_FM1331-2
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Raveling (rating code)
Failures (count)
Distress
ACP
PMIS
TXDOT



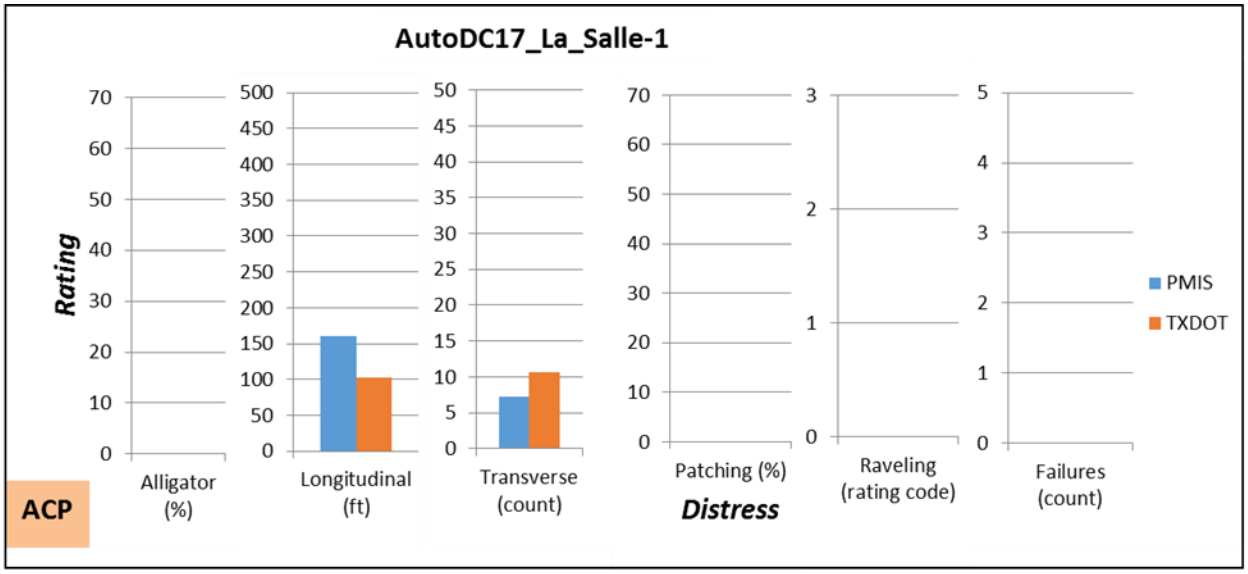
AutoDC12_FM1063-1
Rating
70
60
50
40
30
20
10
0
Alligator (%)
500
450
400
350
300
250
200
150
100
50
0
Longitudinal (ft)
50
45
40
35
30
25
20
15
10
5
0
Transverse (count)
Patching (%)
Distress
3
2
1
0
Raveling (rating code)
5
4
3
2
1
0
Failures (count)
PMIS
TXDOT
ACP



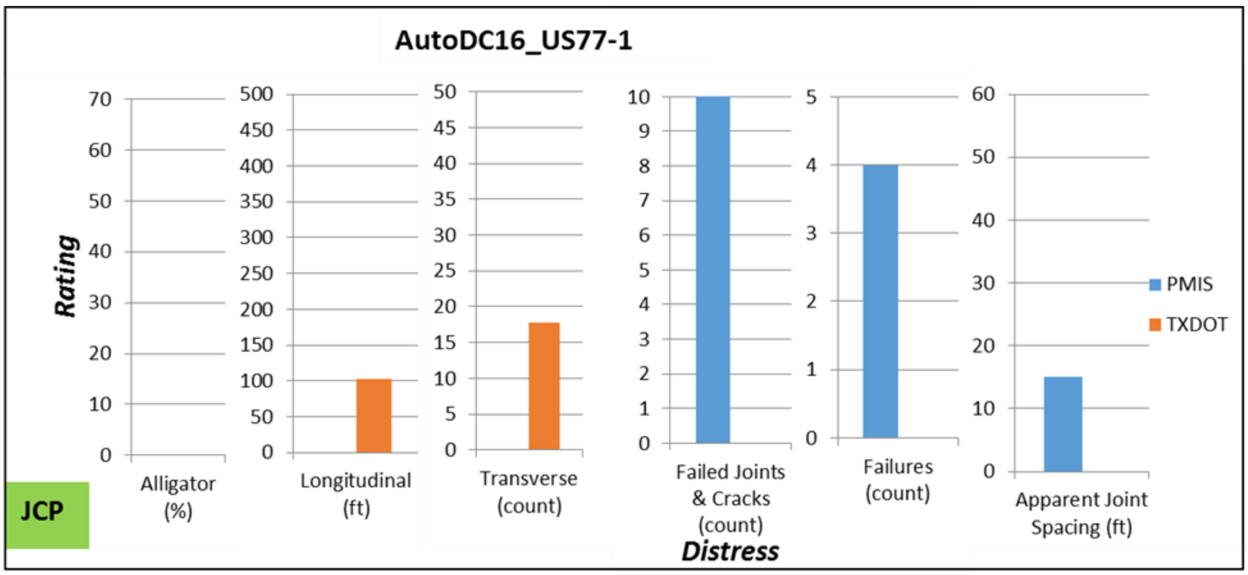
AutoDC13_US79-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Raveling (rating code)
Failures (count)
PMIS
TXDOT
ACP



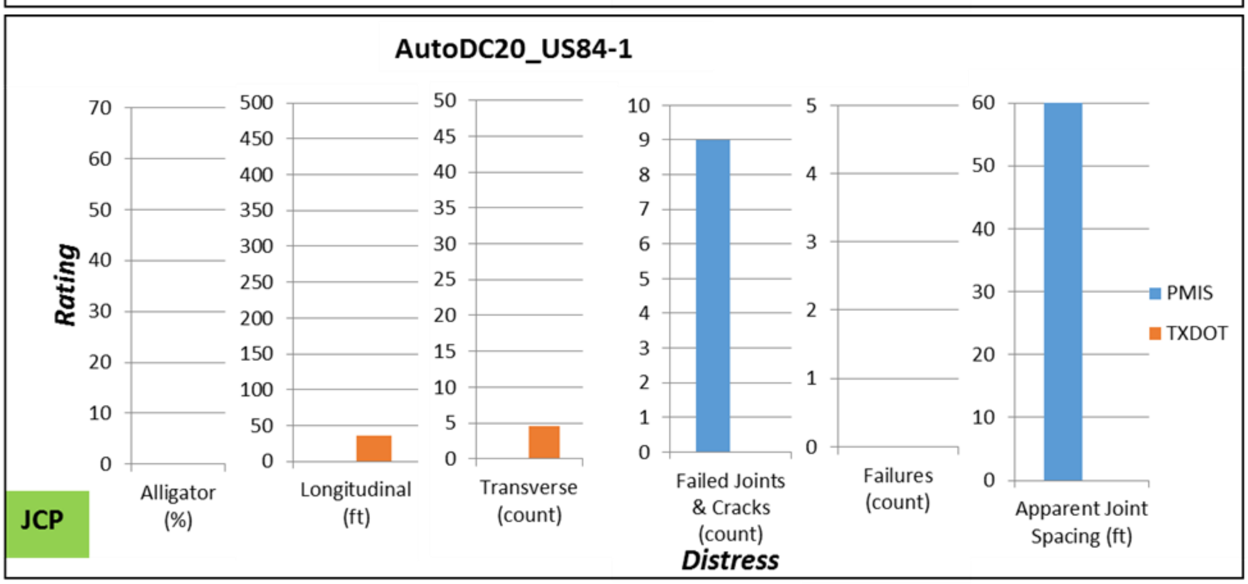
AutoDC15_Spur484-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Raveling (rating code)
Failures (count)
PMIS
TXDOT
ACP



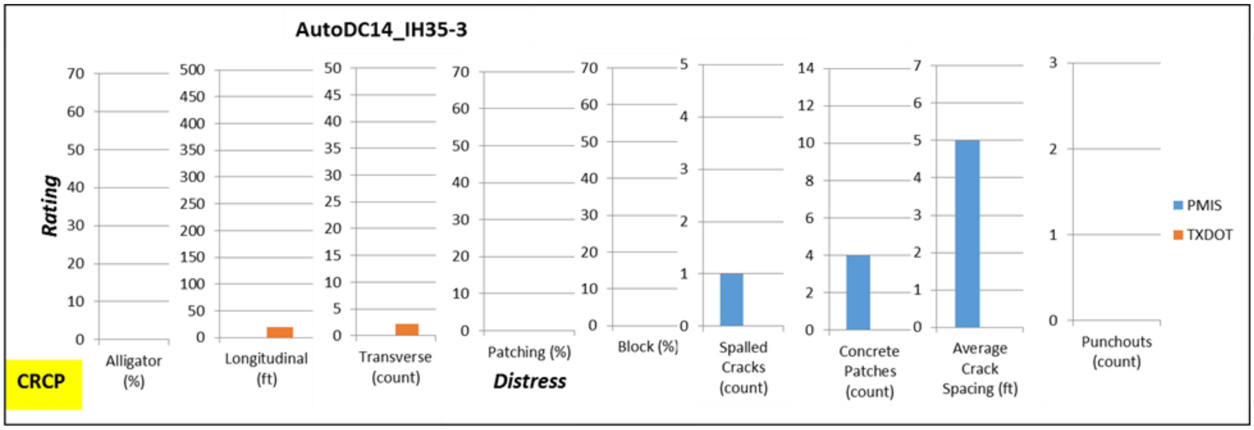
AutoDC17_La_Salle-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Raveling (rating code)
Failures (count)
Distress
PMIS
TXDOT
ACP

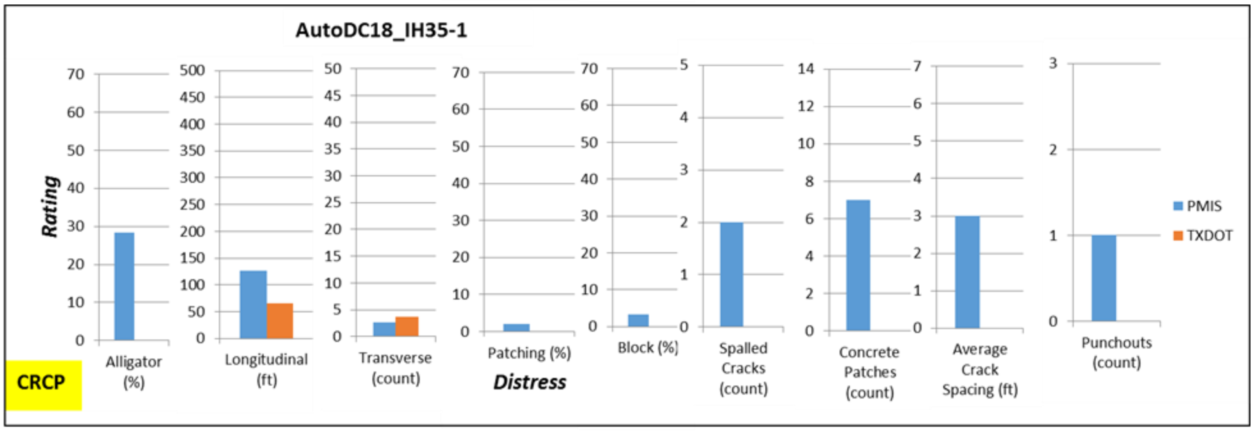


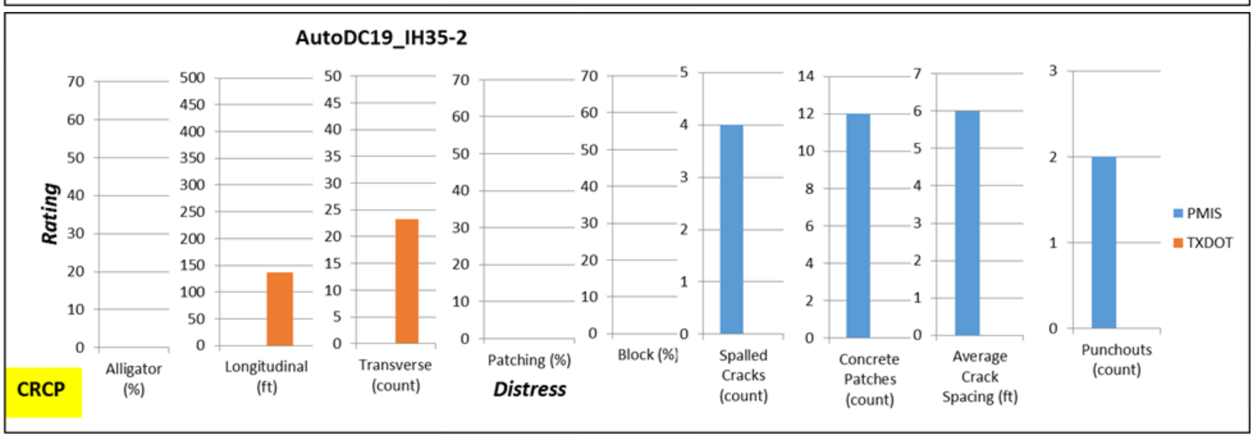
AutoDC16_US77-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Failed Joints & Cracks (count)
Failures (count)
Apparent Joint Spacing (ft)
Distress
PMIS
TXDOT
JCP



AutoDC20_US84-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Failed Joints & Cracks (count)
Failures (count)
Apparent Joint Spacing (ft)
Distress
PMIS
TXDOT
JCP


AutoDC14_IH35-3
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Block (%)
Spalled Cracks (count)
Concrete Patches (count)
Average Crack Spacing (ft)
Punchouts (count)
PMIS
TXDOT
CRCP


AutoDC18_IH35-1
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Block (%)
Spalled Cracks (count)
Concrete Patches (count)
Average Crack Spacing (ft)
Punchouts (count)
PMIS
TXDOT
CRCP


AutoDC19_IH35-2
Rating
Alligator (%)
Longitudinal (ft)
Transverse (count)
Patching (%)
Distress
Block (%)
Spalled Cracks (count)
Concrete Patches (count)
Average Crack Spacing (ft)
Punchouts (count)
PMIS
TXDOT
CRCP

Appendix D.1 – Texture Summary (Inner Wheel Path)

AutoDC1_FM969-1

Inner **wheelpath (IWP) - Mean Profile Depth, MPD (mm)**

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.66	-	-	2.061	-
50'	0.44	-	0.51	2.047	-
100'	0.48	-	0.53	2.036	-
150'	0.55	-	0.57	2.038	-
200'	0.51	-	0.57	2.152	-
250'	0.53	-	0.56	2.174	-
300'	0.41	-	0.53	2.05	-
350'	0.65	-	0.52	2.224	-
400'	0.47	-	0.57	2.075	-
450'	0.65	-	0.52	1.958	-
500'	0.63	-	0.54	2.167	-
550'	0.57	-	0.57	2.138	-
Average	0.55	-	0.54	2.09	-

Inner **wheelpath (IWP) - MPD Error (mm)**

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	-	-1.40	-
50'	-	-0.07	-1.61	-
100'	-	-0.05	-1.56	-
150'	-	-0.02	-1.49	-
200'	-	-0.06	-1.64	-
250'	-	-0.03	-1.64	-
300'	-	-0.12	-1.64	-
350'	-	0.13	-1.57	-
400'	-	-0.10	-1.61	-
450'	-	0.13	-1.31	-
500'	-	0.09	-1.54	-
550'	-	0.00	-1.57	-
Total		-0.10	-18.57	
Average	-	0.00	-1.55	-
Std. Dev.		0.09	0.10	

AutoDC2_FM1377-1

Inner **wheelpath (IWP) - Mean Profile Depth, MPD (mm)**

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.47	-	0.53	1.703	-
50'	0.88	-	0.50	1.795	-
100'	1.02	-	0.66	1.903	-
150'	1.06	-	0.63	1.856	-
200'	0.72	-	0.64	1.934	-
250'	0.42	-	0.50	1.826	-
300'	0.4	-	0.46	1.888	-
350'	0.37	-	0.44	1.897	-
400'	0.44	-	0.51	1.922	-
450'	0.99	-	0.69	1.859	-
500'	0.94	-	0.78	1.788	-
550'	1	-	0.79	1.895	-
Average	0.73	-	0.59	1.86	-

Inner **wheelpath (IWP) - MPD Error (mm)**

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	-0.06	-1.23	-
50'	-	0.38	-0.92	-
100'	-	0.36	-0.88	-
150'	-	0.43	-0.80	-
200'	-	0.08	-1.21	-
250'	-	-0.08	-1.41	-
300'	-	-0.06	-1.49	-
350'	-	-0.07	-1.53	-
400'	-	-0.07	-1.48	-
450'	-	0.30	-0.87	-
500'	-	0.16	-0.85	-
550'	-	0.21	-0.90	-
Total		1.57	-13.56	
Average	-	0.13	-1.13	-
Std. Dev.		0.20	0.29	

AutoDC3_FM696-1

Inner **wheelpath (IWP) - Mean Profile Depth, MPD (mm)**

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.72	-	0.48	2.128	-
50'	0.59	-	0.49	2.719	-
100'	0.65	-	0.55	2.34	-
150'	0.63	-	0.57	2.232	-
200'	1.14	-	0.73	2.218	-
250'	1.4	-	0.86	2.18	-
300'	0.83	-	0.75	2.315	-
350'	0.69	-	0.54	2.101	-
400'	0.94	-	0.70	2.201	-
450'	0.72	-	0.55	2.316	-
500'	0.7	-	0.49	2.133	-
550'	0.82	-	0.62	2.401	-
Average	0.82	-	0.61	2.27	-

Inner **wheelpath (IWP) - MPD Error (mm)**

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.24	-1.41	-
50'	-	0.10	-2.13	-
100'	-	0.10	-1.69	-
150'	-	0.06	-1.60	-
200'	-	0.41	-1.08	-
250'	-	0.54	-0.78	-
300'	-	0.08	-1.49	-
350'	-	0.15	-1.41	-
400'	-	0.24	-1.26	-
450'	-	0.17	-1.60	-
500'	-	0.21	-1.43	-
550'	-	0.20	-1.58	-
Total		2.50	-17.45	
Average	-	0.21	-1.45	-
Std. Dev.		0.14	0.33	

AutoDC4_FM696-3

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.58	-	0.54	1.849	-
50'	0.43	-	0.47	1.673	-
100'	0.57	-	0.51	1.651	-
150'	0.59	-	0.51	1.699	-
200'	0.44	-	0.47	1.672	-
250'	0.43	-	0.48	1.685	-
300'	0.54	-	0.48	1.747	-
350'	0.57	-	0.55	1.634	-
400'	0.48	-	0.52	1.647	-
450'	0.49	-	0.52	1.707	-
500'	0.5	-	0.57	1.755	-
550'	0.59	-	0.47	1.648	-
Average	0.52	-	0.51	1.70	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.04	-1.27	-
50'	-	-0.04	-1.24	-
100'	-	0.06	-1.08	-
150'	-	0.08	-1.11	-
200'	-	-0.03	-1.23	-
250'	-	-0.05	-1.26	-
300'	-	0.06	-1.21	-
350'	-	0.02	-1.06	-
400'	-	-0.04	-1.17	-
450'	-	-0.03	-1.22	-
500'	-	-0.07	-1.26	-
550'	-	0.12	-1.06	-
Total		0.10	-14.16	
Average	-	0.01	-1.18	-
Std. Dev.		0.06	0.08	

AutoDC5_FM696-4

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.56	-	0.49	1.783	-
50'	0.55	-	0.52	1.954	-
100'	0.53	-	0.51	1.901	-
150'	0.48	-	0.51	1.889	-
200'	0.44	-	0.53	1.966	-
250'	0.49	-	0.52	2.075	-
300'	0.61	-	0.56	3.015	-
350'	0.47	-	0.57	1.912	-
400'	0.58	-	0.54	2.04	-
450'	0.51	-	0.51	2.051	-
500'	0.52	-	0.59	2.067	-
550'	0.52	-	-	2.032	-
Average	0.52	-	0.53	2.06	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.07	-1.22	-
50'	-	0.03	-1.40	-
100'	-	0.02	-1.37	-
150'	-	-0.03	-1.41	-
200'	-	-0.09	-1.53	-
250'	-	-0.03	-1.59	-
300'	-	0.05	-2.41	-
350'	-	-0.10	-1.44	-
400'	-	0.04	-1.46	-
450'	-	0.00	-1.54	-
500'	-	-0.07	-1.55	-
550'	-	-	-1.51	-
Total		-0.11	-18.43	
Average	-	-0.01	-1.54	-
Std. Dev.		0.06	0.29	

AutoDC6_FM696-2

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.04	-	-	2.438	-
50'	0.65	-	0.68	2.482	-
100'	0.84	-	0.86	2.431	-
150'	0.81	-	0.67	2.758	-
200'	0.78	-	0.74	2.381	-
250'	0.82	-	0.80	2.528	-
300'	0.9	-	0.72	2.361	-
350'	0.79	-	0.75	2.539	-
400'	0.72	-	0.84	2.554	-
450'	0.78	-	0.88	2.467	-
500'	1.35	-	1.18	2.961	-
550'	0.75	-	0.86	2.35	-
Average	0.85	-	0.82	2.52	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	-	-1.40	-
50'	-	-0.03	-1.83	-
100'	-	-0.02	-1.59	-
150'	-	0.14	-1.95	-
200'	-	0.04	-1.60	-
250'	-	0.02	-1.71	-
300'	-	0.18	-1.46	-
350'	-	0.04	-1.75	-
400'	-	-0.12	-1.83	-
450'	-	-0.10	-1.69	-
500'	-	0.17	-1.61	-
550'	-	-0.11	-1.60	-
Total		0.19	-20.02	
Average	-	0.03	-1.67	-
Std. Dev.		0.11	0.16	

AutoDC7_FM696-5

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.97	-	0.67	2.101	-
50'	1.2	-	0.62	2.025	-
100'	0.94	-	0.86	2.108	-
150'	0.96	-	0.72	1.916	-
200'	0.67	-	0.60	1.861	-
250'	0.78	-	0.58	1.923	-
300'	0.81	-	0.72	2.01	-
350'	0.75	-	0.52	1.882	-
400'	1.1	-	0.66	1.706	-
450'	1.3	-	0.67	2.053	-
500'	1.33	-	0.92	2.111	-
550'	1.45	-	0.93	2.325	-
Average	1.02	-	0.70	2.00	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.30	-1.13	-
50'	-	0.58	-0.83	-
100'	-	0.08	-1.17	-
150'	-	0.24	-0.96	-
200'	-	0.07	-1.19	-
250'	-	0.20	-1.14	-
300'	-	0.09	-1.20	-
350'	-	0.23	-1.13	-
400'	-	0.44	-0.61	-
450'	-	0.63	-0.75	-
500'	-	0.41	-0.78	-
550'	-	0.52	-0.88	-
Total		3.80	-11.76	
Average	-	0.32	-0.98	-
Std. Dev.		0.20	0.21	

AutoDC8_FM619-1

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	2.14	-	1.34	3.048	-
50'	2.13	-	1.30	3.275	-
100'	1.57	-	0.65	2.064	-
150'	1.4	-	0.71	2.488	-
200'	1.18	-	0.54	1.549	-
250'	1.57	-	1.42	2.52	-
300'	0.89	-	0.67	1.83	-
350'	1.06	-	0.69	1.75	-
400'	0.64	-	0.67	1.807	-
450'	1.19	-	0.80	2.214	-
500'	0.86	-	0.81	3.07	-
550'	2.34	-	1.08	3.163	-
Average	1.41	-	0.89	2.40	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.80	-0.91	-
50'	-	0.83	-1.15	-
100'	-	0.92	-0.49	-
150'	-	0.69	-1.09	-
200'	-	0.64	-0.37	-
250'	-	0.15	-0.95	-
300'	-	0.22	-0.94	-
350'	-	0.37	-0.69	-
400'	-	-0.03	-1.17	-
450'	-	0.39	-1.02	-
500'	-	0.05	-2.21	-
550'	-	1.26	-0.82	-
Total		6.27	-11.81	
Average	-	0.52	-0.98	-
Std. Dev.		0.40	0.46	

AutoDC9_FM112-1

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.05	-	0.66	2.218	-
50'	1.8	-	0.57	1.894	-
100'	0.98	-	0.78	2.01	-
150'	1.03	-	0.70	2.147	-
200'	1	-	0.78	2.365	-
250'	0.93	-	0.72	2.004	-
300'	1.27	-	0.70	1.981	-
350'	1.57	-	0.84	1.991	-
400'	0.97	-	0.69	1.67	-
450'	0.5	-	0.61	1.862	-
500'	1.06	-	0.85	1.908	-
550'	0.51	-	0.62	1.989	-
Average	1.06	-	0.71	2.00	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.39	-1.17	-
50'	-	1.23	-0.09	-
100'	-	0.20	-1.03	-
150'	-	0.33	-1.12	-
200'	-	0.22	-1.37	-
250'	-	0.21	-1.07	-
300'	-	0.57	-0.71	-
350'	-	0.73	-0.42	-
400'	-	0.28	-0.70	-
450'	-	-0.11	-1.36	-
500'	-	0.21	-0.85	-
550'	-	-0.11	-1.48	-
Total		4.16	-11.37	
Average	-	0.35	-0.95	-
Std. Dev.		0.37	0.41	

AutoDC10_FM1331-1

Inner **wheelpath (IWP) - Mean Profile Depth, MPD (mm)**

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.35	-	1.17	3.587	-
50'	1.78	-	1.30	3.29	-
100'	1.59	-	1.20	3.717	-
150'	1.41	-	1.14	4.113	-
200'	1.54	-	1.22	4.177	-
250'	1.88	-	1.23	3.548	-
300'	1.5	-	1.03	4.299	-
350'	1.51	-	1.09	4.146	-
400'	1.52	-	1.21	4.056	-
450'	1.35	-	1.37	4.177	-
500'	1.51	-	1.14	3.736	-
550'	1.28	-	-	3.937	-
Average	1.52	-	1.19	3.90	-

Inner **wheelpath (IWP) - MPD Error (mm)**

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.18	-2.24	-
50'	-	0.48	-1.51	-
100'	-	0.39	-2.13	-
150'	-	0.27	-2.70	-
200'	-	0.32	-2.64	-
250'	-	0.65	-1.67	-
300'	-	0.47	-2.80	-
350'	-	0.42	-2.64	-
400'	-	0.31	-2.54	-
450'	-	-0.02	-2.83	-
500'	-	0.37	-2.23	-
550'	-	-	-2.66	-
Total		3.86	-28.56	
Average	-	0.33	-2.38	-
Std. Dev.		0.17	0.44	

AutoDC11_FM1331-2

Inner **wheelpath (IWP) - Mean Profile Depth, MPD (mm)**

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.51	-	0.96	2.309	-
50'	1.28	-	0.72	2.581	-
100'	1.51	-	0.78	2.341	-
150'	1.41	-	0.72	2.536	-
200'	1.26	-	0.87	2.916	-
250'	0.93	-	0.64	2.754	-
300'	1.17	-	0.67	2.937	-
350'	1.46	-	0.97	2.762	-
400'	1.42	-	0.75	2.956	-
450'	1.07	-	0.81	2.627	-
500'	1.68	-	0.85	2.664	-
550'	1.39	-	-	2.558	-
Average	1.34	-	0.79	2.66	-

Inner **wheelpath (IWP) - MPD Error (mm)**

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.55	-0.80	-
50'	-	0.56	-1.30	-
100'	-	0.73	-0.83	-
150'	-	0.69	-1.13	-
200'	-	0.39	-1.66	-
250'	-	0.29	-1.82	-
300'	-	0.50	-1.77	-
350'	-	0.49	-1.30	-
400'	-	0.67	-1.54	-
450'	-	0.26	-1.56	-
500'	-	0.83	-0.98	-
550'	-	-	-1.17	-
Total		5.96	-15.85	
Average	-	0.55	-1.32	-
Std. Dev.		0.18	0.35	

AutoDC12_FM1063-1

Inner **wheelpath (IWP) - Mean Profile Depth, MPD (mm)**

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.55	-	0.93	3.228	-
50'	1.58	-	1.20	3.166	-
100'	1.9	-	1.11	3.389	-
150'	2.42	-	1.54	3.789	-
200'	2.56	-	1.36	3.459	-
250'	1.91	-	1.27	3.07	-
300'	1.71	-	1.18	2.98	-
350'	1.79	-	1.21	3.014	-
400'	1.66	-	1.15	3.015	-
450'	1.72	-	1.12	3.141	-
500'	1.59	-	1.14	2.732	-
550'	1.39	-	1.08	2.441	-
Average	1.82	-	1.19	3.12	-

Inner **wheelpath (IWP) - MPD Error (mm)**

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.62	-1.68	-
50'	-	0.38	-1.59	-
100'	-	0.79	-1.49	-
150'	-	0.88	-1.37	-
200'	-	1.20	-0.90	-
250'	-	0.64	-1.16	-
300'	-	0.53	-1.27	-
350'	-	0.58	-1.22	-
400'	-	0.51	-1.36	-
450'	-	0.60	-1.42	-
500'	-	0.45	-1.14	-
550'	-	0.31	-1.05	-
Total		7.50	-15.64	
Average	-	0.62	-1.30	-
Std. Dev.		0.24	0.22	

AutoDC13_US79-1

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.54	-	1.49	4.529	-
50'	1.51	-	1.48	4.627	-
100'	1.66	-	1.60	4.998	-
150'	1.44	-	1.57	4.658	-
200'	1.76	-	1.62	4.609	-
250'	1.74	-	1.56	5.002	-
300'	1.68	-	1.58	5.103	-
350'	1.97	-	1.57	5.06	-
400'	1.63	-	1.57	4.675	-
450'	1.66	-	1.51	5.069	-
500'	1.14	-	1.56	4.439	-
550'	1.46	-	-	4.333	-
Average	1.60	-	1.56	4.76	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.05	-2.99	-
50'	-	0.03	-3.12	-
100'	-	0.06	-3.34	-
150'	-	-0.13	-3.22	-
200'	-	0.14	-2.85	-
250'	-	0.18	-3.26	-
300'	-	0.10	-3.42	-
350'	-	0.40	-3.09	-
400'	-	0.06	-3.05	-
450'	-	0.15	-3.41	-
500'	-	-0.42	-3.30	-
550'	-	-	-2.87	-
Total		0.61	-37.91	
Average	-	0.04	-3.16	-
Std. Dev.		0.20	0.20	

AutoDC14_IH35-3

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.54	-	0.43	1.464	-
50'	0.6	-	0.45	1.612	-
100'	0.56	-	0.40	1.522	-
150'	0.55	-	0.46	1.62	-
200'	0.39	-	0.45	1.512	-
250'	0.41	-	0.41	1.326	-
300'	0.53	-	0.44	1.451	-
350'	0.45	-	0.50	1.487	-
400'	0.41	-	0.39	1.486	-
450'	0.34	-	0.40	1.305	-
500'	0.31	-	0.36	1.317	-
550'	0.69	-	0.39	1.493	-
Average	0.48	-	0.42	1.47	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.11	-0.92	-
50'	-	0.15	-1.01	-
100'	-	0.16	-0.96	-
150'	-	0.09	-1.07	-
200'	-	-0.06	-1.12	-
250'	-	0.00	-0.92	-
300'	-	0.09	-0.92	-
350'	-	-0.05	-1.04	-
400'	-	0.02	-1.08	-
450'	-	-0.06	-0.97	-
500'	-	-0.05	-1.01	-
550'	-	0.30	-0.80	-
Total		0.71	-11.82	
Average	-	0.06	-0.98	-
Std. Dev.		0.11	0.09	

AutoDC15_Spur484-1

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.56	-	1.24	3.312	-
50'	1.76	-	1.19	3.342	-
100'	1.3	-	1.23	3.265	-
150'	1.5	-	1.24	3.374	-
200'	1.28	-	1.26	3.423	-
250'	1.41	-	1.20	3.349	-
300'	1.4	-	1.20	3.364	-
350'	1.66	-	1.20	3.332	-
400'	1.45	-	1.19	3.306	-
450'	1.45	-	1.20	3.468	-
500'	1.44	-	1.14	3.285	-
550'	1.51	-	1.16	3.237	-
Average	1.48	-	1.20	3.34	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.32	-1.75	-
50'	-	0.57	-1.58	-
100'	-	0.07	-1.97	-
150'	-	0.26	-1.87	-
200'	-	0.02	-2.14	-
250'	-	0.21	-1.94	-
300'	-	0.20	-1.96	-
350'	-	0.46	-1.67	-
400'	-	0.26	-1.86	-
450'	-	0.25	-2.02	-
500'	-	0.30	-1.85	-
550'	-	0.35	-1.73	-
Total		3.27	-22.34	
Average	-	0.27	-1.86	-
Std. Dev.		0.15	0.16	

AutoDC16_US77-1

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.8	-	0.54	2.451	-
50'	0.83	-	0.53	2.003	-
100'	0.97	-	0.49	2.436	-
150'	0.99	-	0.52	2.182	-
200'	0.68	-	0.49	1.958	-
250'	0.83	-	0.49	2.368	-
300'	0.77	-	0.58	2.356	-
350'	0.87	-	0.52	2.088	-
400'	0.79	-	0.46	1.796	-
450'	0.77	-	0.59	2.431	-
500'	0.6	-	0.44	2.217	-
550'	0.71	-	0.55	2.24	-
Average	0.80	-	0.52	2.21	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.26	-1.65	-
50'	-	0.30	-1.17	-
100'	-	0.48	-1.47	-
150'	-	0.47	-1.19	-
200'	-	0.19	-1.28	-
250'	-	0.34	-1.54	-
300'	-	0.19	-1.59	-
350'	-	0.35	-1.22	-
400'	-	0.33	-1.01	-
450'	-	0.18	-1.66	-
500'	-	0.16	-1.62	-
550'	-	0.16	-1.53	-
Total		3.40	-16.92	
Average	-	0.28	-1.41	-
Std. Dev.		0.11	0.22	

AutoDC17_La_Salle-1

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.24	-	0.51	1.727	-
50'	0.43	-	0.54	1.622	-
100'	0.38	-	0.50	1.71	-
150'	0.38	-	0.51	1.565	-
200'	0.56	-	0.55	1.608	-
250'	0.27	-	0.55	1.681	-
300'	0.35	-	0.49	1.683	-
350'	0.31	-	0.53	1.728	-
400'	0.35	-	0.52	1.692	-
450'	0.31	-	0.57	1.656	-
500'	0.32	-	0.54	1.735	-
550'	0.35	-	-	1.706	-
Average	0.35	-	0.53	1.68	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	-0.27	-1.49	-
50'	-	-0.11	-1.19	-
100'	-	-0.12	-1.33	-
150'	-	-0.13	-1.19	-
200'	-	0.01	-1.05	-
250'	-	-0.28	-1.41	-
300'	-	-0.14	-1.33	-
350'	-	-0.22	-1.42	-
400'	-	-0.17	-1.34	-
450'	-	-0.26	-1.35	-
500'	-	-0.22	-1.42	-
550'	-	-	-1.36	-
Total		-1.91	-15.86	
Average	-	-0.17	-1.32	-
Std. Dev.		0.09	0.12	

AutoDC18_IH35-1

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.4	-	0.46	1.494	-
50'	0.75	-	0.41	1.85	-
100'	0.59	-	0.48	1.706	-
150'	0.42	-	0.41	1.5	-
200'	0.47	-	0.41	1.478	-
250'	0.81	-	0.64	2.185	-
300'	0.53	-	0.60	2.091	-
350'	0.58	-	0.59	1.988	-
400'	0.72	-	0.72	2.316	-
450'	0.61	-	0.66	2.654	-
500'	0.49	-	0.69	2.202	-
550'	0.75	-	0.44	2.219	-
Average	0.59	-	0.54	1.97	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	-0.06	-1.09	-
50'	-	0.34	-1.10	-
100'	-	0.11	-1.12	-
150'	-	0.01	-1.08	-
200'	-	0.06	-1.01	-
250'	-	0.17	-1.38	-
300'	-	-0.07	-1.56	-
350'	-	-0.01	-1.41	-
400'	-	0.00	-1.60	-
450'	-	-0.05	-2.04	-
500'	-	-0.20	-1.71	-
550'	-	0.31	-1.47	-
Total		0.61	-16.56	
Average	-	0.05	-1.38	-
Std. Dev.		0.16	0.32	

AutoDC19_IH35-2

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.01	-	0.50	1.958	-
50'	0.3	-	0.39	1.35	-
100'	0.7	-	0.45	2.227	-
150'	0.39	-	0.46	1.48	-
200'	0.37	-	0.41	1.366	-
250'	0.43	-	0.45	1.564	-
300'	0.39	-	0.44	1.468	-
350'	0.4	-	0.43	1.385	-
400'	0.35	-	0.41	1.488	-
450'	0.4	-	0.48	1.58	-
500'	0.31	-	0.45	1.415	-
550'	0.34	-	0.44	1.641	-
Average	0.45	-	0.44	1.58	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.51	-0.95	-
50'	-	-0.09	-1.05	-
100'	-	0.25	-1.53	-
150'	-	-0.07	-1.09	-
200'	-	-0.04	-1.00	-
250'	-	-0.02	-1.13	-
300'	-	-0.05	-1.08	-
350'	-	-0.03	-0.99	-
400'	-	-0.06	-1.14	-
450'	-	-0.08	-1.18	-
500'	-	-0.14	-1.11	-
550'	-	-0.10	-1.30	-
Total		0.09	-13.53	
Average	-	0.01	-1.13	-
Std. Dev.		0.18	0.16	

AutoDC20_US84-1

Inner wheelpath (IWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.52	-	0.46	1.852	-
50'	0.48	-	0.43	2.012	-
100'	0.5	-	0.44	1.777	-
150'	0.38	-	0.38	1.662	-
200'	0.36	-	0.37	1.929	-
250'	0.4	-	0.41	1.89	-
300'	0.48	-	0.38	1.831	-
350'	0.36	-	0.39	1.908	-
400'	0.39	-	0.44	1.779	-
450'	0.37	-	0.43	1.803	-
500'	0.46	-	0.46	1.607	-
550'	0.42	-	0.48	0.742	-
Average	0.43	-	0.42	1.73	-

Inner wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-	0.06	-1.33	-
50'	-	0.05	-1.53	-
100'	-	0.06	-1.28	-
150'	-	0.00	-1.28	-
200'	-	-0.01	-1.57	-
250'	-	-0.01	-1.49	-
300'	-	0.10	-1.35	-
350'	-	-0.03	-1.55	-
400'	-	-0.05	-1.39	-
450'	-	-0.06	-1.43	-
500'	-	0.00	-1.15	-
550'	-	-0.06	-0.32	-
Total		0.07	-15.67	
Average	-	0.01	-1.31	-
Std. Dev.		0.05	0.33	

Appendix D.2 – Texture Summary (Outer Wheel Path)

AutoDC1_FM969-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.48	0.61	-	2.545	1.745
50'	0.47	0.38	0.64	3.615	-
100'	0.4	0.39	0.59	2.322	-
150'	0.44	0.57	0.63	2.102	-
200'	0.47	0.21	0.66	1.81	-
250'	0.4	0.40	0.57	1.798	-
300'	0.53	0.40	0.62	1.87	-
350'	0.5	0.56	0.67	1.746	-
400'	0.59	0.65	0.61	1.868	-
450'	0.54	0.36	0.61	2.831	-
500'	0.48	0.57	0.67	2.36	-
550'	0.53	0.45	0.61	1.78	-
Average	0.49	0.46	0.62	2.22	1.745

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-0.13	-	-2.07	-1.27
50'	0.09	-0.17	-3.15	-
100'	0.01	-0.19	-1.92	-
150'	-0.13	-0.19	-1.66	-
200'	0.26	-0.19	-1.34	-
250'	0.00	-0.17	-1.40	-
300'	0.13	-0.09	-1.34	-
350'	-0.06	-0.17	-1.25	-
400'	-0.06	-0.02	-1.28	-
450'	0.18	-0.07	-2.29	-
500'	-0.09	-0.19	-1.88	-
550'	0.08	-0.08	-1.25	-
Total	0.29	-1.52	-20.82	-1.27
Average	0.02	-0.14	-1.73	-1.26
Std. Dev.	0.13	0.06	0.57	

AutoDC2_FM1377-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.06	0.65	0.68	1.727	1.788
50'	1.43	0.71	0.73	1.796	-
100'	1.29	0.81	0.70	1.762	-
150'	0.87	0.55	0.56	1.628	-
200'	1.37	0.64	0.64	1.711	-
250'	0.66	0.23	0.54	1.763	-
300'	0.62	0.48	0.50	1.755	-
350'	0.66	0.36	0.55	1.822	-
400'	0.54	0.52	0.54	1.795	-
450'	0.75	0.46	0.47	1.549	-
500'	1.29	0.37	0.63	1.845	-
550'	1.45	0.54	0.85	2.109	-
Average	1.00	0.53	0.62	1.77	1.788

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.41	0.38	-0.67	-0.73
50'	0.72	0.70	-0.37	-
100'	0.48	0.59	-0.47	-
150'	0.32	0.31	-0.76	-
200'	0.73	0.73	-0.34	-
250'	0.43	0.12	-1.10	-
300'	0.14	0.12	-1.14	-
350'	0.30	0.11	-1.16	-
400'	0.02	0.00	-1.26	-
450'	0.29	0.28	-0.80	-
500'	0.92	0.66	-0.56	-
550'	0.91	0.60	-0.66	-
Total	5.66	4.59	-9.27	-0.73
Average	0.47	0.38	-0.77	-0.79
Std. Dev.	0.29	0.26	0.32	

AutoDC3_FM696-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.95	0.64	0.67	2.21	4.513
50'	1.23	0.92	0.64	2.756	-
100'	1.49	1.00	0.63	1.963	-
150'	1.23	0.52	0.69	2.284	-
200'	1.67	0.51	0.79	1.981	-
250'	1.44	0.90	0.74	1.979	-
300'	0.97	0.58	0.82	2.131	-
350'	0.93	0.42	0.62	2.381	-
400'	0.69	0.69	0.90	2.42	-
450'	1.29	1.14	0.86	2.29	-
500'	1.11	0.74	0.68	1.909	-
550'	1.41	0.92	0.70	1.887	-
Average	1.20	0.75	0.73	2.18	4.513

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.31	0.28	-1.26	-3.56
50'	0.31	0.59	-1.53	-
100'	0.49	0.86	-0.47	-
150'	0.71	0.54	-1.05	-
200'	1.16	0.88	-0.31	-
250'	0.54	0.70	-0.54	-
300'	0.39	0.15	-1.16	-
350'	0.51	0.31	-1.45	-
400'	0.00	-0.21	-1.73	-
450'	0.15	0.43	-1.00	-
500'	0.37	0.43	-0.80	-
550'	0.49	0.71	-0.48	-
Total	5.44	5.67	-11.78	-3.56
Average	0.45	0.47	-0.98	-3.31
Std. Dev.	0.29	0.31	0.47	

AutoDC4_FM696-3

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.59	0.65	0.54	1.56	3.122
50'	0.56	0.53	0.51	1.511	-
100'	0.57	0.47	0.49	1.555	-
150'	0.7	0.67	0.53	1.55	-
200'	0.6	0.34	0.46	1.527	-
250'	0.54	0.41	0.45	1.526	-
300'	0.57	0.52	0.53	1.514	-
350'	0.63	0.46	0.51	1.563	-
400'	0.48	0.56	0.49	1.493	-
450'	0.56	0.47	0.52	1.404	-
500'	0.49	0.57	0.50	1.447	-
550'	0.45	0.60	0.50	1.487	-
Average	0.56	0.52	0.50	1.51	3.122

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-0.06	0.05	-0.97	-2.53
50'	0.03	0.05	-0.95	-
100'	0.10	0.08	-0.99	-
150'	0.03	0.17	-0.85	-
200'	0.26	0.14	-0.93	-
250'	0.13	0.09	-0.99	-
300'	0.05	0.04	-0.94	-
350'	0.17	0.12	-0.93	-
400'	-0.08	-0.01	-1.01	-
450'	0.09	0.04	-0.84	-
500'	-0.08	-0.01	-0.96	-
550'	-0.15	-0.05	-1.04	-
Total	0.47	0.71	-11.40	-2.53
Average	0.04	0.06	-0.95	-2.56
Std. Dev.	0.12	0.06	0.06	

AutoDC5_FM696-4

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.5	0.59	0.49	1.44	2.049
50'	0.48	0.50	0.50	1.545	-
100'	0.5	0.33	0.50	1.627	-
150'	0.5	0.48	0.52	1.593	-
200'	0.43	0.53	0.52	1.708	-
250'	0.53	0.60	0.53	1.603	-
300'	0.48	0.42	0.52	1.664	-
350'	0.41	0.42	0.56	1.658	-
400'	0.55	0.50	0.56	1.683	-
450'	0.58	0.46	0.53	1.618	-
500'	0.54	0.53	0.56	1.706	-
550'	0.57	0.60	-	1.63	-
Average	0.51	0.50	0.53	1.62	2.049

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-0.09	0.01	-0.94	-1.55
50'	-0.02	-0.02	-1.07	-
100'	0.17	0.00	-1.13	-
150'	0.02	-0.02	-1.09	-
200'	-0.10	-0.09	-1.28	-
250'	-0.07	0.00	-1.07	-
300'	0.06	-0.04	-1.18	-
350'	-0.01	-0.15	-1.25	-
400'	0.05	-0.01	-1.13	-
450'	0.12	0.05	-1.04	-
500'	0.01	-0.02	-1.17	-
550'	-0.03	-	-1.06	-
Total	0.11	-0.30	-13.41	-1.55
Average	0.01	-0.02	-1.12	-1.54
Std. Dev.	0.08	0.05	0.09	

AutoDC6_FM696-2

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.35	0.97	-	2.484	1.427
50'	0.65	0.60	0.82	2.123	-
100'	1.27	0.94	0.82	2.447	-
150'	1.09	1.13	0.85	2.264	-
200'	1.07	0.95	0.82	2.215	-
250'	0.91	0.92	0.94	2.596	-
300'	0.97	0.93	0.85	2.123	-
350'	0.87	0.62	0.78	3.131	-
400'	0.77	0.71	0.77	2.102	-
450'	0.81	1.18	0.97	2.367	-
500'	0.84	0.92	0.94	3.454	-
550'	0.76	0.97	0.89	2.471	-
Average	0.95	0.90	0.86	2.48	1.427

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.38	-	-1.13	-0.08
50'	0.05	-0.17	-1.47	-
100'	0.33	0.45	-1.18	-
150'	-0.04	0.24	-1.17	-
200'	0.12	0.25	-1.15	-
250'	-0.01	-0.03	-1.69	-
300'	0.04	0.12	-1.15	-
350'	0.25	0.09	-2.26	-
400'	0.06	0.00	-1.33	-
450'	-0.37	-0.16	-1.56	-
500'	-0.08	-0.10	-2.61	-
550'	-0.21	-0.13	-1.71	-
Total	0.53	0.57	-18.42	-0.08
Average	0.04	0.09	-1.53	-0.48
Std. Dev.	0.21	0.20	0.48	

AutoDC7_FM696-5

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.08	0.67	0.68	1.938	2.978
50'	1.07	0.60	0.56	1.794	-
100'	1.29	1.16	0.86	2.358	-
150'	0.99	0.73	0.68	1.73	-
200'	0.95	0.69	0.55	1.769	-
250'	1.11	0.62	0.67	1.782	-
300'	1.11	0.59	0.63	1.768	-
350'	0.93	0.85	0.64	1.714	-
400'	1.49	1.15	1.28	2.626	-
450'	1.48	1.29	1.24	2.501	-
500'	1.42	1.06	1.13	2.273	-
550'	1.64	0.77	1.17	2.14	-
Average	1.21	0.85	0.84	2.03	2.978

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.41	0.40	-0.86	-1.90
50'	0.47	0.51	-0.72	-
100'	0.13	0.43	-1.07	-
150'	0.26	0.31	-0.74	-
200'	0.26	0.40	-0.82	-
250'	0.49	0.44	-0.67	-
300'	0.52	0.48	-0.66	-
350'	0.08	0.29	-0.78	-
400'	0.34	0.21	-1.14	-
450'	0.19	0.24	-1.02	-
500'	0.36	0.29	-0.85	-
550'	0.87	0.47	-0.50	-
Total	4.37	4.48	-9.83	-1.90
Average	0.36	0.37	-0.82	-1.76
Std. Dev.	0.21	0.10	0.18	

AutoDC8_FM619-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	2.33	1.13	1.31	3.13	4.101
50'	2.5	1.12	1.47	3.057	-
100'	1.66	0.97	0.85	2.277	-
150'	1.2	0.90	0.87	2.123	-
200'	0.92	0.98	0.75	1.985	-
250'	2.23	1.28	1.25	3.064	-
300'	1.24	0.87	0.83	3.016	-
350'	1.65	1.10	0.84	2.824	-
400'	1.81	0.70	0.91	4.187	-
450'	1.64	0.99	0.83	2.891	-
500'	1.7	0.93	0.72	2.457	-
550'	1.79	0.96	1.04	3.291	-
Average	1.72	0.99	0.97	2.86	4.101

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	1.20	1.02	-0.80	-1.77
50'	1.38	1.03	-0.56	-
100'	0.69	0.81	-0.62	-
150'	0.30	0.33	-0.92	-
200'	-0.06	0.17	-1.07	-
250'	0.95	0.98	-0.83	-
300'	0.37	0.41	-1.78	-
350'	0.55	0.81	-1.17	-
400'	1.11	0.90	-2.38	-
450'	0.65	0.81	-1.25	-
500'	0.77	0.98	-0.76	-
550'	0.83	0.75	-1.50	-
Total	8.75	9.00	-13.63	-1.77
Average	0.73	0.75	-1.14	-2.38
Std. Dev.	0.41	0.29	0.53	

AutoDC9_FM112-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.19	1.08	0.80	1.654	3.3
50'	0.79	0.59	0.73	2.021	-
100'	1.71	0.84	0.78	1.723	-
150'	1.02	1.05	0.79	1.706	-
200'	0.98	1.33	1.02	2.012	-
250'	1.74	0.92	0.85	1.954	-
300'	0.76	0.72	0.65	1.236	-
350'	0.94	1.12	0.65	1.865	-
400'	1.29	1.34	0.82	2.05	-
450'	1.55	0.95	0.90	2.494	-
500'	1.39	1.28	0.96	2.117	-
550'	1.13	0.99	1.06	1.467	-
Average	1.21	1.02	0.83	1.86	3.3

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.11	0.39	-0.46	-2.11
50'	0.20	0.06	-1.23	-
100'	0.87	0.93	-0.01	-
150'	-0.03	0.23	-0.69	-
200'	-0.35	-0.04	-1.03	-
250'	0.82	0.89	-0.21	-
300'	0.04	0.11	-0.48	-
350'	-0.18	0.29	-0.93	-
400'	-0.05	0.47	-0.76	-
450'	0.60	0.65	-0.94	-
500'	0.11	0.43	-0.73	-
550'	0.14	0.07	-0.34	-
Total	2.27	4.49	-7.81	-2.11
Average	0.19	0.37	-0.65	-2.09
Std. Dev.	0.38	0.32	0.36	

AutoDC10_FM1331-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.47	0.77	0.87	3.291	3.481
50'	1.34	0.92	0.88	4.757	-
100'	1.32	0.52	0.80	86.9	-
150'	1.7	0.75	0.83	3.518	-
200'	1.29	0.54	0.84	3.206	-
250'	1.52	0.94	1.08	2.907	-
300'	1.6	1.02	0.98	2.995	-
350'	1.36	0.61	0.97	2.872	-
400'	1.39	0.87	1.00	4.451	-
450'	1.48	1.00	1.08	3.739	-
500'	1.6	1.24	1.01	4.446	-
550'	1.65	0.99	-	8.744	-
Average	1.48	0.85	0.94	10.99	3.481

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.70	0.60	-1.82	-2.01
50'	0.42	0.46	-3.42	-
100'	0.80	0.52	-85.58	-
150'	0.95	0.87	-1.82	-
200'	0.75	0.45	-1.92	-
250'	0.58	0.44	-1.39	-
300'	0.58	0.62	-1.40	-
350'	0.75	0.39	-1.51	-
400'	0.52	0.39	-3.06	-
450'	0.48	0.40	-2.26	-
500'	0.36	0.59	-2.85	-
550'	0.66	-	-7.09	-
Total	7.53	5.76	-114.11	-2.01
Average	0.63	0.54	-9.51	-2.00
Std. Dev.	0.17	0.14	24.01	

AutoDC11_FM1331-2

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.17	0.88	0.74	2.357	3.254
50'	0.89	0.60	0.81	2.484	-
100'	1.01	0.82	0.76	2.342	-
150'	1.03	0.83	0.69	2.776	-
200'	2.2	1.20	0.81	2.313	-
250'	1.15	0.69	0.67	2.32	-
300'	1.59	1.05	0.86	12.12	-
350'	1.75	0.87	0.87	2.667	-
400'	1.55	0.90	0.70	2.586	-
450'	0.9	0.44	0.68	2.41	-
500'	0.96	0.90	0.70	2.555	-
550'	1.54	1.11	-	2.618	-
Average	1.31	0.86	0.75	3.30	3.254

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.29	0.43	-1.19	-2.08
50'	0.29	0.08	-1.59	-
100'	0.19	0.25	-1.33	-
150'	0.20	0.34	-1.75	-
200'	1.00	1.39	-0.11	-
250'	0.46	0.48	-1.17	-
300'	0.54	0.73	-10.53	-
350'	0.88	0.88	-0.92	-
400'	0.65	0.85	-1.04	-
450'	0.46	0.22	-1.51	-
500'	0.06	0.26	-1.60	-
550'	0.43	-	-1.08	-
Total	5.45	5.91	-23.81	-2.08
Average	0.45	0.56	-1.98	-1.94
Std. Dev.	0.28	0.39	2.73	

AutoDC12_FM1063-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	1.18	0.51	0.72	1.882	2.863
50'	1.2	0.43	0.84	2.332	-
100'	0.95	0.78	0.73	3.497	-
150'	2.21	1.29	1.42	3.668	-
200'	2.01	1.01	0.89	2.409	-
250'	1.24	1.12	0.61	1.84	-
300'	1.11	0.85	0.63	2.015	-
350'	1.15	0.59	0.66	1.843	-
400'	1.08	0.83	0.65	3.18	-
450'	0.84	0.45	0.56	1.764	-
500'	1.22	0.47	0.65	1.992	-
550'	1.14	0.74	0.60	1.855	-
Average	1.28	0.76	0.75	2.36	2.863

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.67	0.46	-0.70	-1.68
50'	0.77	0.36	-1.13	-
100'	0.17	0.22	-2.55	-
150'	0.92	0.79	-1.46	-
200'	1.00	1.12	-0.40	-
250'	0.12	0.63	-0.60	-
300'	0.26	0.48	-0.91	-
350'	0.56	0.49	-0.69	-
400'	0.25	0.43	-2.10	-
450'	0.39	0.28	-0.92	-
500'	0.75	0.57	-0.77	-
550'	0.40	0.54	-0.72	-
Total	6.25	6.37	-12.95	-1.68
Average	0.52	0.53	-1.08	-1.59
Std. Dev.	0.30	0.24	0.65	

AutoDC13_US79-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors: Dynatest	Fugro	Waylink-OSU	TxDOT
0'	1.67	0.92	1.49	3.662	4.308
50'	1.6	1.38	1.44	3.803	-
100'	1.76	1.32	1.47	3.71	-
150'	1.38	1.34	1.41	3.705	-
200'	1.71	1.00	1.47	3.651	-
250'	1.95	0.86	1.43	3.672	-
300'	1.43	1.04	1.45	3.76	-
350'	1.7	0.98	1.48	3.583	-
400'	1.35	0.93	1.36	3.568	-
450'	1.42	0.89	1.41	3.674	-
500'	1.21	1.02	1.36	3.38	-
550'	1.51	1.00	-	3.311	-
Average	1.56	1.06	1.43	3.62	4.308

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors: Dynatest	Fugro	Waylink-OSU	TxDOT
0'	0.75	0.18	-1.99	-2.64
50'	0.22	0.16	-2.20	-
100'	0.44	0.29	-1.95	-
150'	0.04	-0.03	-2.33	-
200'	0.71	0.24	-1.94	-
250'	1.09	0.52	-1.72	-
300'	0.39	-0.02	-2.33	-
350'	0.72	0.22	-1.88	-
400'	0.42	-0.01	-2.22	-
450'	0.53	0.01	-2.25	-
500'	0.19	-0.15	-2.17	-
550'	0.51	-	-1.80	-
Total	6.00	1.41	-24.79	-2.64
Average	0.50	0.12	-2.07	-2.75
Std. Dev.	0.29	0.19	0.21	

AutoDC14_IH35-3

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors: Dynatest	Fugro	Waylink-OSU	TxDOT
0'	0.52	0.52	0.46	1.125	1.82
50'	0.66	0.71	0.48	1.194	-
100'	0.37	0.51	0.43	1.157	-
150'	0.71	0.77	0.50	1.151	-
200'	0.39	0.51	0.48	1.211	-
250'	0.42	0.60	0.44	0.968	-
300'	0.56	0.73	0.46	1.093	-
350'	0.44	0.48	0.47	1.054	-
400'	0.41	0.47	0.40	1.05	-
450'	0.47	0.53	0.41	1.004	-
500'	0.64	0.50	0.43	1.255	-
550'	0.41	0.52	0.39	1.083	-
Average	0.50	0.57	0.45	1.11	1.82

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors: Dynatest	Fugro	Waylink-OSU	TxDOT
0'	0.00	0.06	-0.61	-1.30
50'	-0.05	0.18	-0.53	-
100'	-0.14	-0.06	-0.79	-
150'	-0.06	0.21	-0.44	-
200'	-0.12	-0.09	-0.82	-
250'	-0.18	-0.02	-0.55	-
300'	-0.17	0.10	-0.53	-
350'	-0.04	-0.03	-0.61	-
400'	-0.06	0.01	-0.64	-
450'	-0.06	0.06	-0.53	-
500'	0.14	0.21	-0.62	-
550'	-0.11	0.02	-0.67	-
Total	-0.86	0.66	-7.35	-1.30
Average	-0.07	0.05	-0.61	-1.32
Std. Dev.	0.09	0.10	0.11	

AutoDC15_Spur484-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors: Dynatest	Fugro	Waylink-OSU	TxDOT
0'	1.2	1.11	1.07	2.437	3.385
50'	1.41	1.31	1.06	2.494	-
100'	1.24	1.20	1.03	2.446	-
150'	1.4	0.77	1.20	2.53	-
200'	1.43	1.35	1.07	2.435	-
250'	1.32	1.03	1.10	2.478	-
300'	1.37	1.15	1.13	2.483	-
350'	1.5	1.22	1.08	2.435	-
400'	1.51	1.28	1.08	2.448	-
450'	1.41	1.17	1.03	2.454	-
500'	1.22	0.98	1.04	2.347	-
550'	1.36	1.13	1.11	2.519	-
Average	1.36	1.14	1.08	2.46	3.385

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors: Dynatest	Fugro	Waylink-OSU	TxDOT
0'	0.09	0.13	-1.24	-2.19
50'	0.10	0.35	-1.08	-
100'	0.04	0.21	-1.21	-
150'	0.63	0.20	-1.13	-
200'	0.08	0.36	-1.01	-
250'	0.29	0.22	-1.16	-
300'	0.22	0.24	-1.11	-
350'	0.28	0.42	-0.94	-
400'	0.23	0.43	-0.94	-
450'	0.24	0.38	-1.04	-
500'	0.24	0.18	-1.13	-
550'	0.23	0.25	-1.16	-
Total	2.68	3.35	-13.14	-2.19
Average	0.22	0.28	-1.09	-2.02
Std. Dev.	0.15	0.10	0.10	

AutoDC16_US77-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.7	0.68	0.43	1.112	1.555
50'	0.96	0.94	0.54	1.183	-
100'	0.81	0.88	0.52	1.254	-
150'	0.78	0.51	0.48	1.17	-
200'	0.77	0.72	0.48	1.186	-
250'	0.82	0.73	0.51	1.119	-
300'	0.6	0.80	0.47	1.27	-
350'	0.66	0.85	0.50	1.182	-
400'	0.84	0.60	0.45	1.157	-
450'	0.64	0.80	0.45	1.23	-
500'	0.65	0.52	0.48	1.123	-
550'	0.69	0.80	0.44	1.052	-
Average	0.74	0.74	0.48	1.17	1.555

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.02	0.27	-0.41	-0.86
50'	0.02	0.42	-0.22	-
100'	-0.07	0.29	-0.44	-
150'	0.27	0.30	-0.39	-
200'	0.05	0.29	-0.42	-
250'	0.09	0.31	-0.30	-
300'	-0.20	0.13	-0.67	-
350'	-0.19	0.16	-0.52	-
400'	0.24	0.39	-0.32	-
450'	-0.16	0.19	-0.59	-
500'	0.13	0.17	-0.47	-
550'	-0.11	0.25	-0.36	-
Total	0.07	3.18	-5.12	-0.86
Average	0.01	0.27	-0.43	-0.81
Std. Dev.	0.16	0.09	0.13	

AutoDC17_La_Salle-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.53	0.47	0.53	1.49	0
50'	0.52	0.17	0.55	1.488	-
100'	0.62	0.45	0.57	1.509	-
150'	0.57	0.21	0.53	1.507	-
200'	0.61	0.44	0.56	1.513	-
250'	0.35	0.45	0.49	1.553	-
300'	0.35	0.25	0.50	1.485	-
350'	0.28	0.41	0.51	1.565	-
400'	0.37	0.44	0.55	1.591	-
450'	0.5	0.36	0.55	1.513	-
500'	0.55	0.41	0.56	1.52	-
550'	0.45	0.43	-	1.565	-
Average	0.48	0.37	0.54	1.52	0

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	0.06	0.00	-0.96	0.53
50'	0.35	-0.03	-0.97	-
100'	0.17	0.05	-0.89	-
150'	0.36	0.04	-0.94	-
200'	0.17	0.05	-0.90	-
250'	-0.10	-0.14	-1.20	-
300'	0.10	-0.15	-1.14	-
350'	-0.13	-0.23	-1.29	-
400'	-0.07	-0.18	-1.22	-
450'	0.14	-0.05	-1.01	-
500'	0.14	-0.01	-0.97	-
550'	0.02	-	-1.12	-
Total	1.21	-0.65	-12.60	0.53
Average	0.10	-0.06	-1.05	0.48
Std. Dev.	0.16	0.10	0.14	

AutoDC18_IH35-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	
0'	0.5	0.59	0.47	1.691	2.015
50'	0.65	0.38	0.43	1.28	-
100'	0.7	0.79	0.47	1.562	-
150'	0.78	0.77	0.47	1.555	-
200'	0.54	0.65	0.41	1.219	-
250'	0.96	0.65	0.62	1.804	-
300'	0.68	0.85	0.65	1.644	-
350'	1.25	0.91	0.72	2.021	-
400'	0.63	0.87	0.70	1.775	-
450'	1.08	0.53	0.75	1.754	-
500'	0.84	1.14	0.68	1.709	-
550'	0.95	0.94	0.48	1.955	-
Average	0.80	0.75	0.57	1.66	2.015

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	
0'	-0.09	0.03	-1.19	-1.52
50'	0.27	0.22	-0.63	-
100'	-0.09	0.23	-0.86	-
150'	0.01	0.31	-0.78	-
200'	-0.11	0.13	-0.68	-
250'	0.31	0.34	-0.84	-
300'	-0.17	0.03	-0.96	-
350'	0.34	0.53	-0.77	-
400'	-0.24	-0.07	-1.15	-
450'	0.55	0.33	-0.67	-
500'	-0.30	0.16	-0.87	-
550'	0.01	0.47	-1.01	-
Total	0.50	2.72	-10.41	-1.52
Average	0.04	0.23	-0.87	-1.22
Std. Dev.	0.27	0.18	0.18	

AutoDC19_IH35-2

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	TxDOT
0'	1.09	0.99	0.53	2.114	1.609
50'	0.28	0.50	0.43	1.176	-
100'	0.4	0.50	0.46	1.341	-
150'	0.37	0.87	0.46	1.391	-
200'	0.46	0.37	0.45	1.287	-
250'	0.35	0.58	0.43	1.26	-
300'	0.37	0.27	0.45	1.273	-
350'	0.41	0.39	0.46	1.317	-
400'	0.32	0.41	0.43	1.157	-
450'	0.5	0.37	0.57	1.549	-
500'	0.44	0.63	0.43	1.302	-
550'	0.47	0.55	0.48	1.468	-
Average	0.46	0.54	0.46	1.39	1.609

Outer wheelpath (IWP) - MPD Error (mm)

subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	TxDOT
0'	0.10	0.56	-1.02	-0.52
50'	-0.22	-0.15	-0.90	-
100'	-0.10	-0.06	-0.94	-
150'	-0.50	-0.09	-1.02	-
200'	0.09	0.01	-0.83	-
250'	-0.23	-0.08	-0.91	-
300'	0.10	-0.08	-0.90	-
350'	0.02	-0.05	-0.91	-
400'	-0.09	-0.11	-0.84	-
450'	0.13	-0.07	-1.05	-
500'	-0.19	0.01	-0.86	-
550'	-0.08	-0.01	-1.00	-
Total	-0.97	-0.12	-11.18	-0.52
Average	-0.08	-0.01	-0.93	-1.15
Std. Dev.	0.19	0.19	0.08	

AutoDC20_US84-1

Outer wheelpath (OWP) - Mean Profile Depth, MPD (mm)

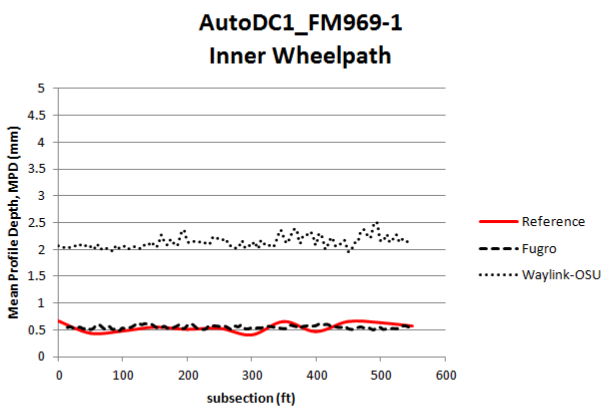
subsection	Reference	Vendors			TxDOT
		Dynatest	Fugro	Waylink-OSU	TxDOT
0'	0.55	0.66	0.49	1.696	1.581
50'	0.4	0.56	0.49	1.612	-
100'	0.3	0.39	0.46	1.581	-
150'	0.5	0.47	0.43	1.403	-
200'	0.36	0.45	0.42	1.608	-
250'	0.34	0.59	0.43	1.63	-
300'	0.42	0.56	0.44	1.425	-
350'	0.36	0.37	0.45	1.455	-
400'	0.27	0.39	0.46	1.65	-
450'	0.29	0.56	0.43	1.516	-
500'	0.34	0.38	0.45	1.809	-
550'	0.41	0.61	0.45	0.833	-
Average	0.38	0.50	0.45	1.52	1.581

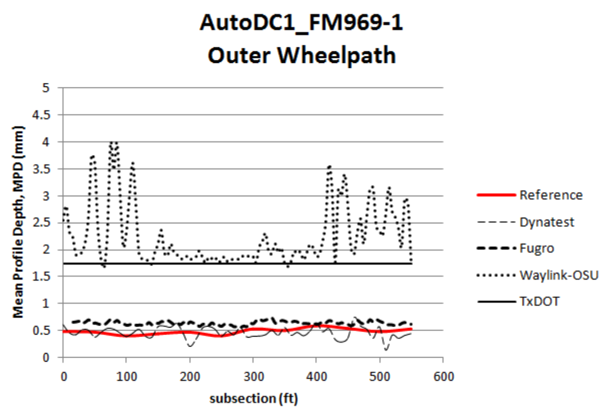
Outer wheelpath (IWP) - MPD Error (mm)

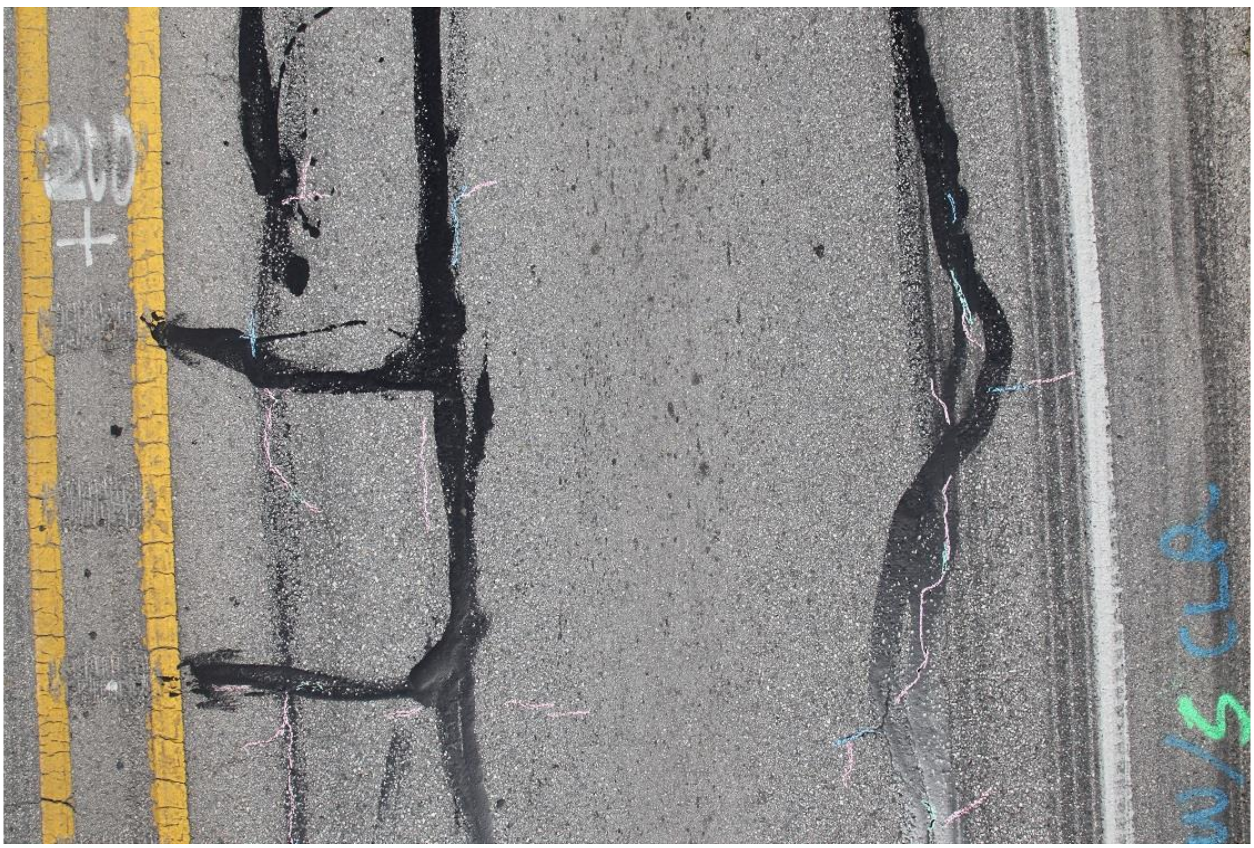
subsection	Vendors			TxDOT
	Dynatest	Fugro	Waylink-OSU	TxDOT
0'	-0.11	0.06	-1.15	-1.03
50'	-0.16	-0.09	-1.21	-
100'	-0.09	-0.16	-1.28	-
150'	0.03	0.07	-0.90	-
200'	-0.09	-0.06	-1.25	-
250'	-0.25	-0.09	-1.29	-
300'	-0.14	-0.02	-1.01	-
350'	-0.01	-0.09	-1.10	-
400'	-0.12	-0.19	-1.38	-
450'	-0.27	-0.14	-1.23	-
500'	-0.04	-0.11	-1.47	-
550'	-0.20	-0.04	-0.42	-
Total	-1.45	-0.87	-13.68	-1.03
Average	-0.12	-0.07	-1.14	-1.20
Std. Dev.	0.09	0.08	0.27	

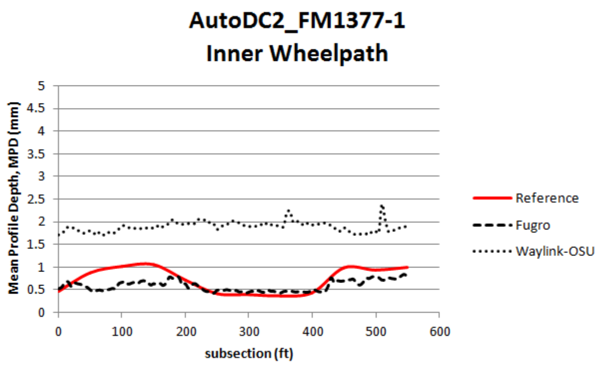
Appendix D.3 – Texture Graphs

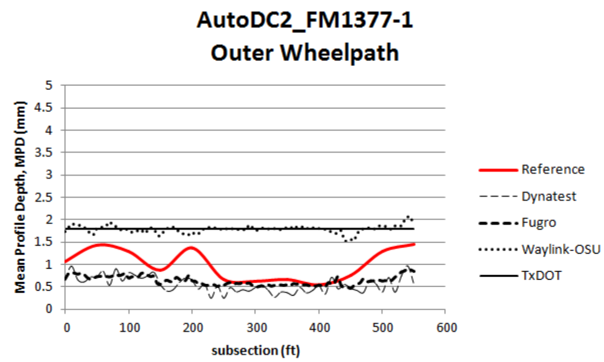
Note: Images of pavement sections Auto DC 5, 6, 8, 9, 10, 14, 15, 16, 17, and 18 are from Google Maps.

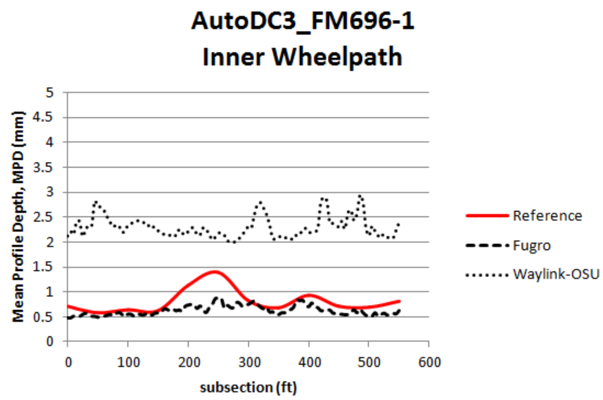


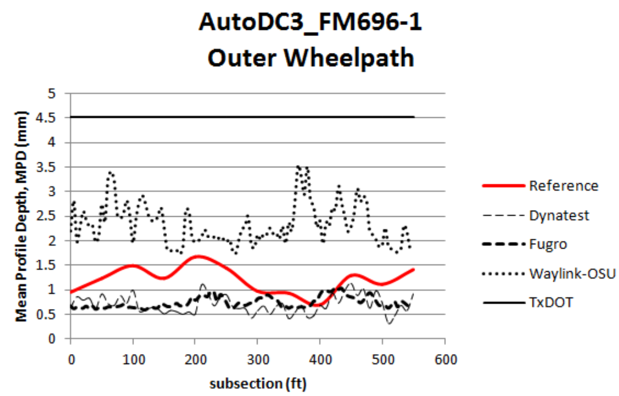


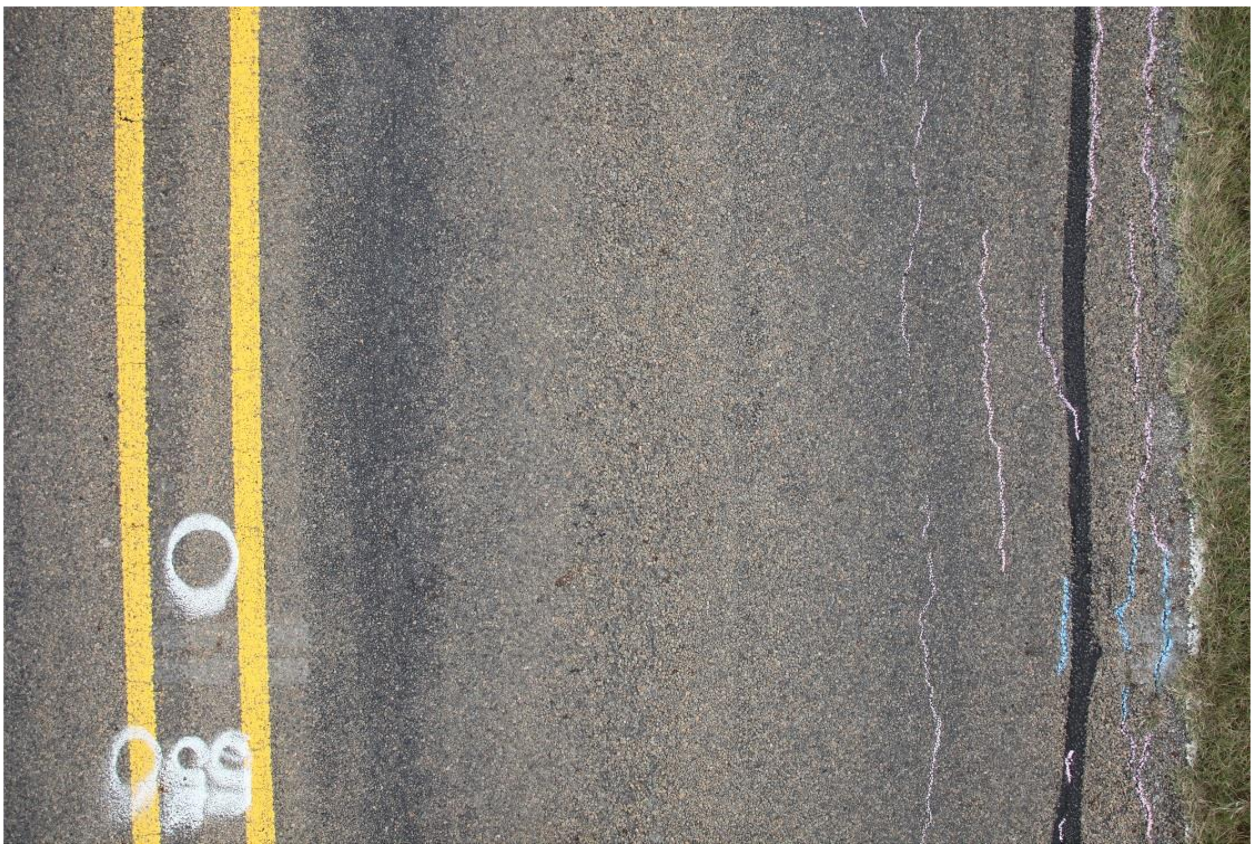


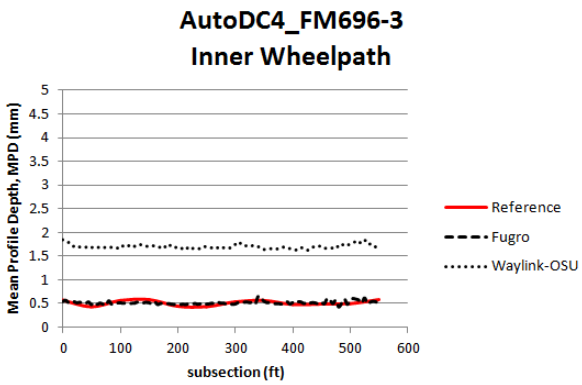

AutoDC2_FM1377-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU

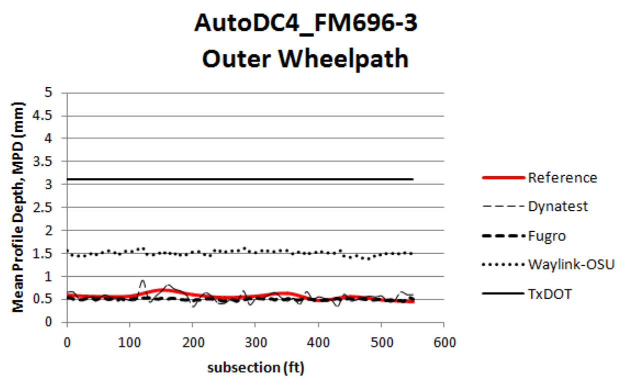

AutoDC2_FM1377-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


AutoDC3_FM696-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU

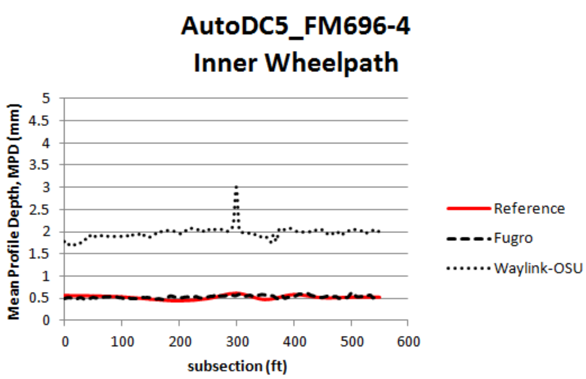

AutoDC3_FM696-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT




AutoDC4_FM696-3
Inner Wheelpath
Mean Profile Depth, MPD (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
subsection (ft)
Reference
Fugro
Waylink-OSU


AutoDC4_FM696-3
Outer Wheelpath
Mean Profile Depth, MPD (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


100
450


AutoDC5_FM696-4
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU

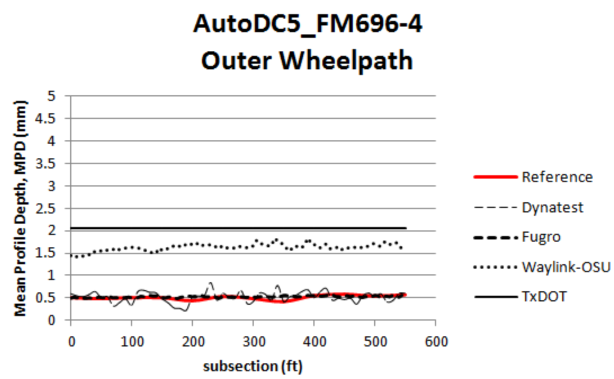
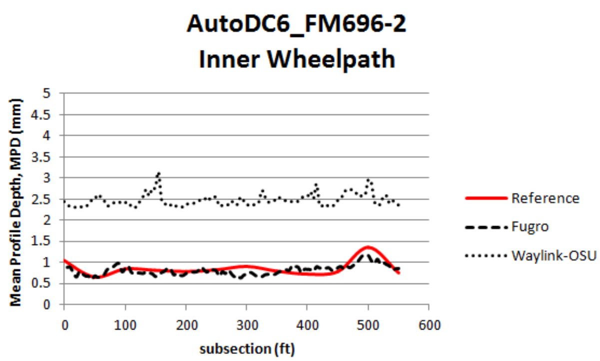

AutoDC5_FM696-4
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


Image Date: May 2011


AutoDC6_FM696-2
Inner Wheelpath
Mean Profile Depth, MPD (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
subsection (ft)
Reference
Fugro
Waylink-OSU

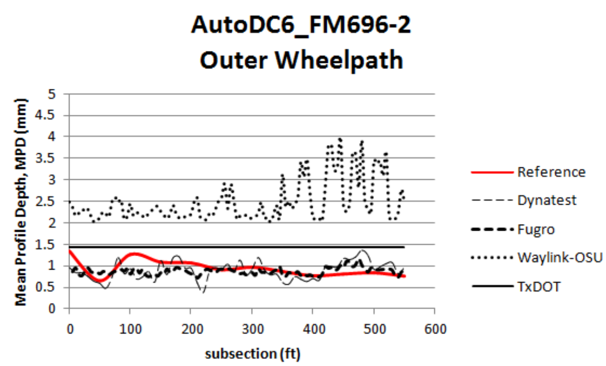
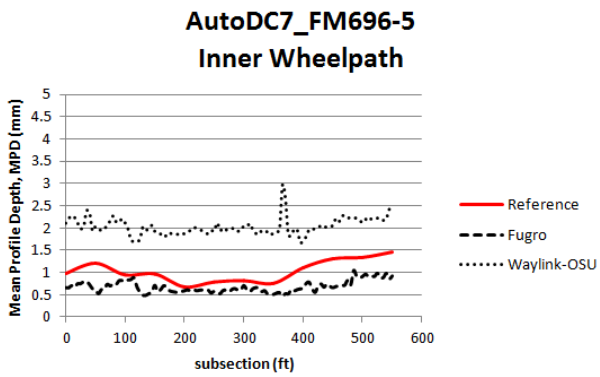
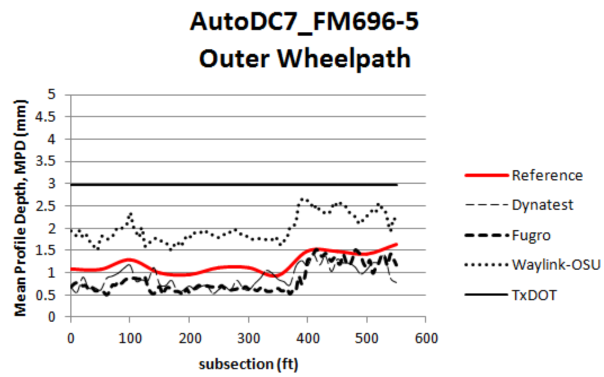
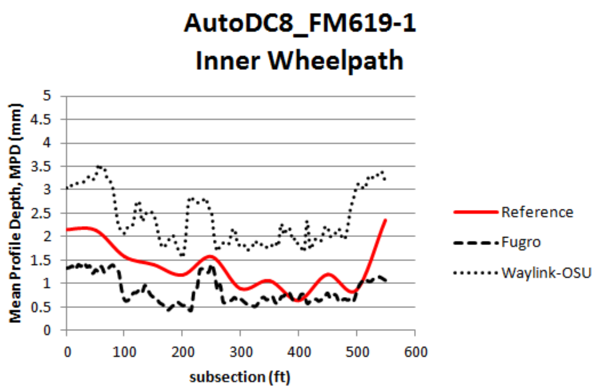

AutoDC6_FM696-2
Outer Wheelpath
Mean Profile Depth, MPD (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


Image Date: May 2011


AutoDC7_FM696-5
Inner Wheelpath
Mean Profile Depth, MPD (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
subsection (ft)
Reference
Fugro
Waylink-OSU


AutoDC7_FM696-5
Outer Wheelpath
Mean Profile Depth, MPD (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


100


AutoDC8_FM619-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU

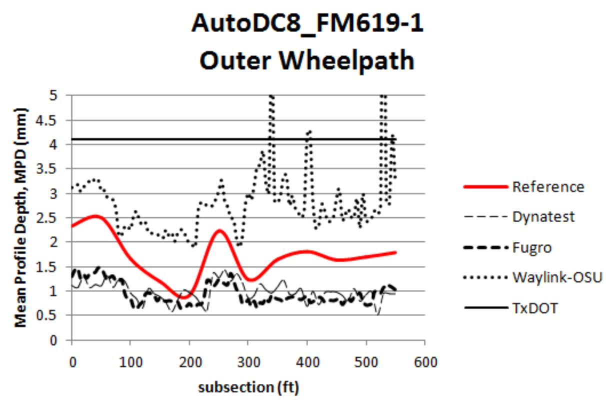
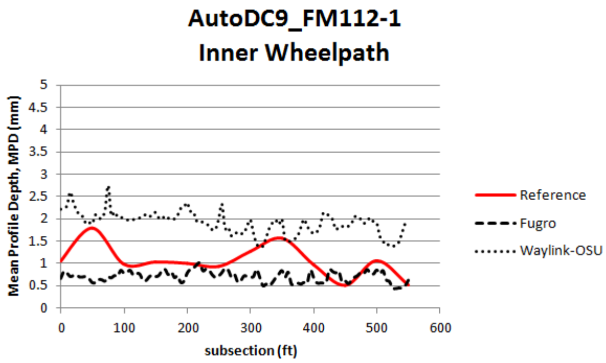
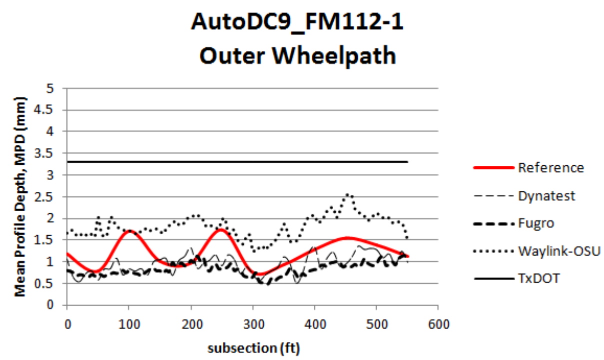

AutoDC8_FM619-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


Image Date: May 2011

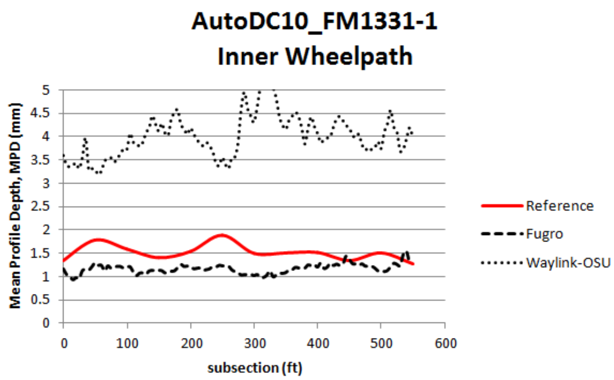


AutoDC9_FM112-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU

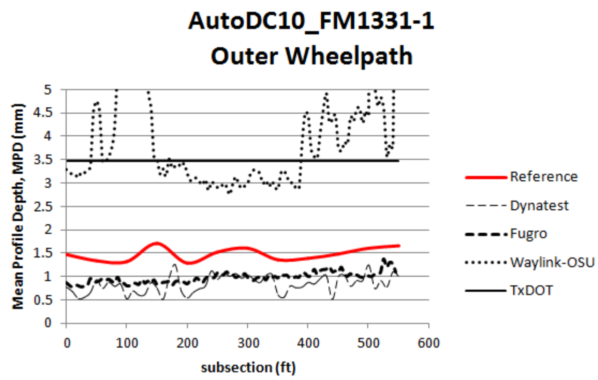


AutoDC9_FM112-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT

Image Date: April 2011

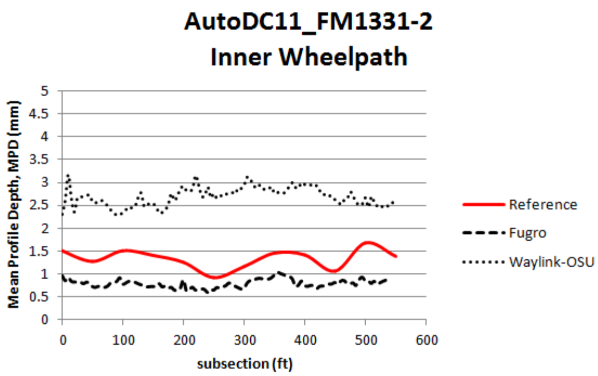


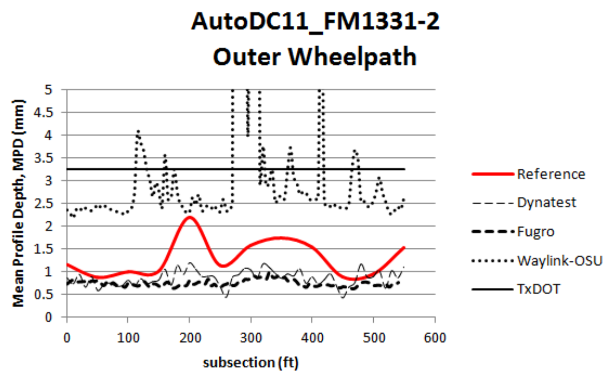
AutoDC10_FM1331-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU



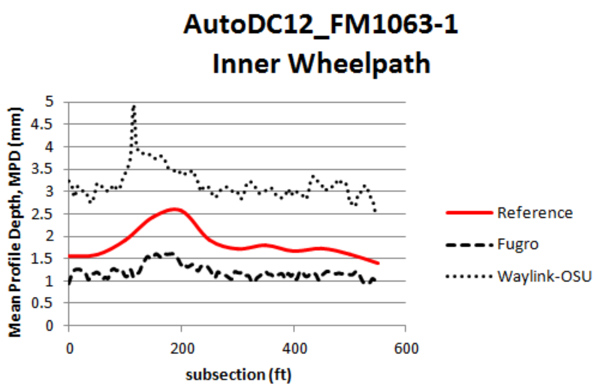
AutoDC10_FM1331-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT

Image Date: May 2011

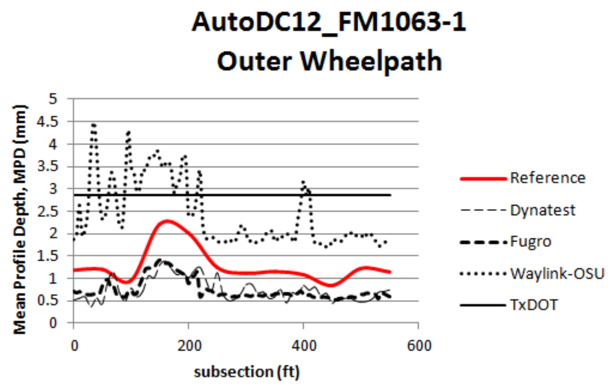

AutoDC11_FM1331-2
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
100
200
300
400
500
600


AutoDC11_FM1331-2
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
100
200
300
400
500
600


200
+
05E

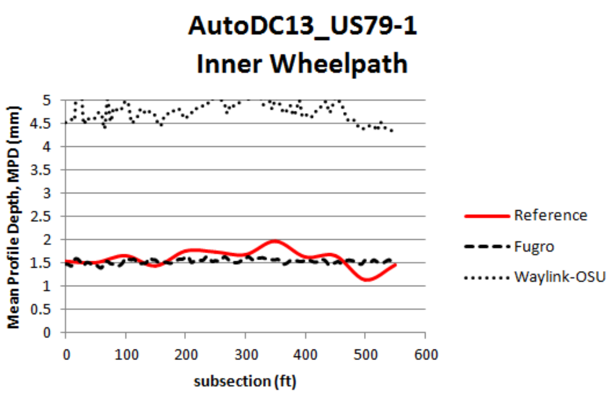


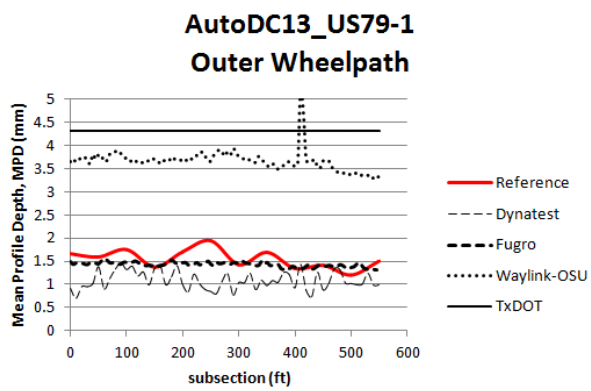
AutoDC12_FM1063-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU



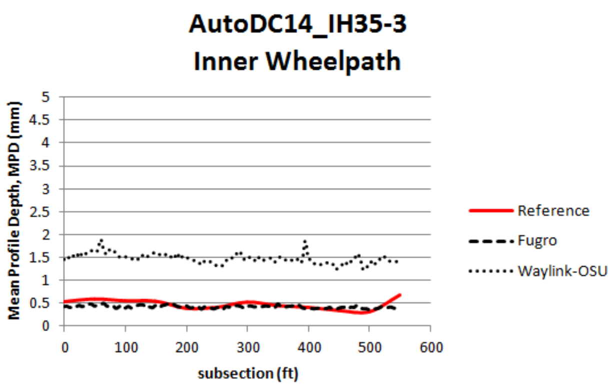
AutoDC12_FM1063-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT

150

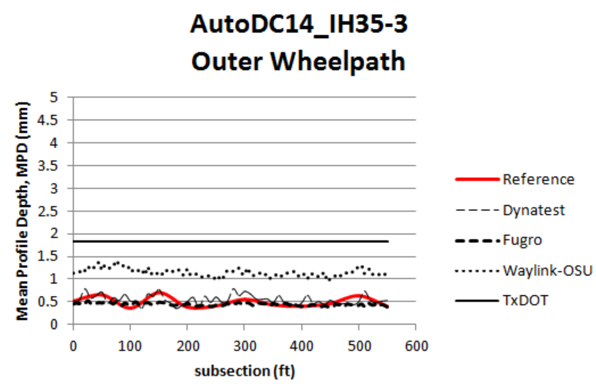

AutoDC13_US79-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU


AutoDC13_US79-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


50

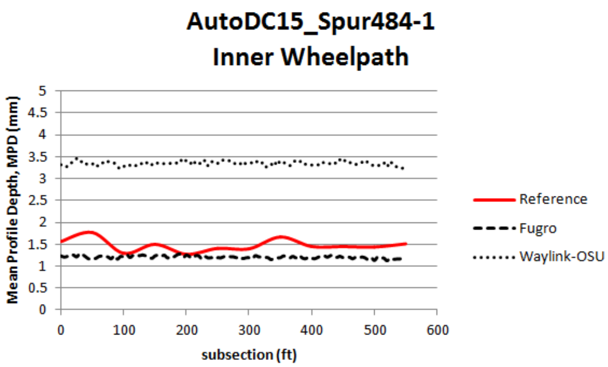


AutoDC14_IH35-3
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU



AutoDC14_IH35-3
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT

Image Date: March 2013


AutoDC15_Spur484-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU

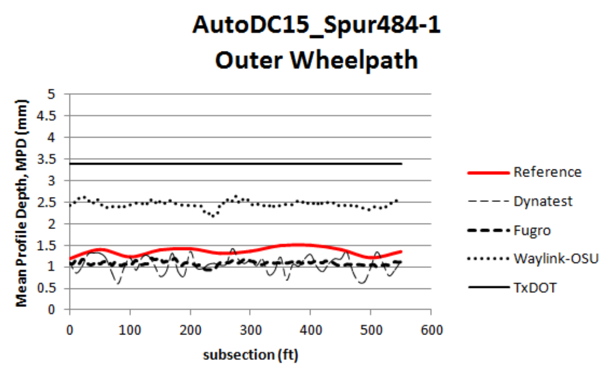
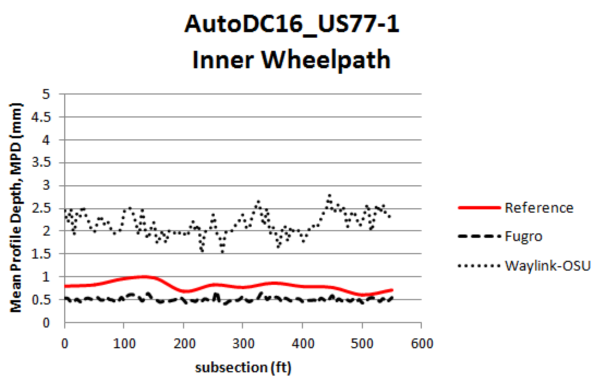
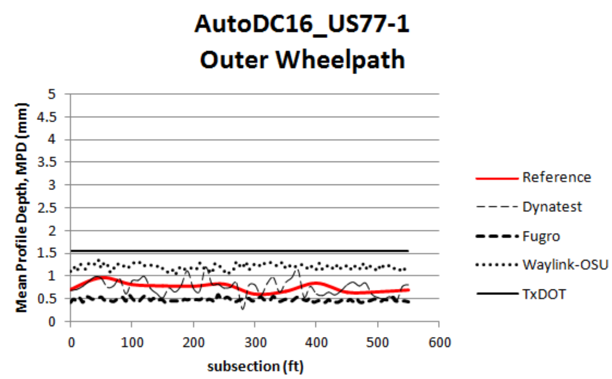

AutoDC15_Spur484-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


Image Date: February 2013

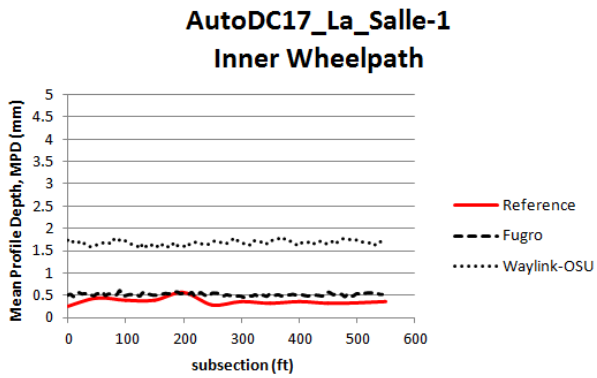


AutoDC16_US77-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
subsection (ft)
Reference
Fugro
Waylink-OSU



AutoDC16_US77-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT

Image Date: December 2012


AutoDC17_La_Salle-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
100
200
300
400
500
600
subsection (ft)
Reference
Fugro
Waylink-OSU

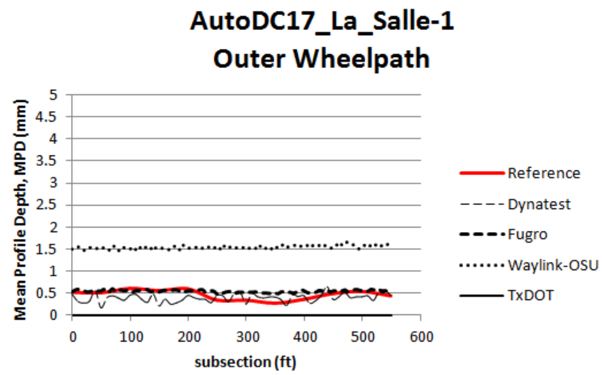
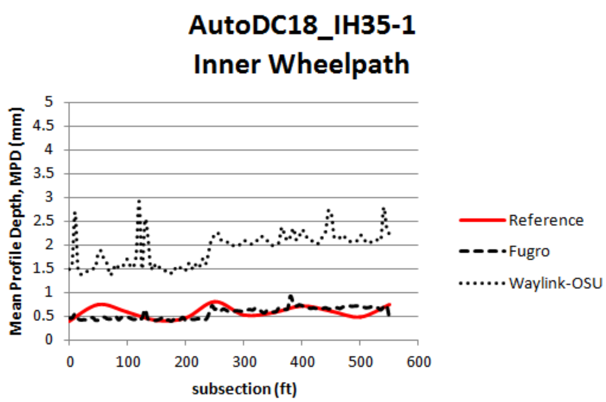

AutoDC17_La_Salle-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


Image Date: November 2012


AutoDC18_IH35-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU

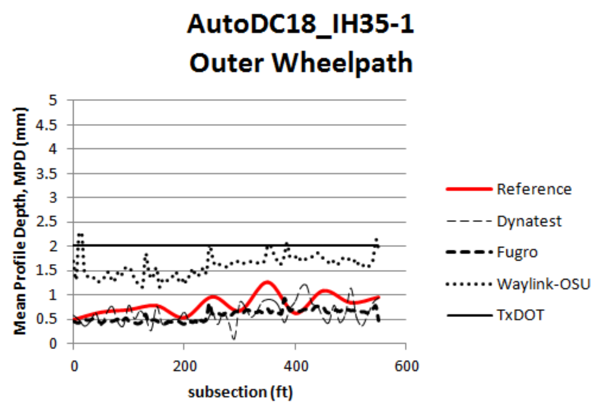
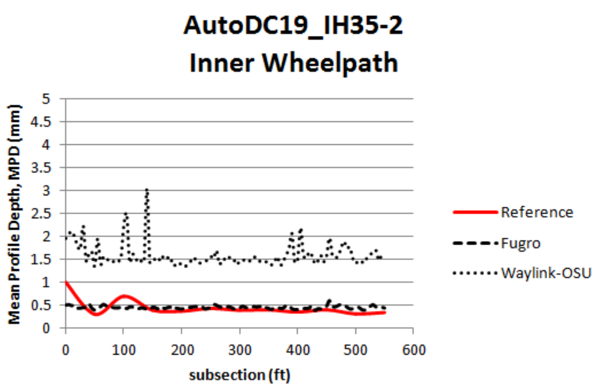
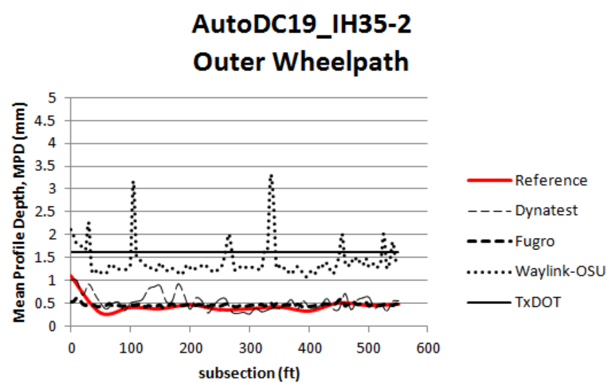
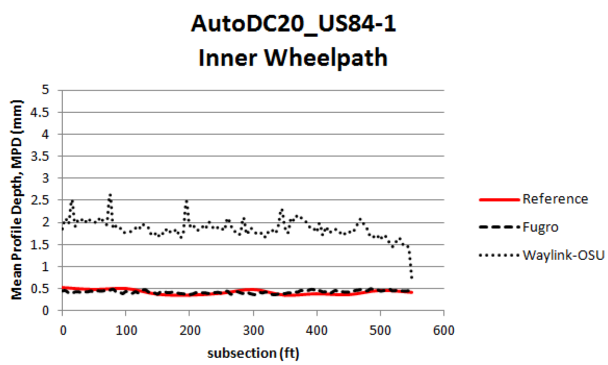

AutoDC18_IH35-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT


Image Date: November 2012

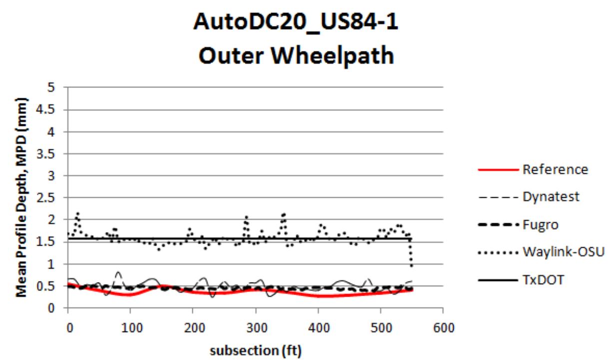

AutoDC19_IH35-2
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
100
200
300
400
500
600


AutoDC19_IH35-2
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
100
200
300
400
500
600


150



AutoDC20_US84-1
Inner Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Fugro
Waylink-OSU
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
100
200
300
400
500
600



AutoDC20_US84-1
Outer Wheelpath
Mean Profile Depth, MPD (mm)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
100
200
300
400
500
600

Appendix E.1 – Cross Slope Error Summary

AutoDC1_FM969-1

subsection	Vender - *Error (percent)*												
	Fugro												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-1.98	-1.45	-1.78	-0.77	-1.48	-2.94	-1.49	-0.56	-16.91	-0.34			
50'	-0.12	-0.74	-0.28	0.38	-0.62	-1.60	-0.23	0.63	-19.85	-2.09			
100'	-0.48	-0.27	-0.14	-0.01	0.35	-0.64	-0.45	0.15	-17.77	-0.26			
150'	0.56	1.27	0.79	1.23	1.02	0.13	0.47	1.56	-21.13	-1.44			
200'	-0.78	0.07	-1.10	0.21	-0.42	-1.17	-0.55	0.07	-10.99	-8.05			
250'	-0.18	0.74	0.29	0.22	0.81	-0.55	-0.55	1.34	0.28	-23.07			
300'	-1.35	0.29	-0.55	-0.12	-0.10	-1.21	-1.06	-0.07	-0.26	-18.05			
350'	-1.48	-0.80	-1.50	-1.01	-0.90	-1.80	-1.97	-0.47	-1.88	-16.28			
400'	-2.42	-1.50	-1.87	-1.73	-2.06	-1.94	-3.04	-0.68	-1.52	-12.74			
450'	-1.64	-1.16	-1.22	-1.55	-1.73	-1.23	-2.35	-0.83	-2.28	-13.15			
500'	-1.46	-2.11	-2.10	-1.94	-1.86	-2.27	-1.87	-2.15	-2.72	-10.42			
550'	-1.38	-1.34	-1.79	-1.43	-1.84	-1.88	-1.77	-1.08	-2.11	-11.31			

subsection	Vender - *Error (percent)*												
	Waylink-OSU												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-1.08	-0.04	-2.20	-0.90	-2.06	-1.69	-1.34	-1.05	-0.72	-1.30			
50'	-0.46	-0.59	-0.25	-0.62	-1.07	-1.29	0.30	-0.91	-0.34	-0.09			
100'	-1.01	0.05	-1.39	0.34	-0.99	-1.22	0.22	-0.70	0.90	0.21			
150'	0.68	-0.54	0.08	1.03	-1.23	-0.76	-0.79	0.81	0.37	1.12			
200'	-1.97	-0.83	0.77	-1.21	-0.47	-2.00	-1.31	-0.19	0.02	0.19			
250'	-2.56	-0.26	0.24	-0.15	-0.73	-1.94	-0.33	-0.47	0.18	-0.08			
300'	-3.23	0.26	-0.04	0.22	-1.38	-2.14	-0.11	-0.66	0.63	-0.52			
350'	-4.50	-0.12	-0.55	-1.41	-1.49	-1.92	-1.13	-0.83	0.14	-1.04			
400'	-3.53	-0.86	-1.34	-0.75	-2.76	-2.36	-1.37	-0.64	-0.48	-0.15			
450'	-4.43	-1.71	-0.12	-1.22	-2.41	-2.68	-1.08	-1.02	-0.91	-0.46			
500'	-3.14	-0.14	-1.80	-1.72	-1.93	-2.58	-1.70	-1.80	-0.19	-0.84			
550'	-4.41	-0.84	-1.31	-0.43	-2.01	-2.17	-1.44	-1.07	-0.09	-0.61			

subsection (ft)	Vendor - *Error after adjusted (percent)*			TxDOT		
	Dynatest	Fugro	Waylink-OSU			
	(percent)	for entire lane width (percent)	(percent) average	using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	3.19	-0.78	-0.76			
50	3.24	-0.79	-0.45			
100	3.15	-0.51	-0.47			
150	3.15	-1.13	-0.02			
200	3.06	-0.84	-0.40			
250	3.04	-1.22	-0.13			
300	3.01	-0.90	0.14			
350	2.96	-1.17	0.23			
400	3.03	-1.00	0.32			
450	3.07	-1.06	-0.03			
500	3.04	-0.66	0.50			
550	3.18	-0.61	0.51			
average	**3.09**	**-0.89**	**-0.89**	**2.25**	**0.85**	**0.80**
std. dev.	0.09	0.23	0.41			

AutoDC2_FM1377-1

subsection	Vender - *Error (percent)*												
	Fugro												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-5.60	27.97	1.62	0.16	-2.06	0.04	-1.52	-4.49	0.07	1.09			
50'	-7.34	16.67	2.38	1.14	-0.10	-0.40	-0.09	-1.20	-0.15	0.01			
100'	-15.66	29.49	1.08	0.30	-0.61	0.26	-1.59	-2.65	-1.29	1.23			
150'	-7.45	18.04	1.43	-1.80	0.71	0.48	-1.77	1.99	3.34	0.26			
200'	-11.64	12.29	1.69	-0.98	-1.06	1.87	-0.65	0.81	2.75	0.84			
250'	-7.99	27.98	0.43	-6.16	-0.67	0.50	-2.33	-1.52	-0.57	-2.53			
300'	-4.60	28.62	-0.75	-7.93	-0.56	-0.09	-3.62	-2.52	-0.39	-1.88			
350'	1.09	28.69	-1.06	-6.79	-1.44	-1.48	-4.66	-0.97	-0.01	-5.73			
400'	-8.54	27.51	0.48	-6.09	-2.33	0.24	-3.15	-2.06	-1.10	-2.39			
450'	-4.09	17.17	-0.87	-0.93	1.25	-1.59	-3.14	-2.60	-1.77	-4.21			
500'	-1.83	21.70	-2.49	0.35	-1.36	-1.71	-3.66	-4.25	-1.82	-6.03			
550'	4.78	18.78	-2.59	0.28	-1.27	-1.61	-3.43	-3.08	-1.90	-9.24			

subsection	Vender - *Error (percent)*												
	Waylink-OSU												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-2.54	-0.08	-0.10	-0.49	-2.99	-1.20	-2.02	-3.67	3.19	4.35			
50'	-0.73	1.23	0.48	-0.60	-1.69	-2.67	-0.29	-1.79	0.02	-0.11			
100'	-1.84	3.19	1.12	-0.81	-2.24	-3.21	-2.41	-0.30	0.14	1.19			
150'	-3.70	0.49	-1.03	-0.28	-1.56	-2.00	-4.80	2.27	3.58	2.48			
200'	-4.39	-1.10	0.27	-2.14	-3.68	-2.25	-1.12	-0.38	3.79	-0.20			
250'	-5.47	-3.28	1.62	-1.52	-1.67	-2.85	-4.95	-0.16	4.56	-2.03			
300'	-4.03	-1.20	1.23	-2.84	-2.23	-4.68	-3.23	0.66	1.50	-2.98			
350'	-7.57	-2.78	-0.99	-2.21	-5.64	-3.07	-5.11	0.01	3.55	-2.41			
400'	-5.77	1.41	-0.60	-1.18	-2.31	-5.16	-2.62	1.50	-1.26	-2.13			
450'	2.66	3.36	-3.39	-1.96	-2.44	-3.38	-2.38	-0.95	-0.56	-4.36			
500'	3.42	4.34	-2.64	-4.01	-3.61	-3.47	-4.79	-0.72	0.16	-6.22			
550'	0.82	3.20	-4.37	-3.08	-3.39	-5.25	-5.03	-0.29	-3.19	-7.91			

subsection (ft)	Vendor - *Error after adjusted (percent)*					
	Dynatest	Fugro	Waylink-OSU	TxDOT		
	(percent)	for entire lane width (percent)	(percent) average	using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-3.63	0.50	0.05			
50	-3.26	0.25	0.60			
100	-3.34	0.53	0.45			
150	-3.26	-0.56	-0.28			
200	-3.43	-0.21	-0.36			
250	-3.37	1.85	0.64			
300	-3.17	2.05	1.50			
350	-3.32	2.64	-0.23			
400	-3.21	2.28	0.05			
450	-3.34	1.78	0.77			
500	-3.21	2.44	1.24			
550	-3.06	2.67	1.86			
average	**1.12**	**1.35**	**0.52**	**-1.58**	**-0.17**	**-0.16**
std. dev.	0.14	1.17	0.72			

AutoDC3_FM696-1

subsection	Vender - *Error (percent)* Fugro												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-5.85	-2.02	-3.01	-5.06	-6.47	-4.76	-5.16	-8.30	-0.21	4.97			
50'	2.40	1.87	2.12	-5.59	-7.07	0.02	-6.45	-10.04	-9.31	-10.14			
100'	-0.55	0.45	0.65	-7.45	-6.77	-0.01	-5.24	-9.80	-9.25	-8.00			
150'	-2.85	-0.31	0.21	-6.76	-5.16	-5.39	-3.90	-8.18	-1.25	1.22			
200'	1.47	-1.41	-1.24	-9.10	-6.49	-8.42	-4.84	-9.57	-10.42	-13.76			
250'	-4.99	-7.93	-6.78	-10.21	-8.90	-8.25	-5.73	-6.49	-11.65	27.44			
300'	-2.11	-0.48	-3.03	-8.68	-7.81	-6.94	-3.65	-6.17	-20.32	-16.10			
350'	-7.15	-5.28	-8.41	-10.67	-13.77	-10.51	-11.39	-12.67	24.78	15.37			
400'	-1.66	-2.02	-2.78	-2.65	-6.79	-5.72	-7.66	-8.59	-1.11	-8.87			
450'	-5.68	-6.36	-5.24	-12.75	-12.16	-7.71	-10.64	-7.70	8.60	4.73			
500'	-7.35	-7.83	-3.34	-6.91	-6.38	-4.91	-6.07	-10.03	6.81	5.70			
550'	-0.58	-0.92	-1.59	-7.50	-7.12	-5.30	-4.32	-7.62	-15.70	-5.37			

subsection	Vender - *Error (percent)* Waylink-OSU												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-4.42	-2.39	-3.48	-5.06	-4.25	-4.16	-2.90	-0.54	-1.67	-5.71			
50'	-2.99	-1.66	-2.17	-6.22	-5.93	-5.62	-5.76	-1.21	1.44	-11.16			
100'	-6.38	-0.93	-2.47	-7.67	-2.82	-7.18	-7.65	3.00	2.82	-13.06			
150'	-6.51	0.29	-0.96	-5.68	-4.73	-2.96	-0.11	1.12	-0.45	-9.16			
200'	1.07	-3.99	-1.64	-5.18	-3.84	-10.04	-5.53	-2.09	-2.37	-6.01			
250'	-4.66	-2.24	-1.05	-4.31	-5.06	-6.83	-3.40	-2.59	0.53	-4.80			
300'	-4.07	-0.61	-2.65	-5.93	-4.68	-10.56	-9.14	-4.99	-1.21	-5.76			
350'	-0.99	2.96	-2.34	-4.70	-5.90	-8.19	-4.46	-4.95	-0.72	-2.89			
400'	-2.04	-1.79	-3.50	-3.57	-5.24	-7.31	-7.76	-5.76	-2.13	-7.25			
450'	-4.65	-2.68	-4.26	-6.29	-8.29	-6.97	-13.64	-2.87	0.34	-2.24			
500'	-7.66	-2.24	-0.82	-2.42	-4.95	-3.81	-5.02	-1.12	0.32	-4.31			
550'	-0.84	-0.48	-0.73	-4.93	-7.14	-9.15	-10.35	-2.02	-2.20	-3.20			

subsection (ft)	Vendor - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	TxDOT using 2 point algorithm (percent)	TxDOT using line fitting algorithm (percent)
0	3.04	-4.98	-1.38			
50	2.93	-1.66	-3.31			
100	3.10	-1.95	-2.53			
150	3.42	-3.02	-0.66			
200	3.11	-3.46	-2.30			
250	4.06	-7.09	-2.25			
300	2.75	-3.89	-3.19			
350	4.73	-8.89	-1.71			
400	3.60	-3.66	-1.83			
450	4.10	-7.15	-4.49			
500	3.95	-5.63	-1.36			
550	2.46	-2.81	-2.57			
average	**3.44**	**-4.52**	**-2.30**	**1.24**	**0.34**	**0.64**
std. dev.	0.66	2.26	1.03			

AutoDC4_FM696-3

subsection	Vender - *Error (percent)* Fugro 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-1.80	-1.82	-2.83	-2.73	-3.71	-3.78	-3.06	-1.67	-2.57	-12.96			
50'	-3.19	-3.78	-3.03	-2.62	-3.88	-4.02	-4.99	-3.65	-4.97	-1.15			
100'	-1.19	-1.76	-1.00	-0.60	-1.20	-0.69	-0.63	1.77	-1.73	-18.46			
150'	-2.07	-2.62	-2.04	-1.50	-2.45	-1.96	-3.44	-3.98	-3.93	-7.78			
200'	-0.81	-1.08	-1.70	-0.64	-1.81	-1.79	-1.27	-0.94	-1.58	-15.07			
250'	-2.30	-2.57	-2.67	-1.59	-1.73	-1.84	-2.79	-1.79	-2.19	-13.97			
300'	-3.95	-3.82	-2.84	-2.42	-2.84	-3.67	-4.74	-4.65	-4.64	-3.90			
350'	-1.53	-2.91	-2.03	-1.77	-2.11	-3.31	-3.78	-2.17	-4.01	-6.86			
400'	-0.21	-0.77	-1.13	-0.95	-1.50	-2.21	-1.11	-1.57	-1.92	-12.27			
450'	0.48	0.17	1.04	1.29	0.08	0.29	1.07	1.33	-22.26	-2.01			
500'	0.64	0.61	0.74	0.83	0.40	1.38	1.94	2.92	-21.33	-0.89			
550'	0.96	1.23	1.56	1.31	0.56	1.14	2.33	2.49	-18.86	-0.76			

subsection	Vender - *Error (percent)* Waylink-OSU 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-3.49	-1.03	-2.32	-3.29	-3.93	-3.77	-2.09	-2.19	-1.91	-2.68			
50'	-2.58	-1.41	-1.62	-1.16	-1.51	-1.35	-1.78	-2.40	-1.89	-2.85			
100'	-2.71	-1.03	-2.07	-1.84	-1.20	-1.92	-1.27	-0.25	-1.28	-0.98			
150'	-2.98	-2.36	-2.19	-0.63	-2.47	-1.14	-1.91	-2.01	-1.85	-3.52			
200'	-1.03	-1.95	-1.10	-1.60	-1.40	-1.88	-1.14	-1.61	-0.87	-1.43			
250'	-2.79	-2.37	-2.57	-1.79	-2.37	-2.53	-0.81	-1.73	-1.62	-3.75			
300'	-3.41	-2.82	-2.02	-2.05	-2.10	-2.06	-1.31	-2.75	-3.43	-4.62			
350'	-2.09	-1.80	-2.26	-1.31	-1.67	-2.47	-0.72	-1.45	-1.71	-2.89			
400'	-0.64	-0.81	0.02	-1.31	-1.82	-1.28	-0.99	-0.28	-1.11	-2.08			
450'	-1.19	0.12	0.24	-0.46	0.80	-1.22	-0.46	-0.67	-0.47	0.30			
500'	-0.42	-1.01	-0.26	-1.27	-0.41	-0.98	0.32	-0.08	0.56	0.53			
550'	-0.14	0.40	-0.87	0.06	-0.52	0.19	-0.27	0.40	1.62	0.32			

subsection (ft)	Vendor - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	3.27	-1.95	-2.63			
50	3.54	0.32	-1.87			
100	3.50	-1.55	-1.55			
150	3.06	-0.74	-2.20			
200	3.28	-1.08	-1.59			
250	3.14	-1.42	-2.46			
300	3.25	-0.88	-2.85			
350	3.30	-0.55	-1.88			
400	3.23	-0.58	-1.18			
450	3.29	-0.52	-0.48			
500	3.20	-1.06	-0.45			
550	3.49	-0.38	0.10			
average	**3.29**	**-1.23**	**-1.59**	**1.03**	**-0.37**	**-0.43**
std. dev.	0.15	0.60	0.93			

AutoDC5_FM696-4

	Vender - *Error (percent)*												
	Fugro												
subsection	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-5.44	-5.46	-5.19	-5.15	-6.17	-7.63	-6.57	-6.51	-7.90	7.89			
50'	-3.86	-4.14	-4.55	-4.64	-4.48	-6.67	-6.21	-5.84	-7.15	-0.62			
100'	-4.27	-4.65	-4.04	-3.76	-4.55	-5.84	-4.79	-5.01	-6.27	-0.86			
150'	-5.20	-5.91	-5.60	-5.03	-6.20	-7.71	-6.42	-6.51	-8.87	4.22			
200'	-4.82	-5.15	-5.22	-4.36	-5.74	-7.39	-6.14	-5.95	-9.60	5.42			
250'	-4.93	-5.06	-5.42	-4.75	-5.38	-6.45	-5.33	-4.95	-7.02	-7.05			
300'	-5.85	-5.89	-6.03	-5.70	-6.12	-7.26	-6.77	-4.20	-8.43	9.03			
350'	-4.91	-4.02	-4.98	-3.95	-4.92	-6.41	-6.15	-3.72	-7.89	5.54			
400'	-2.23	-2.60	-2.44	-3.62	-4.68	-6.08	-6.38	-1.84	-8.23	-5.70			
450'	-4.72	-5.34	-5.12	-4.38	-5.64	-7.00	-6.83	-2.60	-9.01	1.65			
500'	-3.94	-4.46	-5.08	-3.59	-4.58	-5.07	-4.44	-3.20	-5.94	2.50			
550'	-3.78	-3.13	-2.41	-0.42	-1.34	-1.45	-1.31	-1.36	-3.33	-7.27			

	Vender - *Error (percent)*												
	Waylink-OSU												
subsection	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-3.59	-3.18	-2.86	-3.16	-3.73	-3.88	-3.66	-3.73	-3.56	-3.93			
50'	-3.57	-2.56	-2.58	-2.43	-2.38	-4.38	-3.65	-3.13	-3.55	-2.81			
100'	-4.21	-3.78	-3.07	-2.35	-3.31	-4.48	-3.42	-3.57	-3.01	-3.57			
150'	-5.42	-4.54	-3.38	-2.97	-4.83	-5.22	-4.44	-3.80	-4.68	-3.44			
200'	-3.15	-4.01	-3.39	-2.71	-2.96	-3.30	-2.68	-3.46	-4.66	-3.44			
250'	-3.99	-4.50	-3.14	-4.99	-4.81	-5.24	-3.77	-3.61	-3.50	-3.41			
300'	-3.59	-3.40	-3.96	-4.22	-3.48	-4.45	-4.37	-2.05	-3.27	-3.15			
350'	-4.07	-3.96	-3.27	-3.32	-3.93	-3.25	-3.84	-2.77	-2.92	-2.73			
400'	-2.82	-2.75	-0.90	-2.37	-2.60	-3.97	-3.17	-3.64	-3.59	-0.55			
450'	-4.66	-1.93	-3.13	-3.55	-3.73	-4.39	-3.94	-3.51	-5.02	-0.31			
500'	-3.39	-2.51	-3.70	-1.56	-4.53	-3.50	-2.74	-2.24	-1.61	-0.17			
550'	-3.67	-2.89	-3.05	-2.20	-2.65	-2.46	-1.15	-1.66	-1.28	-0.73			

	Vendor - *Error after adjusted (percent)*			TxDOT		
	Dynatest	Fugro	Waylink-OSU			
subsection (ft)	(percent)	for entire lane width (percent)	(percent) average	using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	0.28	-0.69	-3.41			
50	-0.06	-0.77	-2.96			
100	-0.08	-1.18	-3.33			
150	-0.15	-1.20	-4.15			
200	0.21	-0.39	-3.18			
250	0.19	-1.68	-3.89			
300	0.41	-0.06	-3.30			
350	0.44	-0.41	-3.24			
400	0.27	-1.22	-2.43			
450	0.09	-0.99	-3.18			
500	0.48	0.11	-2.44			
550	0.57	-0.98	-1.88			
average	**0.22**	**-2.93**	**-3.12**	**0.84**	**-0.41**	**-0.45**
std. dev.	0.23	0.52	0.63			

AutoDC6_FM696-2

subsection	Vender - *Error (percent)* Fugro 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-1.60	-1.34	-1.83	-3.77	-6.40	-4.31	-2.70	-1.74	-15.18	0.13			
50'	-0.59	-1.43	-2.86	-6.24	-7.39	-7.03	-5.62	-4.79	-4.30	0.52			
100'	-1.21	-1.62	-2.13	-7.52	-5.93	-4.24	-3.92	-2.54	-14.94	0.51			
150'	-1.95	-3.71	-3.72	-7.37	-10.67	-6.24	-5.55	-6.63	-13.44	3.43			
200'	-6.74	-5.16	-6.18	-10.97	-14.38	-9.11	-6.09	-14.78	19.72	9.77			
250'	-0.79	-3.76	-1.04	-4.31	-7.24	-3.11	-7.21	-9.18	-1.31	-3.27			
300'	-0.38	-2.47	-2.97	-5.46	-5.28	-1.03	-6.01	-9.09	-16.72	3.44			
350'	-0.78	-2.61	-1.21	-2.46	-5.72	-5.08	-4.22	-7.33	-10.89	5.38			
400'	-3.41	-5.10	-3.88	-4.31	-4.39	-0.53	-1.91	-5.48	-3.67	0.58			
450'	-0.27	2.19	1.78	0.28	2.70	-0.08	-1.83	-5.36	-27.16	7.56			
500'	-0.71	0.58	2.70	-3.78	-0.39	-2.38	-3.99	-17.08	4.66	-2.70			
550'	2.99	2.56	4.22	0.09	0.40	0.78	-1.01	-8.35	-34.45	11.01			

subsection	Vender - *Error (percent)* Waylink-OSU 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-2.90	-2.29	-2.00	-5.33	-5.85	-4.24	-4.76	-0.73	0.31	-0.50			
50'	-0.44	-0.57	-1.02	-3.56	-6.37	-2.39	-4.81	-2.11	-0.08	0.23			
100'	-3.46	0.92	-0.67	-3.08	-4.95	-1.90	-5.06	-3.53	-0.25	-1.70			
150'	-0.96	-0.07	0.01	-3.89	-5.10	-5.82	-8.41	-4.73	0.03	-0.29			
200'	-0.05	-1.07	-1.05	-4.26	-3.49	-6.44	-8.44	-7.26	-0.37	1.74			
250'	-2.17	-1.59	0.07	0.48	-4.28	-2.58	-3.14	-3.67	-1.51	-0.19			
300'	-2.75	-2.80	-1.58	-0.93	-3.02	-3.01	-5.13	-5.26	3.26	-3.00			
350'	-0.97	-1.08	1.13	1.25	-3.94	-4.92	-6.29	-2.86	0.73	2.31			
400'	-0.86	-1.94	-2.25	-3.30	-3.67	-4.88	-2.35	0.77	1.30	2.49			
450'	-0.52	-2.25	0.40	-1.49	-3.78	-3.07	-3.06	1.06	1.36	-3.68			
500'	-3.36	-3.01	0.53	-3.91	-3.08	-1.71	-0.13	1.90	0.36	-3.02			
550'	-2.37	1.18	2.94	-1.53	-3.22	-1.40	-3.01	-0.48	2.13	-1.30			

subsection (ft)	Vender - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	TxDOT using 2 point algorithm (percent)	TxDOT using line fitting algorithm (percent)
0	-0.06	-2.44	-3.80			
50	0.16	-3.81	-2.14			
100	0.03	-3.45	-0.99			
150	0.41	-3.80	-2.37			
200	0.35	-7.48	-2.18			
250	0.31	-3.77	-2.15			
300	-0.43	-2.70	-1.68			
350	0.57	-2.54	-1.25			
400	0.17	-3.06	-1.31			
450	0.39	1.00	-1.01			
500	0.23	-1.30	-1.59			
550	-0.03	2.09	-0.30			
average	**0.17**	**-2.60**	**-1.73**	**0.43**	**-0.92**	**-0.67**
std. dev.	0.27	2.44	0.89			

AutoDC7_FM696-5

subsection	Vender - *Error (percent)* Fugro 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-1.14	-1.29	-0.52	1.30	0.31	0.73	0.82	0.09	-1.31	-19.06	-2.34		
50'	0.13	-2.31	2.55	-1.04	-4.59	-1.95	-1.79	-2.23	-19.90	-6.88	15.67		
100'	-1.82	-1.67	-2.26	-0.40	-1.14	1.92	1.16	0.30	-24.14	-5.32	5.20		
150'	-2.57	-3.65	-3.05	-2.19	-3.04	-2.62	-2.81	-2.85	-3.72	0.75	-1.48		
200'	-1.67	-0.24	0.07	-0.62	-0.69	-1.39	-0.69	-1.34	-1.75	-14.34	1.32		
250'	-2.21	-1.00	-0.64	-0.76	0.61	-0.34	2.23	-0.92	2.02	-18.88	-3.35		
300'	-1.31	-2.73	-0.27	-0.03	-1.66	0.39	0.40	-1.56	-0.37	-15.15	0.39		
350'	0.77	0.13	-0.17	0.52	-0.21	0.66	0.87	-0.60	0.06	-13.42	-0.97		
400'	-0.06	-1.26	-0.12	-1.23	-1.87	-2.10	-0.94	-1.89	-0.87	-14.68	0.00		
450'	-0.76	-2.25	-0.35	-1.67	-2.18	-2.04	-0.24	0.63	-0.04	-11.66	3.09		
500'	0.43	-0.56	-0.57	-0.42	-0.82	-0.03	-0.25	-0.77	0.07	-23.15	3.48		
550'	1.19	0.25	-1.12	0.80	0.36	-0.99	1.19	-0.92	-0.32	-20.67	2.30		

subsection	Vender - *Error (percent)* Waylink-OSU 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-2.48	-1.56	-1.05	-0.64	-1.53	-0.51	-0.77	-0.31	-0.27	-0.71	0.05		
50'	-2.56	0.81	1.58	0.93	-4.23	-0.91	-4.82	-2.29	0.22	0.22	4.92		
100'	-6.62	-0.59	-2.65	-3.46	-1.36	-2.17	-3.14	-1.67	0.54	-0.67	-0.10		
150'	0.87	-1.86	-0.32	-0.80	-0.98	-2.15	-2.03	-1.30	-0.86	-2.39	-1.52		
200'	-1.80	1.39	0.16	-1.09	-1.22	-1.16	-0.11	-0.90	-0.88	-1.63	0.52		
250'	-2.66	-0.34	-0.47	-1.17	-0.95	-1.41	-1.34	-0.67	1.41	0.38	0.57		
300'	-0.52	-2.75	-1.47	0.29	-2.38	-0.71	0.32	-1.59	-0.79	-3.39	-0.42		
350'	3.46	1.08	-0.63	0.22	0.73	-0.38	0.49	-0.87	0.63	-1.86	-0.20		
400'	1.09	0.19	-1.75	-1.55	-1.81	-3.32	-1.05	-2.17	-2.60	-2.35	-0.62		
450'	0.83	-0.93	-1.57	-3.99	0.98	-4.13	-1.00	-0.85	1.39	-2.81	-0.99		
500'	0.92	0.28	-0.57	0.27	-2.44	-1.03	-1.03	1.14	-1.59	-1.07	0.31		
550'	0.33	2.22	-0.13	0.05	0.94	-0.26	-0.40	0.13	-0.10	-1.50	-0.56		

subsection (ft)	Vendor - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.05	-0.13	-0.73			
50	0.29	-1.12	-1.03			
100	0.21	-0.91	-2.38			
150	0.36	-2.79	-1.38			
200	0.06	-0.74	-0.65			
250	-0.07	-0.42	-0.45			
300	-0.08	-0.88	-1.12			
350	0.24	0.37	0.18			
400	0.13	-0.97	-1.54			
450	0.39	-0.85	-1.58			
500	0.25	-0.20	-0.52			
550	0.07	0.56	0.33			
average	**0.15**	**-0.67**	**-0.91**	**1.85**	**0.60**	**0.72**
std. dev.	0.17	0.86	0.77			

AutoDC8_FM619-1

subsection	Vender - *Error (percent)*												
	Fugro												
subsection	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-15.50	-15.23	-17.39	-16.61	-19.37	-17.92	-19.54	-20.25	-19.92				
50'	-14.55	-15.59	-14.28	-17.11	-16.93	-18.64	-21.27	-24.67	29.26				
100'	-16.11	-17.54	-17.65	-17.91	-17.38	-20.66	-22.00	-19.55	27.77				
150'	-16.35	-20.39	-19.15	-15.54	-19.19	-15.28	-17.72	-25.11	-14.18	62.08			
200'	-13.54	-11.96	-13.17	-14.90	-13.65	-12.85	-15.11	-18.74	-4.61				
250'	-15.14	-15.29	-17.29	-16.78	-16.72	-22.18	-23.68	-16.25					
300'	-12.92	-13.55	-11.93	-13.99	-14.14	-13.67	-19.40	-23.34	33.99				
350'	-11.52	-13.98	-14.18	-12.25	-13.57	-17.67	-17.54	-23.46	41.14				
400'	-7.70	-8.00	-10.35	-11.17	-9.13	-7.40	-10.15	-13.60	22.57	3.11			
450'	-5.83	-6.07	-6.61	-11.72	-4.23	-8.28	-12.07	3.00	-1.45				
500'	-2.88	-4.04	-3.88	-4.69	-5.23	-4.43	-12.63	16.18	-20.88				
550'	-0.63	-2.48	-2.55	-3.32	-3.97	-4.94	-12.16	8.96					

subsection	Vender - *Error (percent)*												
	Waylink-OSU												
subsection	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-9.14	-9.80	-6.89	-9.08	-10.65	-10.51	-10.02	-7.15	-10.83				
50'	-8.48	-9.58	-7.34	-8.89	-11.30	-8.94	-11.08	-8.12	-12.42				
100'	-10.44	-11.40	-8.43	-10.33	-11.71	-10.27	-6.87	-12.61	-7.96				
150'	-10.49	-9.96	-8.81	-9.61	-11.73	-8.67	-12.13	-4.37	-7.71	-11.06			
200'	-8.65	-5.39	-5.13	-7.15	-8.73	-9.94	-5.10	-4.41	-6.20				
250'	-6.80	-8.74	-9.46	-9.26	-9.78	-10.13	-10.32	-8.41					
300'	-7.77	-4.05	-7.45	-7.85	-7.79	-5.03	-11.75	-2.43	-9.56				
350'	-3.35	-2.21	-5.00	-7.26	-9.01	-10.80	-3.74	0.40	-7.65				
400'	-2.79	-2.61	-3.23	-5.46	-5.89	-7.44	-5.11	0.21	-1.49	-11.13			
450'	-4.22	-2.26	-3.78	-2.77	-4.91	-9.39	-0.93	0.74	-5.66				
500'	-0.63	-0.61	-1.19	-2.12	-2.61	-2.70	-1.42	-0.08	-5.29				
550'	-2.99	0.84	-1.39	-4.56	-4.68	-2.64	-0.21	3.27					

subsection (ft)	Vendor - *Error after adjusted (percent)*			TxDOT		
	Dynatest	Fugro	Waylink-OSU			
	(percent)	for entire lane width (percent)	(percent) average	using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.14	-1.10	-8.77			
50	0.45	-1.17	-9.22			
100	0.52	-1.88	-9.19			
150	0.15	0.28	-8.69			
200	0.84	-1.11	-6.99			
250	1.06	-0.71	-7.80			
300	0.75	-0.95	-6.39			
350	0.63	0.77	-4.66			
400	0.06	-0.34	-4.14			
450	0.57	-1.22	-3.89			
500	-0.07	-1.36	-1.11			
550	0.58	-1.03	-0.13			
average	**0.45**	**-6.67**	**-5.91**	**-7.60**	**-5.87**	**-5.93**
std. dev.	0.37	0.73	3.13			

AutoDC9_FM112-1

subsection	Vender - *Error (percent)* Fugro												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-6.73	-4.95	-7.18	-2.48	-2.08	-4.72	-3.11	-0.40	-8.02	3.87	-1.44		
50'	-3.48	-4.10	-1.58	-2.51	-5.36	-2.27	-3.95	-6.20	-4.77	3.97	2.55	-4.53	
100'	-3.12	-0.51	-1.47	0.25	0.65	0.57	0.42	-2.10	-20.62	-7.95	-3.52	-7.71	
150'	-3.75	-2.73	-0.96	-2.28	-2.34	-2.56	-3.45	-4.18	-14.52	-4.65	-1.94		
200'	-3.33	-4.57	-1.43	-3.31	-1.97	-1.18	-1.46	-1.06	-21.04	1.90	-2.76		
250'	-1.60	2.04	-1.72	-0.29	0.59	-2.44	0.13	-3.99	-16.52	1.12	-3.18	6.82	
300'	1.22	-0.21	-0.36	0.98	-0.23	-1.81	-1.95	-5.37	-10.45	-5.66	-2.19	-4.76	
350'	-0.31	-2.12	0.40	-0.65	-1.91	-1.03	-2.08	-2.74	-12.50	-3.77	-1.61	-3.38	
400'	1.03	-1.85	-1.18	-1.03	0.45	-3.82	-3.21	-3.50	-15.91	-8.11	2.18	-5.84	
450'	-1.78	-1.87	0.26	0.70	-2.77	-1.92	-1.62	-4.69	-10.33	-4.69	-3.52	-8.63	
500'	0.37	1.98	0.98	-0.59	0.76	0.45	-1.80	-2.53	-17.72	-10.33	-1.90		
550'	-3.66	-3.44	-0.80	-2.98	-1.63	-0.32	-0.67	-2.00	-10.67	4.33	-3.66		

subsection	Vender - *Error (percent)* Waylink-OSU												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-6.71	-4.20	-3.55	-2.24	-3.67	-3.70	2.51	0.14	0.78	-0.94	-1.21		
50'	-4.89	-2.74	-2.62	-3.04	-4.24	-2.00	-0.47	-0.74	-0.37	-2.11	-0.47	-3.55	
100'	-3.25	-2.78	-0.83	-3.44	-2.12	-4.21	1.78	-1.42	-0.48	-2.16	-2.91	-9.89	
150'	-6.54	-1.54	-0.27	-2.78	-2.99	-6.57	0.28	-3.20	0.82	-3.17	-1.84		
200'	-2.71	-4.80	-1.68	-1.80	-6.00	-7.50	0.61	1.14	-0.68	-3.55	-8.88		
250'	-0.87	-1.04	0.46	-1.19	-2.61	-5.71	-0.95	1.40	1.51	-0.59	-1.22	6.72	
300'	-2.80	0.53	-0.11	0.10	-1.32	-0.97	-3.09	-2.20	-1.84	-2.30	-5.81	-6.94	
350'	0.81	-0.36	2.11	-2.58	-2.43	-1.37	-0.69	2.16	-0.56	-2.88	-3.94	-4.03	
400'	-0.64	2.97	4.79	1.93	0.40	-5.47	-4.09	-1.25	-4.67	-3.52	-4.81	-7.59	
450'	-5.31	-0.68	-2.50	-1.19	-0.45	-3.12	0.37	-0.65	-0.92	-2.85	-3.26	-8.20	
500'	-0.11	-0.56	0.56	-0.50	0.16	-3.13	-1.25	1.42	-0.05	-2.66	-1.73		
550'	-1.03	-2.83	-1.66	-3.72	-2.27	-2.11	-0.31	-0.40	0.28	-0.75	-0.36		

subsection (ft)	Vendor - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	TxDOT using 2 point algorithm (percent)	TxDOT using line fitting algorithm (percent)
0	0.29	-3.78	-1.71			
50	-0.69	-3.93	-0.53			
100	-0.39	-1.14	-1.77			
150	-0.01	-2.92	-1.94			
200	-0.07	-2.21	-3.75			
250	0.95	-0.03	0.15			
300	-0.55	-1.36	-2.10			
350	-0.20	-1.28	-0.99			
400	-0.33	-1.93	-1.79			
450	-0.64	-2.45	-1.94			
500	-0.30	-0.45	-0.14			
550	-0.04	-2.20	-1.19			
average	**-0.16**	**-1.97**	**-1.47**	**1.10**	**-0.30**	**-0.58**
std. dev.	0.45	1.20	1.04			

AutoDC10_FM1331-1

subsection	Vender - *Error (percent)* Fugro 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-7.43	25.85	-1.21	0.10	0.75	-1.18	-0.26	-2.86	-2.36	-4.64	-12.63		
50'	-10.21	10.74	1.65	1.43	0.83	-1.30	-0.39	-2.02	-2.52	-2.33	-6.80		
100'	-6.12	14.29	5.27	1.69	-0.34	-1.37	-2.45	-3.95	-4.10	-5.64	-5.18		
150'	-0.35	16.62	3.47	2.18	2.33	-3.60	-2.48	-4.70	-7.29	-5.45	-5.10		
200'	1.58	27.22	2.33	2.22	-2.24	-3.33	-11.05	-5.00	-5.61	-5.15	-8.11		
250'	16.74	28.50	0.76	-0.93	-3.43	-9.06	-4.93	-7.09	-8.00	-6.83	-4.19		
300'	12.70	0.53	6.03	3.06	0.74	0.30	-6.45	-1.87	-4.24	-5.56	-5.57		
350'	13.58	34.61	1.06	3.42	-1.18	-6.64	-10.79	-7.11	-6.73	-9.06	-8.04		
400'	5.13	18.31	10.96	4.43	2.39	-1.27	-5.20	-5.31	-9.56	-6.52	-8.53		
450'	-30.81	41.13	12.13	5.79	1.55	-0.18	-0.46	-11.46	-1.59	-6.39	-19.68		
500'	-7.12	23.29	13.06	7.45	-0.16	1.06	-2.92	-6.10	-5.76	-8.37	-6.10		
550'	-25.79	31.63	9.22	7.92	0.33	-1.79	-1.99	-8.00	-4.90	-4.03	-18.21		

subsection	Vender - *Error (percent)* Waylink-OSU 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-10.04	-0.73	-0.81	-1.33	-4.17	-4.61	-1.88	-4.50	1.42	-2.09	-11.48		
50'	-5.30	-0.46	-0.28	-2.60	-3.11	-3.30	-1.83	-1.80	-3.62	-2.80	-4.05		
100'	-3.77	-3.45	-1.72	-4.35	-5.66	-7.12	-5.71	-3.15	2.33	-2.08	0.52		
150'	-3.35	-3.44	-1.87	-1.76	-4.28	-8.11	-5.20	-4.80	0.27	-0.07	0.64		
200'	-1.11	-3.82	-6.12	-3.22	-4.02	-3.62	-11.84	-3.17	-1.07	1.99	-3.09		
250'	-1.65	-5.35	-2.47	-1.92	-4.11	-10.15	-7.39	-1.60	-0.91	8.27	-4.66		
300'	0.58	-5.61	-3.19	-3.43	-4.65	-4.75	-11.04	-3.15	3.50	-3.49	-4.15		
350'	-2.12	1.07	-3.60	-3.85	-0.94	-8.54	-12.45	-3.94	0.53	0.91	-3.95		
400'	2.53	-0.06	-3.34	-2.73	-2.63	-1.95	-7.00	-2.92	-7.49	-1.45	-2.57		
450'	4.76	2.37	-5.89	-1.45	0.88	-3.57	1.16	-11.95	-1.61	-3.39	-5.26		
500'	6.22	0.88	-5.68	-3.62	-0.87	-2.75	-1.21	-7.62	-4.23	-7.34	2.07		
550'	4.91	0.09	-6.38	-1.06	-2.39	-4.20	-0.47	-8.92	-3.39	-2.57	-7.21		

subsection (ft)	Vender - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	0.46	1.06	1.54			
50	0.58	2.21	1.62			
100	0.29	1.50	0.74			
150	-0.13	1.09	0.75			
200	-0.23	0.32	1.21			
250	-0.55	-0.95	1.65			
300	-0.31	2.24	1.00			
350	-0.62	-0.41	1.52			
400	-0.50	-0.31	1.29			
450	-0.60	-0.46	1.20			
500	-1.92	-1.07	-0.06			
550	-0.53	0.63	2.45			
average	**1.79**	**1.79**	**1.24**	**-1.96**	**-0.83**	**-1.00**
std. dev.	0.65	1.15	0.62			

AutoDC11_FM1331-2

subsection	Vender - *Error (percent)* Fugro												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	9.78	25.79	-5.65	-1.43	-0.42	-3.60	-6.22	-4.07	-2.18	-0.78	-3.14		
50'	2.74	28.60	-4.05	-3.21	-0.19	-7.22	-4.13	-6.64	-1.10	-1.92	-3.28		
100'	7.00	37.93	-6.95	-7.00	-1.52	-8.00	-8.84	-6.52	-3.60	-5.80	-6.89		
150'	19.66	27.57	-3.77	-1.44	-1.85	-2.30	-5.96	-7.24	-3.23	-6.58	-3.63		
200'	-7.17	31.99	-1.16	-2.03	-0.44	-3.30	-8.76	-4.36	-10.19	-3.35	-6.14		
250'	-4.65	26.45	-4.02	-2.03	-2.48	-3.02	-6.95	0.49	-6.70	-3.58	-2.19		
300'	-24.42	37.73	-0.54	-0.12	-3.11	-0.86	-2.01	-6.42	-1.65	-3.14	-13.51		
350'	-2.88	15.40	3.35	-1.06	-0.64	-4.50	-2.59	-11.60	3.11	-6.07	-8.24		
400'	2.15	36.97	-1.34	-4.15	-3.38	-4.79	-5.11	-4.79	-5.56	-7.48	-7.27		
450'	10.92	9.93	-1.59	-0.94	0.24	-1.60	-6.39	0.14	-5.79	-3.98	-0.89		
500'	1.94	27.81	0.01	2.67	0.38	-3.14	-1.70	-3.62	-3.94	-6.79	-7.43		
550'	9.63	-0.73	4.25	4.88	4.31	3.58	-1.94	2.15	-0.59	-4.48	-0.84		

subsection	Vender - *Error (percent)* Waylink-OSU												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-1.11	-4.69	-3.61	-3.06	-3.39	-3.15	-5.27	0.75	-1.48	1.53	-3.51		
50'	-2.69	-3.66	-2.64	-6.41	-2.65	-7.29	-2.15	-0.40	0.76	-2.04	-4.01		
100'	0.31	-1.30	-8.04	-7.57	-3.72	-2.82	-5.79	-4.05	1.57	-0.38	-4.71		
150'	1.01	-0.74	-2.64	-1.64	-2.81	-3.54	-1.19	-10.25	2.40	1.75	-5.17		
200'	0.67	0.62	-1.56	-3.07	-3.00	-4.08	-8.14	0.31	-4.54	-0.82	-2.87		
250'	-6.21	-4.52	-1.32	-2.51	-4.10	-3.16	-3.19	-3.77	-5.56	-2.08	-1.64		
300'	-4.00	-1.56	1.79	-2.31	-4.72	-2.54	2.23	-7.04	-3.44	-2.04	-6.61		
350'	-1.27	-1.47	0.39	-4.82	-2.79	-5.05	-1.44	-2.13	-2.61	-4.66	-6.50		
400'	1.99	1.59	-1.14	-4.73	-3.36	-4.53	-2.66	-0.36	-3.27	-4.12	-0.73		
450'	1.40	1.12	-2.60	-3.14	-3.78	-3.13	-9.45	1.06	-4.21	-1.95	-3.45		
500'	3.48	0.30	-2.90	-0.39	-1.14	-1.98	-3.01	0.40	-3.48	-5.94	-9.59		
550'	4.30	2.76	-1.47	-1.02	1.30	-3.28	-2.17	-1.29	-2.07	-6.21	-6.26		

subsection (ft)	Vendor - *Error after adjusted (percent)*			TxDOT		
	Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.36	0.52	1.16			
50	-0.33	0.60	0.78			
100	-0.28	0.18	2.85			
150	-0.46	0.39	2.34			
200	-0.26	1.49	4.25			
250	-0.14	1.00	2.07			
300	0.17	1.68	3.20			
350	0.05	2.86	4.56			
400	-0.33	-0.31	3.03			
450	0.01	1.95	2.71			
500	-0.35	-0.69	0.22			
550	0.03	0.51	-0.18			
average	**2.10**	**2.10**	**2.25**	**-2.18**	**-1.49**	**-1.81**
std. dev.	0.20	1.00	1.50			

AutoDC12_FM1063-1

subsection	Vender - *Error (percent)*												
	Fugro												
subsection	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	5.32	3.37	0.05	0.75	-2.20	-4.39	-1.85	1.84	-23.03	-8.56	3.26		
50'	2.99	3.95	1.23	2.24	-0.80	-2.12	2.58	-2.60	-22.80	-10.33			
100'	0.44	2.32	2.24	2.29	0.24	-0.96	2.08	-9.10	-6.11	-2.21			
150'	3.99	2.16	3.58	2.34	-0.60	-1.35	3.04	-10.74	-13.35	-11.22			
200'	4.15	4.94	2.97	2.12	-1.27	-2.63	-2.83	-7.59	-14.96	-14.36			
250'	2.22	3.10	1.75	0.63	0.38	0.14	0.97	-10.58	-9.99	-9.13			
300'	1.91	-0.47	0.03	-3.04	-2.74	-2.08	-1.27	-9.75	-4.59	-5.57			
350'	-2.32	-1.85	-2.85	-5.42	-4.34	-5.18	-5.50	-3.01	-0.19	4.32			
400'	-3.75	-3.40	-3.62	-5.12	-4.69	-4.09	-2.30	-3.15	-7.65	7.53			
450'	2.69	-0.08	-0.79	-1.29	-1.08	-0.34	-1.38	-1.05	-15.30	-5.55			
500'	0.37	0.45	-0.48	-2.52	-2.52	-1.28	-1.53	0.71	-16.27	-1.80	-2.03		
550'	-1.81	-4.50	-3.35	-3.83	-4.44	-1.79	-0.46	-2.54	-9.32	2.14	-3.61		

subsection	Vender - *Error (percent)*												
	Waylink-OSU												
subsection	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-3.10	0.00	0.17	1.19	-2.69	-4.52	-6.26	-3.39	-2.16	0.52	-0.61		
50'	-4.53	-0.33	-1.59	-0.77	-4.33	-6.18	-2.24	-5.34	-2.20	-0.53			
100'	-3.27	2.20	-0.21	-0.36	-0.34	-2.33	0.19	0.02	-2.44	-2.23			
150'	-0.38	-1.22	0.02	0.37	-0.47	-3.93	-1.65	-3.12	-3.50	-2.42			
200'	-0.74	0.65	0.53	0.98	-0.56	-3.59	-3.66	-4.85	-0.54	-1.53			
250'	-3.11	0.35	-0.16	-0.67	-3.22	-3.38	-0.59	0.45	0.87	-5.73			
300'	-3.62	-3.16	-1.34	-3.47	-4.91	-6.85	-0.18	0.52	1.57	-3.41			
350'	-2.24	-3.70	-2.42	-3.12	-4.25	-5.35	-5.43	-0.69	0.79	0.48			
400'	-1.85	-5.87	0.94	-1.07	-4.38	-5.39	-1.93	-0.57	0.88	1.05			
450'	-1.62	-3.90	0.71	-0.48	-4.35	-2.71	-3.61	-0.16	1.19	3.74			
500'	-2.76	-0.99	-0.58	-2.80	-3.67	-4.04	-3.47	1.97	-0.16	2.97	0.04		
550'	-5.80	-3.86	-2.16	-6.21	-3.88	-6.93	-3.79	-1.58	3.33	-1.38	-6.23		

subsection (ft)	Vendor - *Error after adjusted (percent)*			TxDOT		
	Dynatest	Fugro	Waylink-OSU			
subsection (ft)	(percent)	for entire lane width (percent)	(percent) average	using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.09	0.32	-0.50			
50	0.10	1.48	-1.08			
100	-0.06	0.96	-1.31			
150	-0.62	1.16	-0.75			
200	-0.37	1.06	-1.39			
250	-0.28	1.33	-0.92			
300	-0.15	-1.04	-1.95			
350	-0.03	-3.61	-1.27			
400	0.31	-3.45	-0.24			
450	0.35	0.16	-0.39			
500	0.09	-0.85	-0.40			
550	0.53	-2.75	-1.91			
average	**-0.02**	**-0.44**	**-1.01**	**2.32**	**1.22**	**1.27**
std. dev.	0.32	1.89	0.58			

AutoDC13_US79-1

subsection	Vender - *Error (percent)* Fugro												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'		-0.13	27.65	-3.65	-4.86	-3.89	-1.11	-2.91	-3.54	-0.14	-1.72	-0.55	
50'		2.65	-2.75	23.93	-3.30	-2.84	-3.45	-3.78	-1.05	-1.02	-1.73	-0.01	
100'		8.21	-10.50	19.84	-3.23	-2.47	-2.36	-2.30	-1.61	-2.65	-1.83	1.94	
150'	-1.41	2.53	-2.94	19.24	-3.03	-4.25	-2.38	-3.47	-3.66	-2.50	-3.22	-1.58	
200'	-1.80	3.06	1.98	31.63	-5.06	-4.66	-5.26	-3.43	-3.74	-3.09	-4.22	-2.78	
250'	-1.64	-1.41	0.70	25.45	-3.77	-3.18	-1.43	-3.35	-2.39	-3.40	-3.04	-2.31	
300'	-4.69	-1.47	26.70	-4.12	-4.17	-4.60	-3.90	-4.35	-4.12	-4.14	-4.56	-1.91	
350'	6.42	-8.51	35.85	-4.43	-6.32	-3.75	-4.31	-4.80	-5.29	-6.30	-3.65	-3.35	
400'	1.16	-4.03	29.49	-5.31	-5.23	-5.78	-4.66	-3.40	-4.81	-4.48	-3.79	-2.25	
450'	-7.25	-0.96	30.37	-3.84	-4.18	-3.61	-4.45	-3.49	-4.03	-2.49	-3.92	-2.35	
500'	-1.97	0.29	29.33	-4.65	-4.21	-3.43	-3.83	-3.90	-2.82	-3.84	-3.97	-1.93	
550'	1.10	-5.71	28.04	-3.62	-4.33	-4.36	-3.57	-5.10	-3.34	-4.90	-3.89	-3.04	

subsection	Vender - *Error (percent)* Waylink-OSU												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'		-2.78	-2.19	-1.55	-2.91	-2.17	0.84	-1.76	-2.69	-1.16	0.13	-2.07	
50'		-5.98	-3.49	-3.73	-1.84	-2.49	-0.16	-1.94	-1.60	-2.27	-1.46	-0.66	
100'		-3.24	-2.44	-5.40	-2.44	-1.74	-3.36	-2.51	-1.90	-2.92	-2.38	-4.60	
150'	-3.49	-2.22	-3.68	-3.67	-3.11	-2.76	-3.14	-0.94	-3.56	-3.36	-2.67	-3.06	
200'	-5.41	-2.20	-3.24	-3.86	-1.92	-1.72	-1.58	-2.68	-0.78	-2.74	-1.08	-1.92	
250'	-1.21	-4.42	-4.01	1.04	-4.61	-2.98	-1.06	-2.34	-2.00	-3.38	-1.43	-3.22	
300'	-1.71	-2.57	-5.18	-4.00	-2.53	-1.42	-3.66	-3.07	-4.04	-3.43	-4.13	-1.19	
350'	-2.67	-2.80	-3.90	-3.66	-3.42	-4.63	-4.14	-2.87	-2.93	-2.07	-4.19	-2.82	
400'	-3.37	-2.98	-4.17	-2.42	-3.43	-4.65	-3.13	-3.70	-2.31	-3.70	-3.66	-1.82	
450'	-3.41	0.96	-4.02	-1.20	-3.84	-2.02	-2.87	-2.56	-3.29	-2.50	-1.20	-4.19	
500'	-5.24	3.06	-2.90	-2.69	-3.60	-5.30	1.69	-1.89	-3.47	-1.99	-3.80	-2.39	
550'	-6.96	-0.68	-4.62	0.07	-3.60	-3.94	-5.17	-3.44	-4.45	-2.13	-3.65	-2.78	

subsection (ft)	Vendor - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	TxDOT using 2 point algorithm (percent)	TxDOT using line fitting algorithm (percent)
0	-0.60	0.11	0.70			
50	-0.42	0.61	0.60			
100	-0.26	1.76	0.78			
150	-0.23	1.52	1.71			
200	-0.30	-0.60	1.28			
250	0.00	1.08	1.49			
300	-0.14	1.55	2.48			
350	-0.28	0.34	1.91			
400	-0.13	1.17	2.25			
450	-0.31	0.74	1.87			
500	-0.26	0.69	1.92			
550	-0.04	1.35	1.93			
average	**2.13**	**2.13**	**1.58**	**-1.67**	**-0.67**	**-0.58**
std. dev.	0.16	0.69	0.62			

AutoDC14_IH35-3

subsection	Vender - *Error (percent)* Fugro												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-2.82	-2.92	-1.61	-2.50	-2.11	-1.85	-1.09	-1.53	-1.61	-9.05	0.46	-3.14	
50'	-2.68	-1.74	-0.78	-1.27	-1.17	-0.81	-0.16	0.53	-0.13	-18.20	2.28	-1.10	
100'	-3.18	-1.21	-0.14	-1.25	-0.11	-0.42	0.75	0.62	0.70	-18.09	-2.11	-0.46	
150'	-3.36	-1.55	-0.44	-1.32	-0.33	-0.48	-0.45	0.35	0.34	-17.33	0.18	-0.62	
200'	-2.04	-0.60	-0.50	-0.39	0.51	-0.25	0.51	0.85	1.86	-20.13	0.25	0.76	
250'	-4.34	-3.89	-2.18	-2.87	-2.62	-3.02	-2.63	-2.55	-3.42	-0.15	-0.17	-4.92	
300'	-2.82	-3.27	-1.63	-2.01	-2.19	-2.75	-1.69	-1.97	-2.05	-7.34	-0.22	-3.53	
350'	-5.49	-5.61	-3.23	-4.20	-4.83	-4.15	-3.00	-3.89	-4.29	0.96	-1.80	-7.03	
400'	-6.81	-7.13	-5.18	-5.35	-6.79	-5.83	-4.34	-5.70	-5.72	6.24	0.78	-7.69	
450'	-8.40	-8.11	-5.61	-6.32	-7.49	-7.38	-6.32	-7.81	-6.95	9.40	-1.01	-7.21	
500'	-6.54	-7.53	-5.58	-5.41	-5.97	-6.15	-4.07	-4.58	-4.37	6.63	-0.58	-3.61	
550'	-5.68	-5.91	-4.20	-4.04	-5.38	-5.74	-3.97	-5.60	-5.20	7.90	-1.13	-3.83	

subsection	Vender - *Error (percent)* Waylink-OSU												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-1.37	-1.78	-0.89	-1.89	-1.16	-1.38	-0.88	-0.32	-0.43	-1.22	-1.13	-1.85	
50'	-1.21	-0.45	-0.17	-1.08	-1.59	-1.26	-1.54	-0.62	-0.11	-1.79	-1.03	-1.06	
100'	-0.86	-1.70	-1.41	-1.30	-1.10	-1.87	-0.46	-0.26	-0.55	-0.90	-0.58	-0.61	
150'	-2.99	-2.19	-1.44	-0.96	-0.62	-0.50	-1.62	-0.63	-0.68	-1.59	-0.81	1.15	
200'	-1.06	-0.16	-1.14	-1.05	-1.04	-1.13	-0.69	-0.41	-0.57	-0.70	0.36	-0.87	
250'	-0.86	-1.96	-1.00	-1.91	-0.82	-2.72	-1.51	-1.06	-1.27	-2.11	-1.58	-2.94	
300'	-0.81	-0.44	-1.76	-1.52	-1.61	-1.59	-0.68	-0.79	-0.64	-2.21	-2.10	-1.18	
350'	-2.68	-2.15	-2.13	-2.43	-2.15	-2.01	-2.69	-1.34	-1.71	-2.59	-2.75	-3.11	
400'	-2.96	-3.02	-3.21	-2.65	-4.38	-3.61	-2.51	-2.56	-2.42	-3.90	-4.14	-4.96	
450'	-4.11	-3.95	-2.63	-2.74	-3.63	-2.65	-4.54	-3.60	-3.33	-4.19	-4.53	-4.36	
500'	-1.78	-3.86	-2.85	-3.13	-4.09	-3.70	-2.57	-2.66	-2.04	-2.26	-3.16	-3.36	
550'	-2.39	-3.29	-2.73	-2.35	-3.11	-3.21	-2.54	-2.44	-1.98	-3.48	-3.73	-2.96	

subsection (ft)	Vendor - *Error after adjusted (percent)*					
	Dynatest	Fugro	Waylink-OSU	TxDOT		
	(percent)	for entire lane width (percent)	(percent) average	using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.03	-0.55	-3.59			
50	0.03	-0.91	-0.85			
100	0.14	-1.25	-3.47			
150	-0.10	-1.11	-3.69			
200	0.66	-1.16	-3.57			
250	0.08	-0.31	-1.88			
300	0.58	-1.11	-4.06			
350	0.21	-1.56	-5.26			
400	0.12	-1.42	-3.22			
450	-0.10	-0.89	-6.59			
500	0.42	-0.15	-5.49			
550	-0.02	-0.57	-5.54			
average	**0.17**	**-2.03**	**-3.93**	**-0.24**	**-1.27**	**-0.63**
std. dev.	0.26	0.44	1.61			

AutoDC15_Spur484-1

subsection	Vender - *Error (percent)* Fugro 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-0.43	-2.11	31.99	-5.08	-4.46	-4.09	-4.18	-4.11	-4.72	-5.81	-4.63	-3.58	
50'	-6.06	-6.23	29.73	-4.74	-4.34	-3.97	-4.72	-3.60	-4.86	-3.68	-4.63	-4.86	
100'	-7.00	-4.38	34.23	-5.51	-5.36	-3.51	-4.05	-4.48	-4.70	-3.74	-5.02	-5.39	
150'	1.53	-4.81	26.52	-5.11	-4.55	-3.44	-3.86	-3.97	-3.52	-4.60	-3.68	-4.62	
200'	2.73	-7.06	26.87	-5.55	-4.53	-4.03	-4.34	-4.52	-5.59	-5.49	-3.86	-3.96	
250'	-5.65	-5.22	37.89	-5.63	-5.07	-4.51	-3.84	-6.20	-4.62	-5.87	-5.88	-7.08	
300'	-0.57	-4.64	27.50	-3.59	-5.09	-2.93	-4.30	-3.78	-3.73	-5.04	-4.88	-5.53	
350'	-4.16	-3.92	28.87	-4.64	-4.64	-3.57	-3.66	-4.38	-3.65	-4.33	-4.56	-5.11	
400'	-4.83	-1.87	24.59	-4.10	-2.79	-3.25	-3.84	-2.46	-4.43	-3.86	-4.42	-4.52	
450'	-4.07	-2.70	21.77	-4.44	-4.59	-1.50	-3.70	-3.23	-3.13	-2.83	-3.80	-4.77	
500'	-6.91	-2.53	21.80	-5.24	-2.68	-3.76	-4.18	-3.58	-3.96	-3.01	-4.53	-3.56	
550'	-6.70	-4.94	31.04	-5.12	-3.10	-3.69	-4.53	-3.96	-4.41	-3.71	-4.79	-5.83	

subsection	Vender - *Error (percent)* Waylink-OSU 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-4.14	-4.03	-3.04	-1.59	-3.37	-3.38	-4.35	-1.66	-3.38	-2.69	-3.20	-1.77	
50'	-3.61	-2.89	-2.46	-3.52	-1.54	-2.50	-4.12	-3.55	-2.70	-2.40	-3.10	-1.99	
100'	-4.01	-2.06	-2.55	-1.34	-2.68	-3.48	-2.30	-2.74	-2.66	-0.69	-4.04	-1.85	
150'	-1.73	-2.07	-3.69	-1.98	-2.88	-3.64	-0.90	-6.14	-0.20	-2.27	-3.03	-2.92	
200'	-4.99	-2.38	-2.87	-3.22	-3.42	-2.93	-5.98	-3.27	-2.06	-2.44	-3.07	-2.34	
250'	-6.11	-3.30	-3.09	-1.66	-3.78	-2.84	-3.97	-1.74	-3.57	-3.53	-2.99	-3.13	
300'	-2.66	-2.36	-2.63	-2.17	-2.38	-2.02	-5.65	-2.30	-2.82	-3.00	-2.22	-4.32	
350'	-2.11	-2.27	-3.12	-2.64	-2.34	-3.61	-0.91	-3.80	-2.14	-2.85	-2.57	-3.06	
400'	-2.26	-1.52	-2.47	-2.46	-1.13	-3.38	-1.48	-3.34	-2.41	-2.19	-2.73	-3.28	
450'	-1.66	-2.47	-1.98	-1.32	-3.56	-1.78	-0.65	-4.83	-1.32	-2.11	-3.38	-3.97	
500'	-2.30	-2.82	-2.97	-2.76	-1.70	-3.79	-1.50	-1.63	-2.20	-2.39	-3.71	-2.76	
550'	-2.74	-1.93	-1.92	-3.47	-1.03	-3.09	-4.73	-1.94	-1.70	-1.83	-2.76	-2.50	

subsection (ft)	Vendor - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.14	0.76	2.28			
50	-0.06	1.09	2.67			
100	-0.03	0.70	2.83			
150	0.00	1.20	2.59			
200	-0.02	1.28	2.43			
250	-0.07	0.62	2.65			
300	-0.06	0.95	2.49			
350	-0.07	0.93	2.53			
400	0.05	1.14	2.42			
450	0.06	0.91	2.14			
500	0.07	1.38	2.73			
550	-0.02	0.90	2.74			
average	**2.65**	**2.65**	**2.54**	**-0.67**	**0.50**	**0.62**
std. dev.	0.06	0.23	0.20			

AutoDC16_US77-1

subsection	Vender - *Error (percent)* Fugro 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-3.75	-0.90	16.55	-2.80	-2.27	-2.68	-2.53	-2.82	-2.08	-1.80	-2.99	-2.11	
50'	-2.50	-2.90	21.86	-3.49	-2.57	-1.91	-2.42	-2.58	-3.02	-1.56	-2.02	-2.57	
100'	-1.34	-3.54	17.03	-3.07	-2.16	-1.31	-2.13	-2.07	-1.29	-1.24	-1.98	-0.93	
150'	-5.87	-3.39	21.27	-3.92	-4.19	-3.49	-3.33	-3.53	-3.38	-3.27	-3.77	-4.38	
200'	-3.36	-1.98	20.42	-2.57	-1.99	-2.31	-1.78	-2.45	-2.66	-2.51	-3.16	-2.11	
250'	-6.96	0.38	15.27	-1.07	-1.60	-1.35	-0.90	-2.03	-2.04	-0.37	-2.24	-1.30	
300'	-2.52	-3.17	21.28	-2.81	-3.35	-2.04	-2.73	-2.70	-1.98	-2.29	-3.45	-2.21	
350'	-2.73	-2.07	20.07	-2.60	-4.31	-1.74	-2.38	-2.64	-3.11	-2.55	-2.55	-2.41	
400'	-1.80	-3.21	12.55	-2.12	-0.99	-1.76	-1.50	-0.47	-1.56	-1.35	-2.12	-1.98	
450'	-2.80	0.11	13.33	-2.21	-2.12	-1.33	-1.25	-1.78	-1.92	-1.66	-2.84	-1.81	
500'	-2.08	-1.76	14.15	-0.88	-1.82	-1.44	-1.56	-1.47	-2.38	-1.42	-2.69	-2.45	
550'	-2.78	-0.62	18.28	-2.48	-2.33	-2.11	-2.31	-3.51	-2.63	-1.87	-2.93	-1.75	

subsection	Vender - *Error (percent)* Waylink-OSU 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-0.49	-2.00	-0.93	-1.93	-2.62	-2.56	-1.74	-1.12	-1.07	-1.49	-2.37	-1.67	
50'	-1.72	-1.70	-1.39	-1.16	-1.08	-1.69	-1.01	-0.01	-0.64	-0.07	-2.11	-1.73	
100'	-1.27	-0.76	-1.53	-1.69	-1.93	-0.84	-1.44	-0.84	-0.74	-0.95	-2.16	1.28	
150'	-6.15	-2.35	-3.01	-1.77	-2.06	-2.85	-2.14	-2.29	-2.32	-2.23	-2.64	-2.26	
200'	-2.15	-0.83	-1.29	-0.69	-1.19	-0.91	-2.98	-1.36	-1.44	-1.35	-1.92	-0.75	
250'	-0.71	-1.48	-0.64	-0.88	-2.32	-2.49	-1.05	-1.06	-1.20	-1.66	-1.60	-1.38	
300'	-0.95	-1.92	-0.52	-1.97	-1.69	-1.66	-2.72	-0.30	-1.40	-1.58	-3.03	-1.80	
350'	-1.88	-0.72	-1.75	-2.18	-2.12	-1.21	-2.26	-2.18	-1.35	-2.52	-2.44	-2.59	
400'	-0.26	-1.29	-0.54	-1.51	-0.54	-2.11	-0.73	-0.82	-0.93	-1.97	-2.50	-1.04	
450'	-1.33	-1.37	-2.10	-2.48	-2.50	-1.63	-1.82	-1.15	-2.40	-2.02	-2.40	-1.79	
500'	-0.56	0.01	-1.60	-0.98	-1.40	-2.18	-2.68	-0.89	-0.81	-0.92	-2.41	-1.93	
550'	-0.72	-2.61	-2.06	-1.53	-1.30	-0.69	-2.83	-2.79	-1.01	-0.80	-2.55	-0.91	

subsection (ft)	Vender - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.18	1.01	1.61			
50	-0.06	0.40	1.80			
100	-0.19	0.91	1.38			
150	0.21	1.45	2.37			
200	-0.01	0.88	1.93			
250	-0.24	1.20	1.17			
300	0.06	0.74	1.72			
350	-0.03	1.14	1.94			
400	0.10	1.33	1.55			
450	0.01	1.36	1.15			
500	-0.01	1.06	1.45			
550	-0.05	1.10	1.72			
average	**1.61**	**1.61**	**1.65**	**-0.67**	**0.45**	**0.54**
std. dev.	0.13	0.29	0.34			

AutoDC17_La_Salle-1

subsection	Vender - *Error (percent)* Fugro 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-3.21	-0.15	10.58	-1.79	-0.69	-0.59	-1.37	-0.64	-0.87	-0.73	-1.13	-0.24	
50'	-3.93	-1.73	13.93	-1.26	-0.03	-0.57	-0.78	-0.91	-0.91	0.24	-0.91	-0.89	
100'	-1.40	-1.21	11.32	-1.88	0.78	-1.79	-0.66	0.43	-0.89	-0.82	-0.53	-0.09	
150'	-2.32	-1.72	9.56	-0.92	0.04	-0.80	-0.34	-0.28	-0.78	-0.35	-0.67	0.01	
200'	0.18	-4.04	10.83	-1.98	-0.17	-0.82	-1.22	0.00	-1.47	-1.07	-0.20	-0.37	
250'	-5.71	-0.64	18.00	-1.23	-1.65	-2.38	-1.73	-1.15	-3.16	-1.78	-1.84	-3.18	
300'	-10.68	2.44	16.24	-1.92	-1.73	-2.42	-0.60	-2.26	-1.70	-0.09	-1.56	-2.19	
350'	-5.44	-1.65	9.75	-0.78	-0.44	-1.26	-0.73	-0.01	-1.94	-0.48	-0.17	-1.29	
400'	-7.38	-0.72	13.99	-1.89	-1.28	-0.57	-0.57	-2.70	-2.13	-0.63	-1.44	-1.46	
450'	-1.94	-5.08	21.07	-3.39	-1.52	-3.26	-1.05	-2.21	-2.53	-1.74	-0.93	-2.32	
500'	-6.44	-2.11	17.81	-2.03	-1.71	-1.28	-0.95	-1.36	-2.30	-0.93	-2.46	-1.52	
550'	-1.82	-2.16	13.16	-3.99	-0.82	-1.21	-0.79	-1.19	-1.81	-1.51	-1.71	-0.06	

subsection	Vender - *Error (percent)* Waylink-OSU 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-2.24	-1.93	-1.76	-0.42	-1.34	-0.61	-1.87	-0.95	-0.88	-1.40	-0.74	-1.22	
50'	-0.39	-0.71	-0.84	0.37	-0.21	-1.92	-1.39	0.38	-0.64	0.42	-1.10	-1.65	
100'	0.05	-0.57	0.93	-1.52	-0.60	-1.84	-0.29	-1.85	0.08	-0.71	-0.68	-1.23	
150'	-2.02	0.37	-1.79	0.53	-0.33	-1.91	-0.73	0.90	-0.05	0.00	-1.06	-1.27	
200'	-3.14	0.34	-0.88	-0.93	0.43	-2.75	-1.67	0.62	-1.55	-0.69	-1.47	-0.01	
250'	-4.33	1.04	-1.93	-1.59	-0.77	-3.94	0.36	0.66	-2.20	-2.00	-1.36	-2.91	
300'	-3.55	0.87	-2.39	-1.50	-1.08	-2.06	-0.99	-0.07	-1.47	-0.98	-1.05	-3.48	
350'	-1.87	0.48	-0.61	-1.72	-1.14	-2.57	-5.13	0.82	-1.31	-2.26	-0.16	-1.28	
400'	-3.97	-0.44	-1.57	-1.59	-0.76	-0.99	-1.32	-0.99	-1.99	-1.23	-1.06	-1.15	
450'	-2.73	-1.39	-1.60	-2.89	-1.16	-2.01	-2.21	-2.47	-1.80	-0.64	-1.36	-1.41	
500'	-2.78	-0.26	-1.89	-1.67	-1.41	-2.43	0.17	0.28	-1.45	-1.57	-1.66	-1.16	
550'	-2.55	0.23	-1.39	-2.34	-1.13	-1.93	-3.34	-0.21	-2.69	-1.31	-1.50	-1.27	

subsection (ft)	Vendor - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.16	1.00	0.90			
50	-0.23	0.65	0.66			
100	-0.17	0.55	0.59			
150	-0.12	0.49	1.03			
200	-0.20	0.76	1.15			
250	0.08	2.08	1.44			
300	0.10	1.70	1.57			
350	-0.10	0.70	0.84			
400	0.06	1.76	1.34			
450	0.01	2.14	1.37			
500	-0.17	1.45	1.01			
550	-0.16	1.26	0.76			
average	**1.15**	**1.21**	**1.06**	**-0.86**	**0.40**	**0.46**
std. dev.	0.12	0.60	0.32			

AutoDC18_IH35-1

	Vender - *Error (percent)*												
	Fugro												
subsection	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-3.15	-1.59	-1.73	-1.77	-0.98	-1.98	-1.89	-1.35	-4.28	-9.63	-2.65	-5.15	
50'	-6.16	-1.24	-1.21	0.18	-0.36	-1.54	-0.86	-0.86	-1.69	-26.50	0.17	-1.77	
100'	-4.63	-1.63	-2.26	-2.00	-2.07	-2.65	-2.20	-2.64	-3.01	-6.51	-4.21	-1.54	
150'	-8.61	-4.84	-5.19	-4.09	-4.41	-5.19	-3.71	-4.16	-4.59	-0.08	-0.86	-2.76	
200'	-6.62	-2.68	-2.82	-2.59	-2.63	-3.22	-3.32	-2.47	-3.09	-5.71	-2.64	-2.19	
250'	-4.34	-2.27	-3.13	-2.24	-2.40	-4.51	-4.02	-3.39	-2.73	-11.03	-3.10	0.68	
300'	-3.17	-4.79	-5.02	-4.78	-4.92	-6.08	-4.89	-4.53	-4.84	-6.23	-0.53	-1.56	
350'	-2.34	-2.09	-3.39	-2.98	-3.92	-5.05	-3.92	-3.82	-3.23	-16.87	-4.29	-0.20	
400'	-1.63	-0.32	-1.53	-1.28	-1.89	-3.11	-2.30	-2.03	-5.02	-11.18	-5.64	-1.21	
450'	-1.58	-4.01	-6.65	-4.89	-5.41	-7.63	-6.37	-6.91	-6.56	0.19	-3.60	3.25	
500'	-6.10	-7.23	-6.22	-6.45	-7.79	-6.45	-7.97	-4.89	-6.93	9.48	-1.14	-4.93	
550'	-2.53	-2.49	-3.80	-3.58	-4.16	-4.64	-5.63	-5.32	-5.95	-7.30	-4.98	-1.23	

	Vender - *Error (percent)*												
	Waylink-OSU												
subsection	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-3.06	-0.48	-1.95	-0.64	-1.77	-1.23	-1.88	-0.92	-0.91	-1.26	-3.57	-5.15	
50'	-7.00	-1.20	-2.83	-0.62	-1.31	-2.84	-1.33	-1.23	-0.58	-1.51	-2.45	-1.23	
100'	-5.00	-1.49	-1.31	-1.61	-2.10	-1.88	-2.25	-1.05	-1.17	-1.46	-2.42	-3.40	
150'	-7.06	-2.54	-2.70	-3.56	-3.03	-3.76	-2.61	-2.44	-2.17	-3.16	-2.61	-4.29	
200'	-5.94	-1.22	-1.26	-1.50	-1.91	-3.27	-1.01	-0.55	-1.49	-1.83	-1.98	-2.17	
250'	-0.83	-1.43	-2.48	-1.19	-1.89	-2.83	-2.01	-3.41	-2.44	-3.61	-2.80	-1.80	
300'	-2.91	-2.63	-3.47	-4.35	-4.81	-4.56	-3.08	-3.91	-2.88	-4.51	-3.54	-4.24	
350'	-1.54	-1.81	-2.28	-2.24	-2.34	-4.28	-3.22	-3.86	-2.17	-2.52	-3.11	-4.72	
400'	-3.58	-1.52	-1.44	0.03	-2.51	-2.81	-3.78	-2.44	-1.85	-2.10	-3.77	-7.72	
450'	-5.90	-2.06	-3.44	-2.75	-2.52	-4.95	-4.36	-4.24	-3.80	-4.05	-3.80	-4.82	
500'	2.30	-3.85	-4.27	-3.48	-3.76	-4.47	-4.89	-3.87	-3.90	-3.48	-3.42	-3.01	
550'	-0.91	-2.02	-2.93	-2.53	-2.86	-3.98	-4.05	-3.82	-3.64	-3.81	-3.89	-4.99	

	Vendor - *Error after adjusted (percent)*			TxDOT		
	Dynatest	Fugro	Waylink-OSU			
subsection (ft)	(percent)	for entire lane width (percent)	(percent) average	using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.45	-1.24	-1.89			
50	-0.24	-2.08	-1.93			
100	0.08	-0.72	-2.06			
150	-0.34	-1.12	-3.29			
200	-0.35	-1.68	-1.97			
250	0.23	-1.05	-2.36			
300	-0.26	-1.85	-3.60			
350	-0.32	-2.45	-2.74			
400	-0.55	-2.77	-2.72			
450	-0.41	-1.30	-3.83			
500	0.22	-0.67	-3.31			
550	-0.20	-2.33	-3.25			
average	**-0.22**	**-2.66**	**-2.75**	**0.54**	**-0.47**	**-0.53**
std. dev.	0.26	0.70	0.70			

AutoDC19_IH35-2

subsection	Vender - *Error (percent)*												
	Fugro												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-7.32	-10.05	-9.11	-7.97	-7.45	-8.05	-8.92	-7.37	-8.77	1.47	-2.54	-1.45	
50'	-7.84	-6.20	-5.70	-5.43	-4.57	-5.99	-5.80	-5.68	-6.76	7.34	-3.27	-2.32	
100'	-2.64	-2.32	-4.21	-3.08	-2.80	-3.88	-4.37	-4.58	-4.81	-11.05	-2.19	1.88	
150'	-2.99	-2.12	-2.30	-2.11	-1.48	-2.52	-1.90	-1.65	-1.66	-16.96	-0.53	-1.35	
200'	-5.61	-3.40	-3.03	-2.97	-3.00	-3.66	-3.03	-2.47	-3.04	-9.94	-0.29	-4.11	
250'	-4.89	-3.59	-3.26	-3.15	-3.42	-4.55	-4.40	-4.19	-4.33	1.38	-3.57	-2.56	
300'	-2.87	-2.78	-2.92	-2.64	-2.57	-3.31	-2.38	-2.42	-2.59	-9.93	-0.50	-2.57	
350'	-2.79	-3.25	-3.41	-2.66	-3.26	-3.71	-3.29	-3.15	-3.89	-4.79	-1.14	-1.94	
400'	-3.98	-2.94	-2.88	-3.09	-3.68	-3.94	-4.01	-4.32	-9.03	1.52	-3.55	-2.85	
450'	-3.62	-3.01	-2.66	-2.27	-3.13	-3.78	-2.37	-2.63	-3.65	-7.21	-1.68	-2.46	
500'	-1.71	-2.39	-2.44	-1.26	-1.70	-2.19	-1.43	-1.58	-2.15	-13.73	0.65	-0.56	
550'	-5.19	-4.09	-3.58	-3.20	-2.84	-3.51	-2.87	-2.87	-3.28	-10.82	-1.61	-2.43	

subsection	Vender - *Error (percent)*												
	Waylink-OSU												
	0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-5.25	-6.86	-6.19	-5.58	-4.90	-6.27	-6.22	-4.74	-6.30	-5.00	-4.87	-4.82	
50'	-5.82	-3.18	-2.86	-3.06	-2.89	-3.27	-4.02	-1.18	-3.60	-2.93	-3.95	-3.08	
100'	-3.91	-1.78	-2.86	-1.00	-3.03	-2.85	-3.29	-2.20	-2.76	-3.23	-3.43	-3.75	
150'	-3.83	-0.70	-1.93	-1.21	-2.31	-1.44	-2.98	-1.25	-0.65	-1.82	-2.27	-2.35	
200'	-5.12	-1.37	-2.20	-1.38	-2.21	-2.43	-2.44	-0.90	-1.13	-1.39	-1.72	-2.01	
250'	-1.16	-2.03	-2.55	-1.94	-1.74	-2.70	-2.09	-2.16	-3.27	-2.75	-4.26	-2.23	
300'	-2.50	-1.29	-2.22	-2.12	-3.59	-2.99	-1.81	-0.47	-3.53	-2.09	-3.58	-2.21	
350'	-1.71	-1.62	-1.65	-2.08	-2.53	-2.23	-3.15	-1.73	-2.12	-1.94	-2.32	-2.37	
400'	-0.53	-1.87	-1.01	-1.72	-2.31	-3.40	-2.52	-2.14	-2.83	-2.64	-3.84	-2.53	
450'	-1.90	-1.85	-1.50	-2.41	-2.90	-1.89	-3.44	-1.59	-1.53	-2.96	-2.38	-2.79	
500'	2.12	-0.08	-2.54	-1.20	-1.36	-1.93	-1.49	-0.85	-1.51	-1.13	-1.68	-0.67	
550'	-2.04	-2.82	-2.05	-2.27	-2.58	-1.86	-2.34	-1.53	-2.03	-1.37	-2.10	-1.87	

subsection (ft)	Vendor - *Error after adjusted (percent)*					
	Dynatest	Fugro	Waylink-OSU	TxDOT		
	(percent)	for entire lane width (percent)	(percent) average	using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	0.06	-2.65	-5.57			
50	0.60	0.21	-3.27			
100	-0.21	-1.26	-2.92			
150	0.25	-1.12	-1.84			
200	-0.02	-1.63	-2.04			
250	0.12	-0.68	-2.47			
300	0.06	-1.33	-2.28			
350	0.05	-1.05	-2.13			
400	-0.12	-1.27	-2.29			
450	-0.07	-1.74	-2.33			
500	0.22	-0.95	-1.01			
550	-0.20	-1.23	-2.10			
average	**0.06**	**-2.50**	**-2.52**	**0.04**	**-0.94**	**-0.75**
std. dev.	0.22	0.67	1.11			

AutoDC20_US84-1

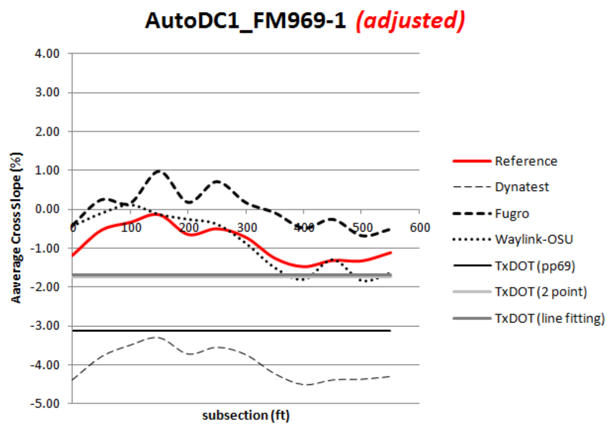
subsection	Vender - *Error (percent)* Fugro 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-0.11	-0.20	1.22	0.89	0.78	0.23	0.62	1.19	1.00	-6.68	3.86		
50'	1.02	0.81	1.17	1.58	1.38	1.01	1.42	1.70	2.08	-8.76	3.50		
100'	0.62	1.88	1.69	1.36	1.28	0.82	0.79	0.70	-2.50	-6.84	-0.92		
150'	1.28	1.98	1.14	1.89	1.87	1.17	1.93	1.20	1.30	-12.38	2.29		
200'	-0.17	0.79	0.67	1.03	1.14	0.51	0.33	0.78	1.72	-6.27	1.69		
250'	0.72	1.20	1.40	1.18	1.44	1.09	0.83	1.47	1.56	-9.14	1.17		
300'	0.63	1.89	1.28	0.51	1.72	0.89	1.02	1.12	1.93	-8.25	1.25		
350'	0.87	1.24	2.66	1.62	1.43	-0.07	1.27	1.16	1.46	-8.42	1.94		
400'	1.34	0.55	0.93	1.40	1.08	0.48	1.08	1.00	1.04	-5.41	4.51		
450'	0.85	0.97	1.02	1.43	1.33	0.70	0.73	1.24	0.92	-6.83	1.78		
500'	0.67	0.28	1.22	1.16	1.38	0.83	1.23	1.41	1.09	-3.30	3.09		
550'	0.27	1.15	1.03	1.27	1.08	1.05	0.87	1.40	-0.06	-3.38	0.34		

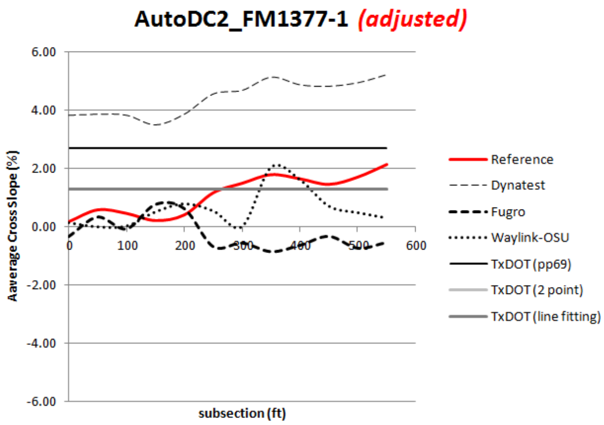
subsection	Vender - *Error (percent)* Waylink-OSU 0' - 1'	1' - 2'	2' - 3'	3' - 4'	4' - 5'	5' - 6'	6' - 7'	7' - 8'	8' - 9'	9' - 10'	10' - 11'	11' - 12'	12' - 13'
0'	-0.37	0.92	2.03	0.76	0.89	1.19	1.62	1.42	2.74	1.51	1.26		
50'	1.51	1.56	1.85	1.85	1.97	1.22	1.89	2.21	3.61	3.44	0.19		
100'	2.45	2.22	1.84	1.88	1.29	1.07	0.99	2.14	3.22	2.38	0.85		
150'	0.56	2.35	2.47	1.36	1.57	1.33	1.25	1.59	2.44	2.13	1.72		
200'	1.44	1.94	2.57	1.71	1.43	-0.20	1.51	1.97	2.13	1.95	0.97		
250'	0.77	2.28	2.20	0.29	1.14	1.24	1.26	1.00	1.06	1.16	1.49		
300'	0.42	2.76	2.48	2.13	0.82	1.15	1.41	2.64	3.01	2.71	0.25		
350'	1.09	2.75	2.98	1.47	2.80	1.74	1.70	1.82	2.02	2.21	1.53		
400'	1.67	2.45	1.88	2.52	0.66	1.36	1.44	2.08	1.96	2.71	1.18		
450'	4.52	0.79	0.02	0.77	2.89	2.11	3.26	0.09	1.02	1.37	5.54		
500'	1.46	2.08	2.47	1.14	2.37	1.41	2.18	2.72	2.06	2.19	2.33		
550'	1.67	1.12	2.47	1.97	2.30	1.30	1.56	2.21	2.24	2.01	1.47		

subsection (ft)	Vendor - *Error after adjusted (percent)* Dynatest (percent)	Fugro for entire lane width (percent)	Waylink-OSU (percent) average	TxDOT using AASHTO pp69 algorithm (percent)	using 2 point algorithm (percent)	using line fitting algorithm (percent)
0	-0.10	0.52	1.33			
50	0.10	1.21	1.95			
100	0.00	1.23	1.89			
150	0.00	1.59	1.60			
200	-0.01	0.71	1.61			
250	-0.13	1.11	1.26			
300	0.00	1.22	1.62			
350	-0.01	1.24	1.99			
400	-0.84	0.93	1.62			
450	-0.59	0.98	2.01			
500	-0.18	1.02	1.96			
550	-0.16	1.09	1.81			
average	**1.59**	**1.07**	**1.72**	**-0.68**	**0.46**	**0.87**
std. dev.	0.28	0.27	0.26			

Appendix E.2 – Cross Slope Graphs

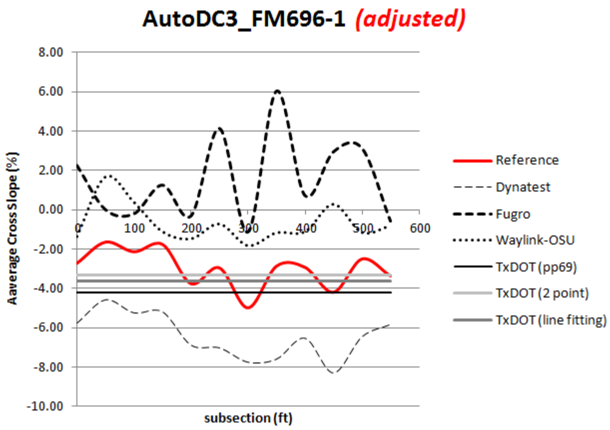
Note: Images of pavement sections are from Google Maps.




AutoDC2_FM1377-1 (adjusted)
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
0
100
200
300
400
500
600
Aaverage Cross Slope (%)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)


Blue Goose Rd
290
Decker Ln
13_FM1377-1
SB direction
Decker Ln

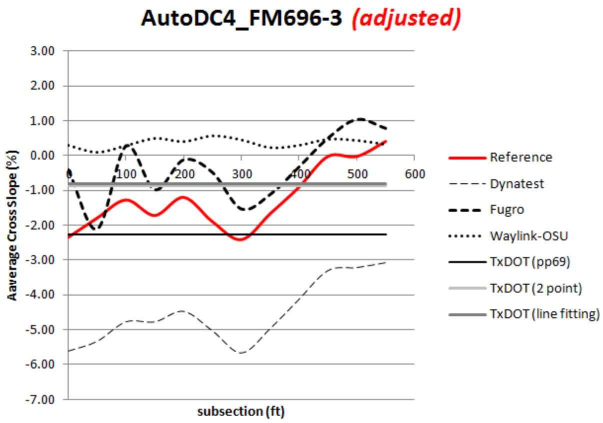

Image Date: April 2011



AutoDC3_FM696-1 *(adjusted)*
Aaverage Cross Slope (%)
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

696
W FM 696 Rd
2_FM696-1
EB direction (Side-by-side section)

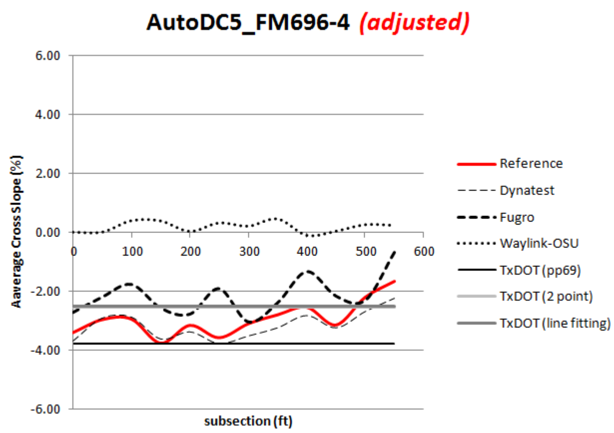
Image Date: May 2011



AutoDC4_FM696-3 (adjusted)
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
100
200
300
400
500
600
Aaverage Cross Slope (%)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

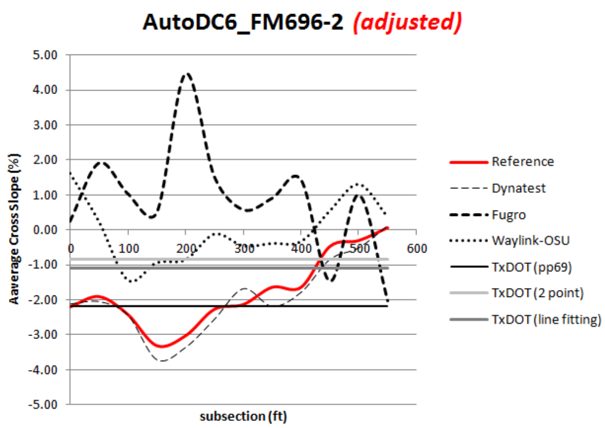
696
4_FM696-3
EB direction (Side-by-side section)
696

Image Date: May 2011


AutoDC5_FM696-4 (adjusted)
Aaverage Cross Slope (%)
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

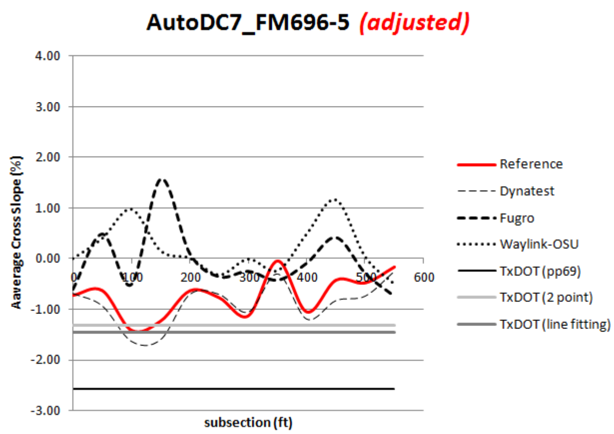

696
5_FM696-4
WB direction (Side-by-side section)
696


Image Date: May 2011


AutoDC6_FM696-2 (adjusted)
Aaverage Cross Slope (%)
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

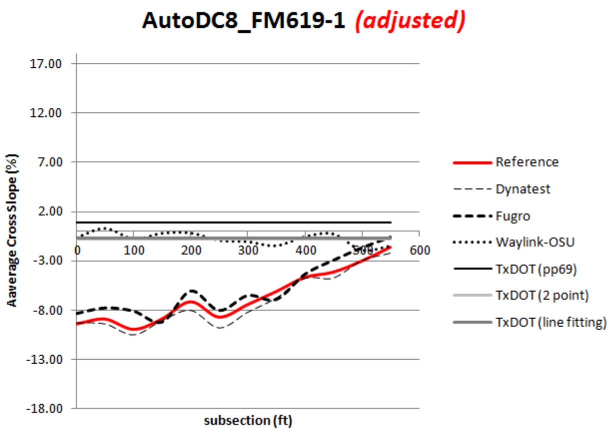

696
3_FM696-2
WB direction (Side-by-side section)
W FM 696 Rd
Wood Triple D Airport


Image Date: May 2011


AutoDC7_FM696-5 (adjusted)
Aaverage Cross Slope (%)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)


Willow Creek Dr
Farm-To-Market Rd
6_FM696-5
WB direction
619
696
To-Market Rd

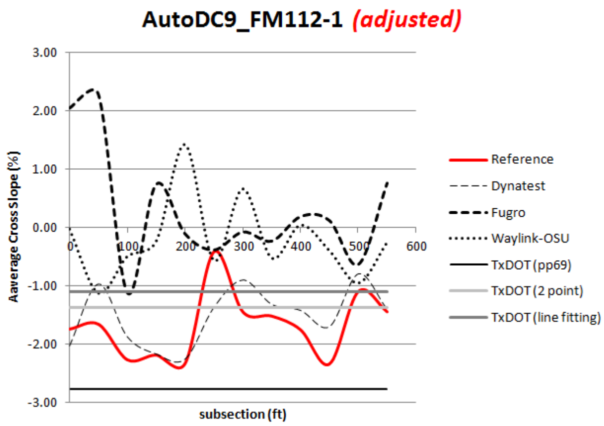

Image Date: May 2011



AutoDC8_FM619-1 (adjusted)
17.00
12.00
7.00
2.00
-3.00
-8.00
-13.00
-18.00
0
100
200
300
400
500
600
Aaverage Cross Slope (%)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

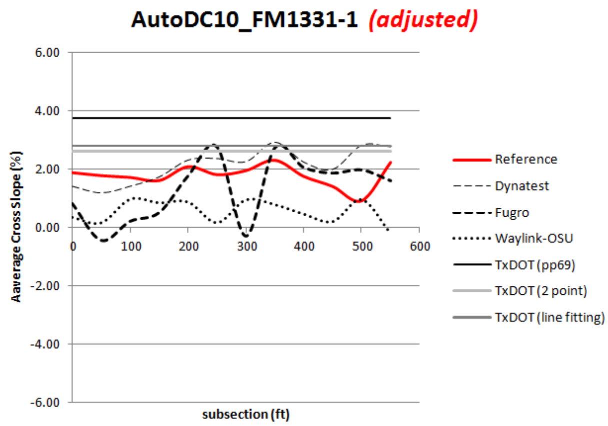
619
1_FM619-1
NB direction
619

Image Date: May 2011



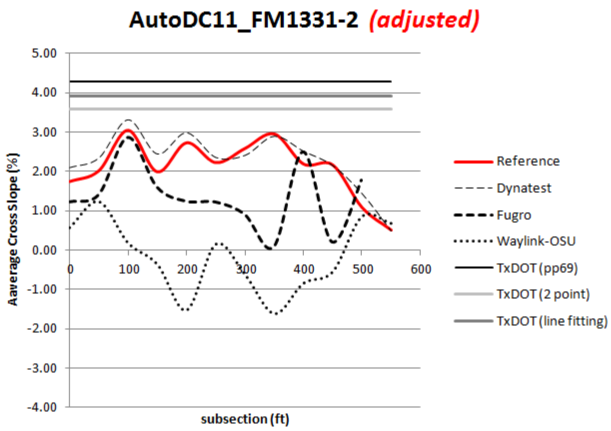
AutoDC9_FM112-1 (adjusted)
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Aaverage Cross Slope (%)
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

S Dolan St
Tennessee St
Royal St
1st Ave
2nd Ave
Fannie Robinson Park
Carolina St
112
E Walnut St
7_FM112-1
EB direction


AutoDC10_FM1331-1 (adjusted)
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
0
100
200
300
400
500
600
Aaverage Cross Slope (%)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

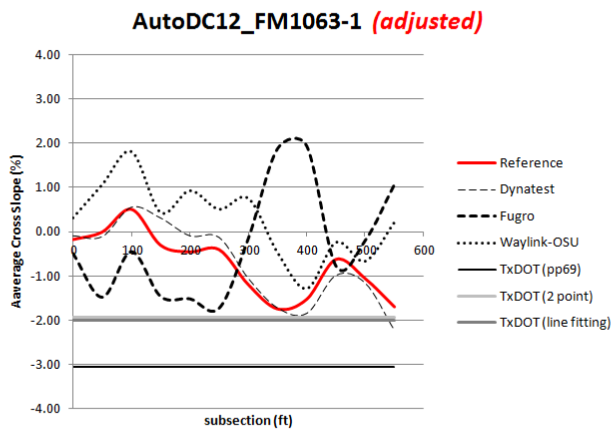

8_FM1331-1
WB direction
1331
1331


Image Date: May 2011


AutoDC11_FM1331-2 (adjusted)
Aaverage Cross Slope (%)
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

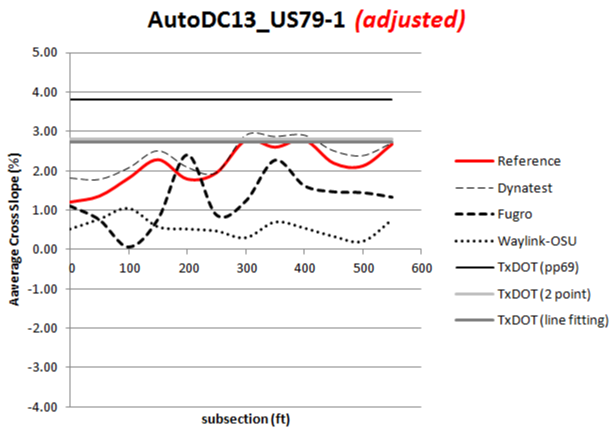

9_FM1331-2
EB direction
1331
1331


Image Date: May 2011


AutoDC12_FM1063-1 *(adjusted)*
Aaverage Cross Slope (%)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

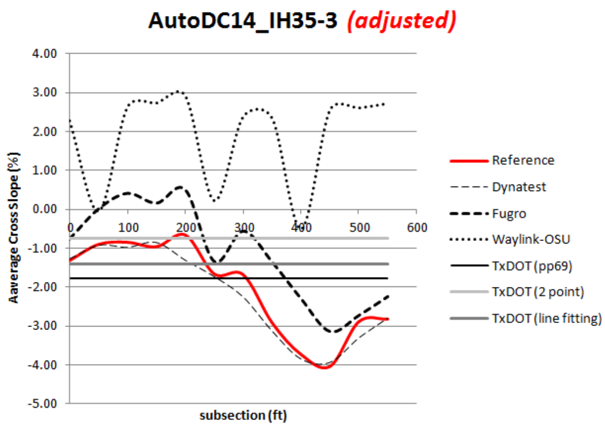

1063
1063
10_FM1063-1
SB direction
1063


Image Date: May 2011


AutoDC13_US79-1 (adjusted)
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
0
100
200
300
400
500
600
Aaverage Cross Slope (%)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

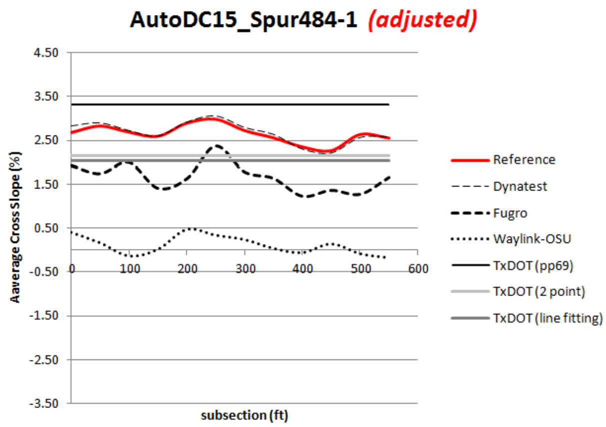

11_US79-1
WB direction
79
79


Image Date: May 2011


AutoDC14_IH35-3 (adjusted)
Aaverage Cross Slope (%)
subsection (ft)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
0
100
200
300
400
500
600
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

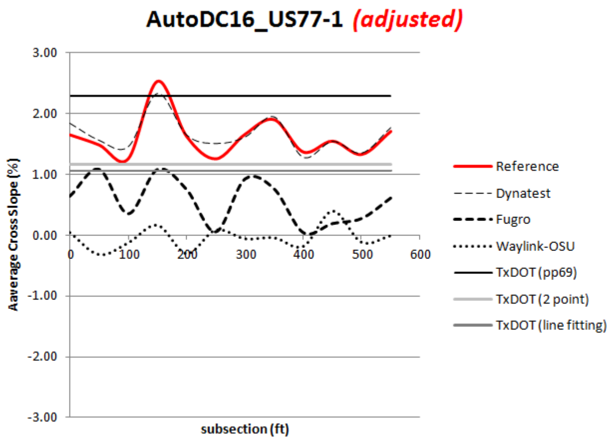

New Dallas Hwy
N I IH 35
Hogan Ln
Wheeler
Nealton St
Hogan Ln
20_IH35-3
SB direction
Parrish St
Briarwood Ln
339
35
77
338B


SPEED LIMIT 40
Image Date: March 2013

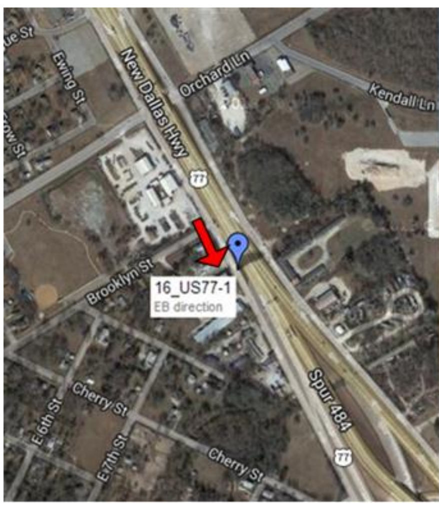

AutoDC15_Spur484-1 (adjusted)
4.50
3.50
2.50
1.50
0.50
-0.50
-1.50
-2.50
-3.50
0
100
200
300
400
500
600
Aaverage Cross Slope (%)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)


Old Marlin Rd
Marlin Hwy
15_SPUR484-1
EB direction
Marlin Hwy
Spur 484


Image Date: February 2013

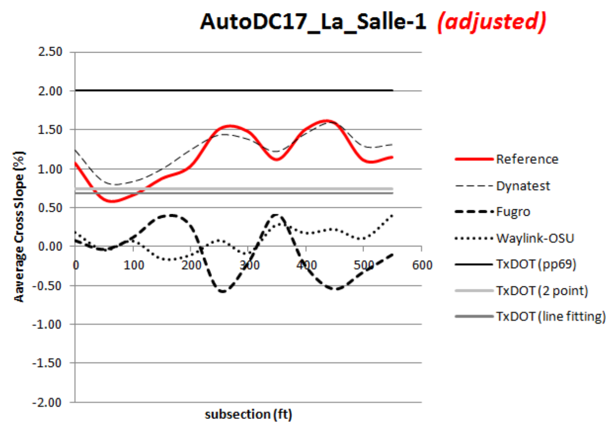


AutoDC16_US77-1 (adjusted)
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
0
100
200
300
400
500
600
Aaverage Cross Slope (%)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

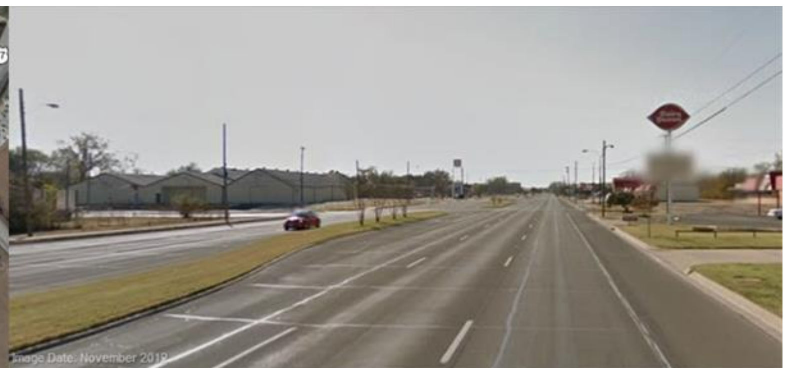


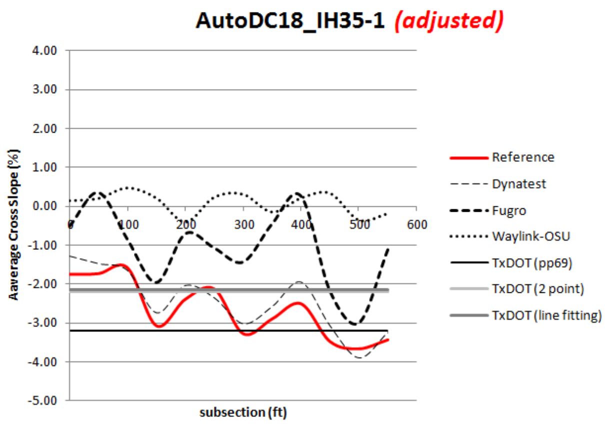
New Dallas Hwy
Orchard Ln
Kendall Ln
Ewing St
Brooklyn St
16_US77-1
EB direction
Cherry St
E6th St
E7th St
Spur 484
77

Image Date: December 2012
40


AutoDC17_La_Salle-1 (adjusted)
Aaverage Cross Slope (%)
subsection (ft)
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
0
100
200
300
400
500
600
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

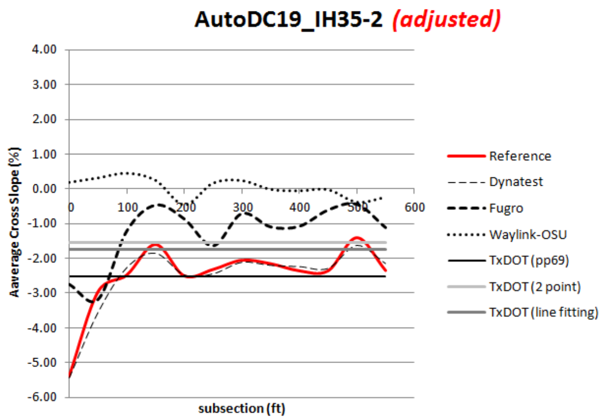

14_La_Salle-1
SB direction
La Salle Ave
Bagby Ave
Edge Field
Cottonwood St
Plum St
River St
S 1st St
S 2nd St
Daughtrey Ave
S 3rd St
S 4th St
S 2nd St
University Parks Apartments
434
77




AutoDC18_IH35-1 (adjusted)
Aaverage Cross Slope (%)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)


18_IH35-1
SB direction
333A
35
Alma Dr
Jane St
Joey St
Von Ave
331
Alta Vista Park

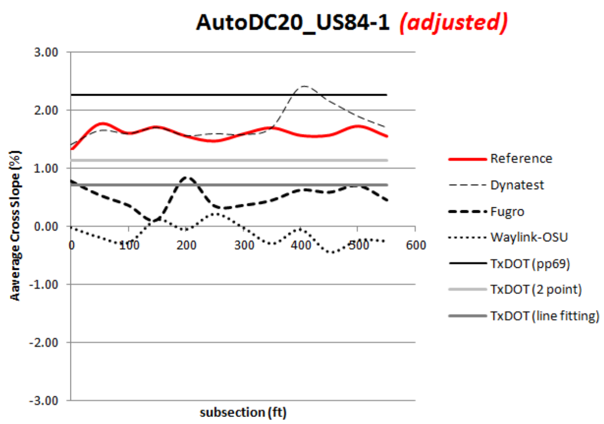

Image Date: November 2012



AutoDC19_IH35-2 (adjusted)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
0
100
200
300
400
500
600
Aaverage Cross Slope (%)
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

19_IH35-2
SB direction
Alma Dr
Jane St
Von Ave
Alta Vista Park
Alta Vista Dr
333A
331
35

Image Date: November 2012



AutoDC20_US84-1 (adjusted)
Aaverage Cross Slope (%)
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
0
100
200
300
400
500
600
subsection (ft)
Reference
Dynatest
Fugro
Waylink-OSU
TxDOT (pp69)
TxDOT (2 point)
TxDOT (line fitting)

N Valley Mills Dr
N New Rd
W Waco Dr
Hodde Dr
Staton St
Esther St
Villa Dr
17_US84-1
NB direction

Image Date: December 2012

Appendix F – Fugro Submittal

Fugro Submission for Automatic Crack Detection

For the dates of July 23 & 24, 2013, Fugro used Automatic Road Analyzer Number 48 (ARAN 48) to evaluate a series of test sites established by the University of Texas. A total of 20 sites were evaluated and each site was 550 ft in length and was composed of either and asphalt, JPCP, or CRCP pavement. The equipment was operated by Ben Ong and D.J. Swan of Fugro.

ARAN 48 was equipped with Fugro's Pave3D system. This system is formed with Pavemetric's Laser Crack Measurement System (LCMS) and other systems to measure a 3D image of the pavement surface into a proprietary file format (.FIS). The equipment was set to measure up to 4,000 pixels across a 4m wide lane with a testing frequency of one scan every 5mm down the road. This system is capable of measuring up to 70 mph and was operated within 5mph of the posted speed limit where ever feasible during the data collection process.

Data Importing and Segmenting

Upon completion of testing, the data was exported from the vehicle to a removable hard drive for processing. The data was then transferred into Fugro's Vision software suite for viewing, analysis, and reporting.

Since information on the location of the sites could not be provided in advance of the testing, manual segmenting was completed. Based on the pavement images, the start and stop locations of each site were identified within 6". If advanced location details had been provided with accurate GPS measurements, this matching process could be automated as well to reduce manual interpretation.

For data collection sites 18 & 19, the data collection was completed back to back in a single file and during this segmentation process, the results were separated into the 2 distinct sections.

Cross-Slope Analysis

The cross-slope is measured using several systems on the vehicle. The main systems used were the Applanix POS LV 220 system and the Pave3D system. The POS LV 220 system is used to measure the roll and pitch of the vehicle as compared to the direction of gravity. More information on the POS LV 220 can be found here:

http://www.applanix.com/media/downloads/products/brochures/poslv_brochure.pdf

The Pave3D system was then used to measure the cross-slope of the road as compared to the orientation of the vehicle. The values are then combined to determine the complete cross-slope of the road.

Since the complete profile of the road is available and there may be some changes in slope along the road, a straight line is fit through the transverse profile to determine the average slope. This is then used to determine the average cross-slope.

Texture Analysis

The texture was measured using the Pave3D system. A series of 5 road zones were established based on the locations outlined by CTR. The 3D measurements available are used to mimic a volumetric texture measurement as outlined in the following reference:

http://pavemetrics.com/pdf/Article_Mairepav.pdf

This was completed for the Center (middle 1.0m of the lane), left and right wheelpaths (0.75m wide), and left and right lane edges (width varies based on lane width). This was calculated on a 5ft interval for the purposes of this study. In some areas, some invalid results were found and the results were displayed simply as a ‘null’.

Automatic Crack Detection, Classification, and Rating

Fugro uses a three step process in our automatic distress process. The first stage is the crack detection phase where the images are analyzed and cracks are located. After an initial review of the conditions on the TX DoT road network survey, it was noted that a successful crack sealing program is used in Texas that successfully seals the cracks and provides an overbanded seal on the surface of the pavement. As such, there is no depth to any of these sealed cracks and the 3D technology does not often locate these distresses. So the automated process was established to use a combination of the 3D and 2D technologies. For the asphalt pavement, crack detection was completed initially based on the range images to determine unsealed crack locations. After that, a 2D detection was used to aid in the detection of the sealed cracks.

During the classification part of the process, the cracking orientation and patterns are reviewed to determine if the cracks are transverse, longitudinal, or have an alligator pattern. Cracks are also grouped at this stage to ensure that things such as multiple cracks with small gaps between them are combined to be a more realistic continuous distress.

The last stage is the rating stage, where cracks are converted to a distress as identified in the LTPP Distress Identification Manual. For example, longitudinal cracks are divided into wheelpath and non-wheelpath groups depending on their location within the lane. Edge cracking was established to have the alligator pattern on be on the outside of the lane and LTPP Alligator Cracking was deemed to be the alligator pattern cracks found within in the wheelpaths.

With the existing level of technology, we felt confident to be able to report for asphalt pavement the alligator cracking, edge cracking, longitudinal cracking (wheelpath), longitudinal cracking (non-wheelpath), and transverse cracking. For Jointed Concrete Pavements, we felt confident to report longitudinal cracking and transverse cracks. For the Continuous Reinforced Concrete Pavements, we felt confident to report longitudinal cracking and spalled transverse cracks.

Summary

Fugro has a high level of confidence in the cross-slope and texture measurements produced by our equipment. Our experience has shown that the relative values and repeatability of the texture are good, however comparisons with other sensor types may show differences.

The cracking descriptions discussed above are for a fully automated pavement distress solution. While we are confident that the fully automated results represent a high level of accuracy for fully automated solutions, there is definitely obvious room for improvement by using semi-automated techniques and quality control.

Manual work will be completed and submitted in the near future which we believe will be more accurate to the field conditions and will able to capture a wider range of distress types and conditions including special cases. We find this manual solution is more likely to meet client expectations for quality and completeness.

Should you have any questions regarding our equipment or process, please do not hesitate to ask.

Appendix G – Waylink-OSU Submittal

Data Process for the TxDOT Project 663

Kelvin C.P. Wang, Oklahoma State University

August 12, 2013

Digital Highway Data Vehicle (DHDV) equipped with PaveVision3D Ultra is used to collect 1mm 3D data for the TxDOT project 663. DHDV is developed by the WayLink Systems Corporation with collaborations from the University of Arkansas and the Oklahoma State University. With the latest PaveVision3D Ultra (3D Ultra in short), the resolution of surface data in vertical direction is about 0.3 mm and in the longitudinal direction is approximately 1 mm at 60MPH data collection speed. Figure 1(a) shows the exterior appearance of the DHDV equipped with the 3D Ultra technology. With the high power line laser projection system and custom optic filters, DHDV can work at highway speed during daytime and nighttime and maintain image quality and consistency. 3D Ultra is the latest imaging sensor technology that is able to acquire both 2D and 3D laser imaging data from pavement surface through two separate left and right sensors. Each sensor in the rear of the vehicle consists of two lasers and five special-function cameras. For the two lasers, one is for providing 2D visual illumination and the other one is for providing the 3D data illumination. For the five cameras, four cameras are for capturing 3D laser illumination and the other one is for capturing 2D laser illumination. The camera and laser working principle is shown in Figure 1(b). An example of 1mm 3D pavement surface image is illustrated in Figure 2.

(a) (b)

Figure 1 Photographs of (1) DHDV exterior appearance; (b) Pavevision3D working principle

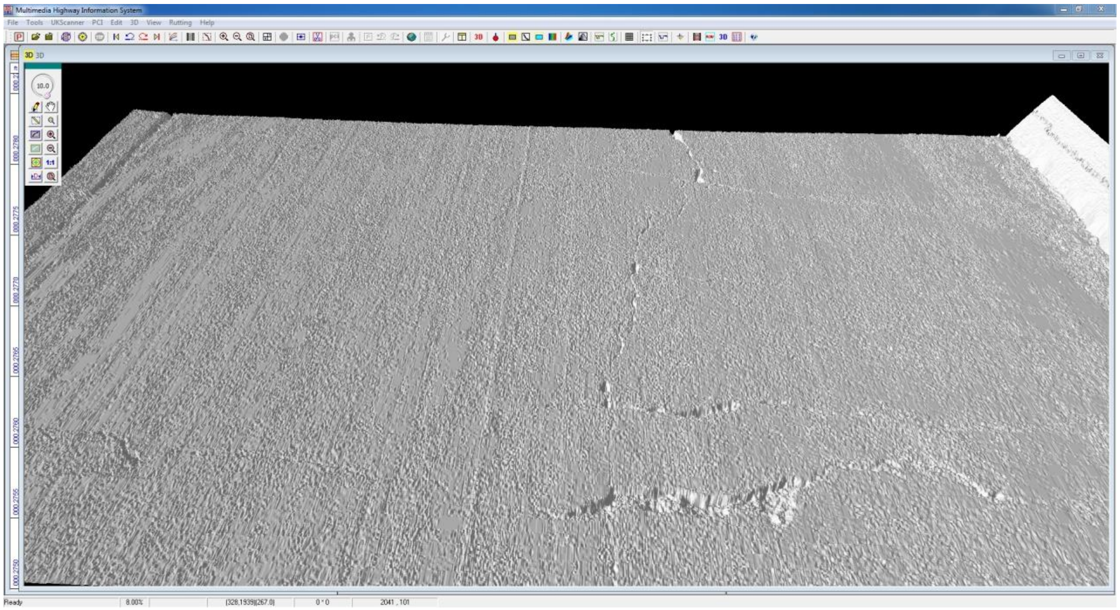


Figure 2 Example of 1mm 3D pavement surface data at 60MPH

PaveVision3D Ultra system is also equipped with AMES Engineering point texture laser that can calculate MPD values. However, AMES profiler can only collect texture data at the right wheelpath. In addition, the Inertial Measuring Unit (IMU) is capable of measuring three-directional movement of the PaveVision3D Ultra data collection system, and the data can be used to generate cross slope data for each transverse segment.

All data sets are processed using WayLink developed software with manual corrections. PaveVision3D Ultra is capable of generating required data sets for the full lane coverage at much shorter interval than 50ft defined by the UT Austin team. The following deliverables are submitted to the UT Austin team:

- Spreadsheets, which save distress, cross slope, texture data for the twenty 550-ft pavement segments based on 1mm 3D data. Distress data are reported every 50ft segment, the 13 cross-slope values in the transverse direction every 50-ft, and MPD texture data every 5ft at both wheelpath.
- Crack Maps, which include all the close-up maps for every 5 feet of pavement segment with three crack width categories. The cracks with less than 3-mm in width is marked in red, cracks with 3-6mm in blue, and cracks with over 6mm in green. The color invention is also used by the UT Austin group.