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**PAVEMENT DAMAGE
PREDICTION (PDP) AND
GIS NETWORK MANUAL
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Conducted for:

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PAVEMENT DAMAGE PREDICTION (PDP) AND GIS NETWORK MANUAL

An add-in was developed for the geographic information system (GIS) network called Pavement Damage Prediction program. This program evaluates the damage on pavement generated by a super-heavy vehicle compared to a standard truck. In this appendix, the process of selecting an Origin-Destination, execution of shortest path algorithm, and route pavement damage evaluation is explained.

ARCVIEW GIS

ArcView GIS is opened from Desktop or Start Menu program and deploys the main window as shown in Figure 1, with a smaller window with a welcome message appears with different options. The user must create a new project **as a blank project** when the user accesses this program for the first time. Selecting this option adds new buttons that appear on the title bar corresponding to the Views, Tables, Charts, Layouts and Scripts menu options. Double clicking the **Scripts** tab, a new Script window appears, see Figure 2. Selecting the **Load Text File** button will prompt a Load Script dialogue, as shown in Figure 3, where a script file titled *Load4.txt* must be selected. This script must be compiled and once executed, the user will be prompted to load a map or a theme.

The user must load a map, and by following instructions shown on screen lets the user load three themes required for executing the Pavement Damage Prediction (PDP) program. These themes are titled *Streets.shp*, *Roads.shp* and *OD.shp*, which correspond to the state highway network, the state supercorridors network, and the Origin-Destination algorithm. These themes are loaded into a View named *New York*. Figure 4 presents all opened views up to this step. The PDP program automatically saves the project file as *NewYork.apr* and a backup file named *NewYorkPDP.apr* into the *...maps* directory.

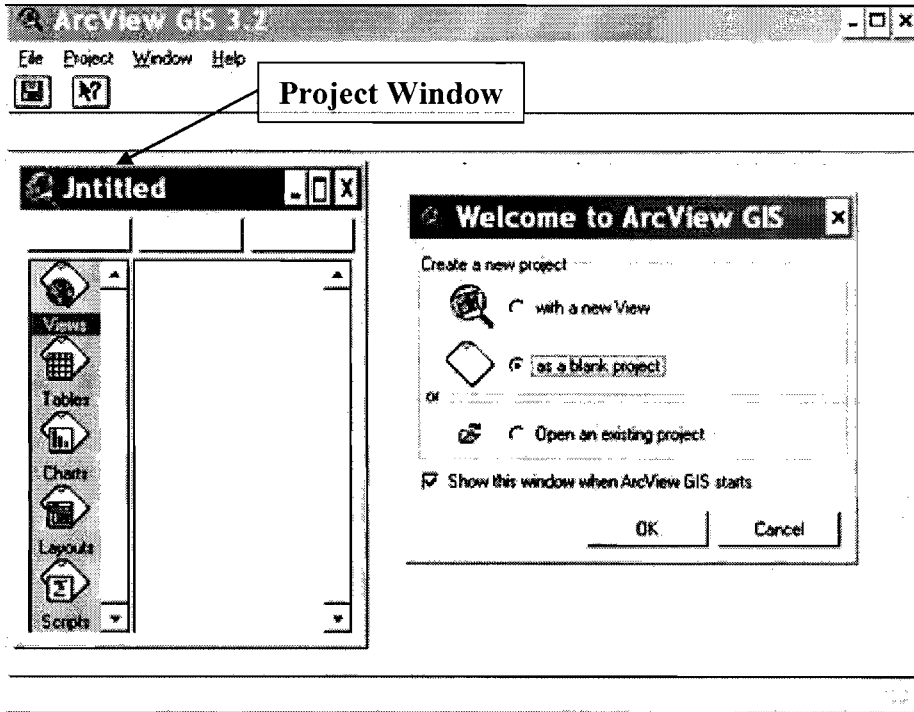


Figure 1 – ArcView GIS main window.

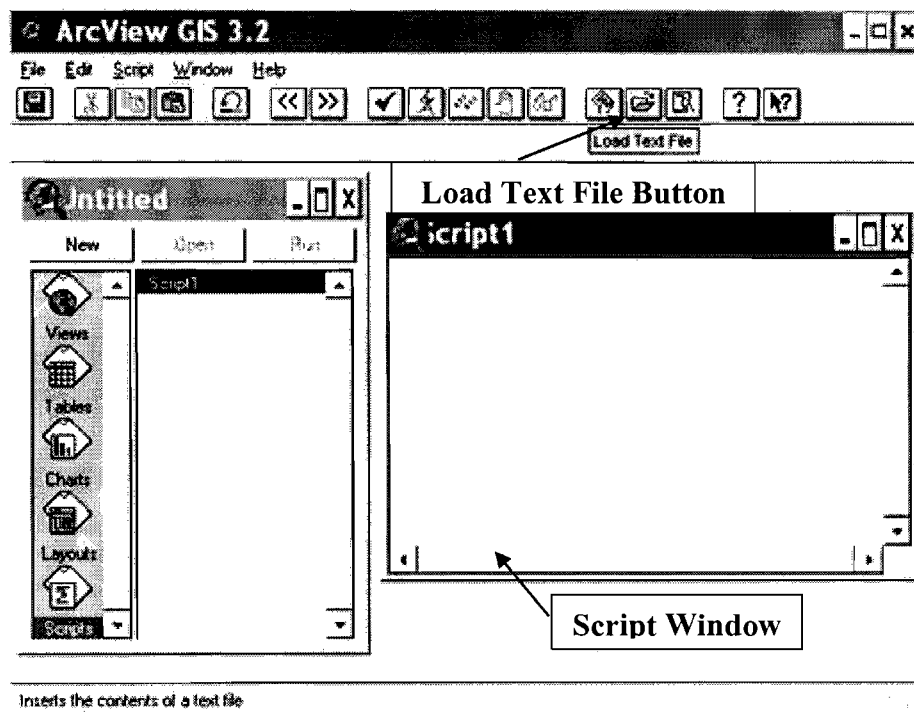


Figure 2 – Creating a new project.

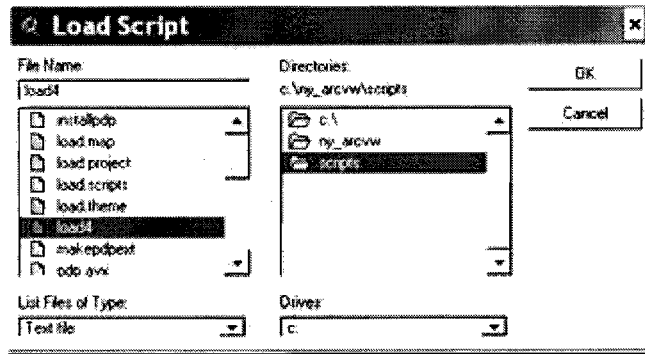


Figure 3 – Load script dialog.

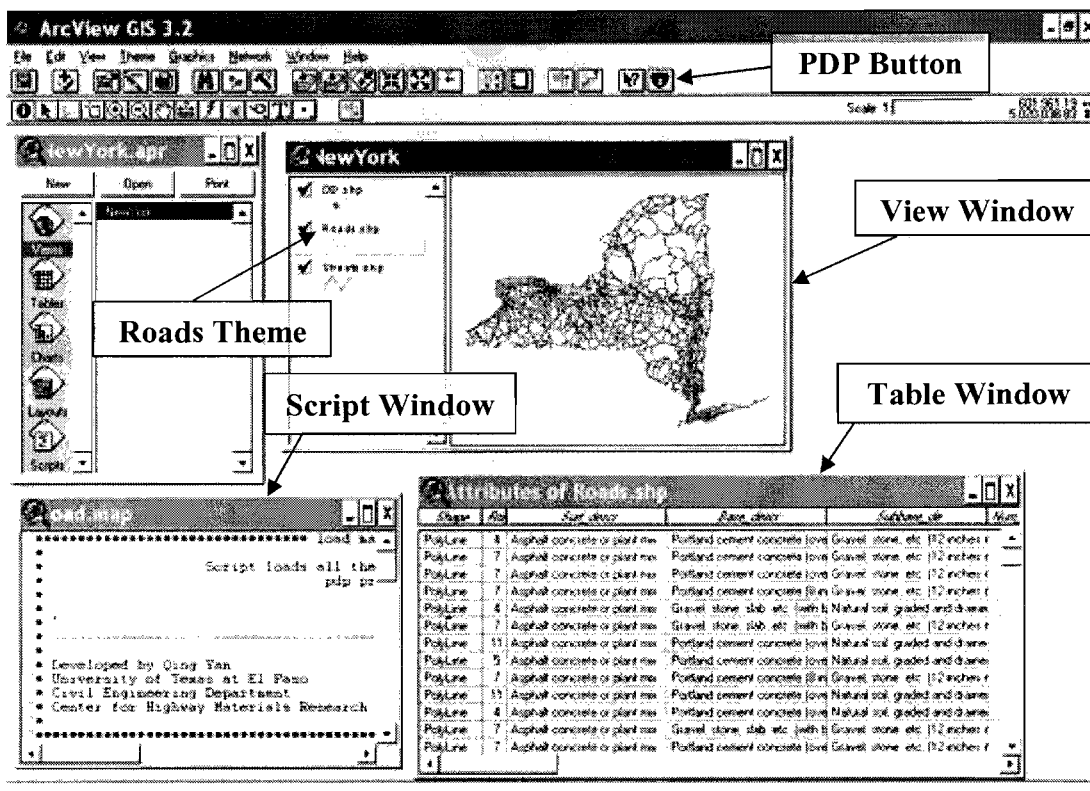


Figure 4 – New York State Map and Themes.

ADDING EXTENSIONS: NETWORK ANALYST AND PAVEMENT DAMAGE PREDICTION (PDP)

In order to execute the Pavement Damage Prediction (PDP) program, it is required to add extension into ArcView. Selecting **File** → **Extensions** on the menu opens the Extensions Dialog window shown in Figure 5. In this dialog, Network Analyst and PDP extensions must be checked from the available list of extensions. To avoid this step again, it is possible to default loading these two extensions whenever opening the project file again by selecting *Make Default*.

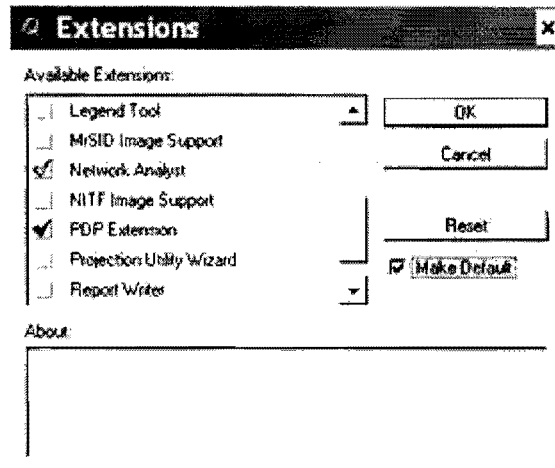



Figure 5 – Adding extensions.

Once the extensions are loaded, a U.S. Interstate icon  will appear on the buttons bar. Clicking on this button will execute the Pavement Damage Program (PDP) program. Execution of PDP initializes the map, removes previous paths; assigns a line width and color for Roads, Streets and OD themes. Furthermore, a window is opened with the PDP toolbox. A screenshot to this point is shown on Figure 6.

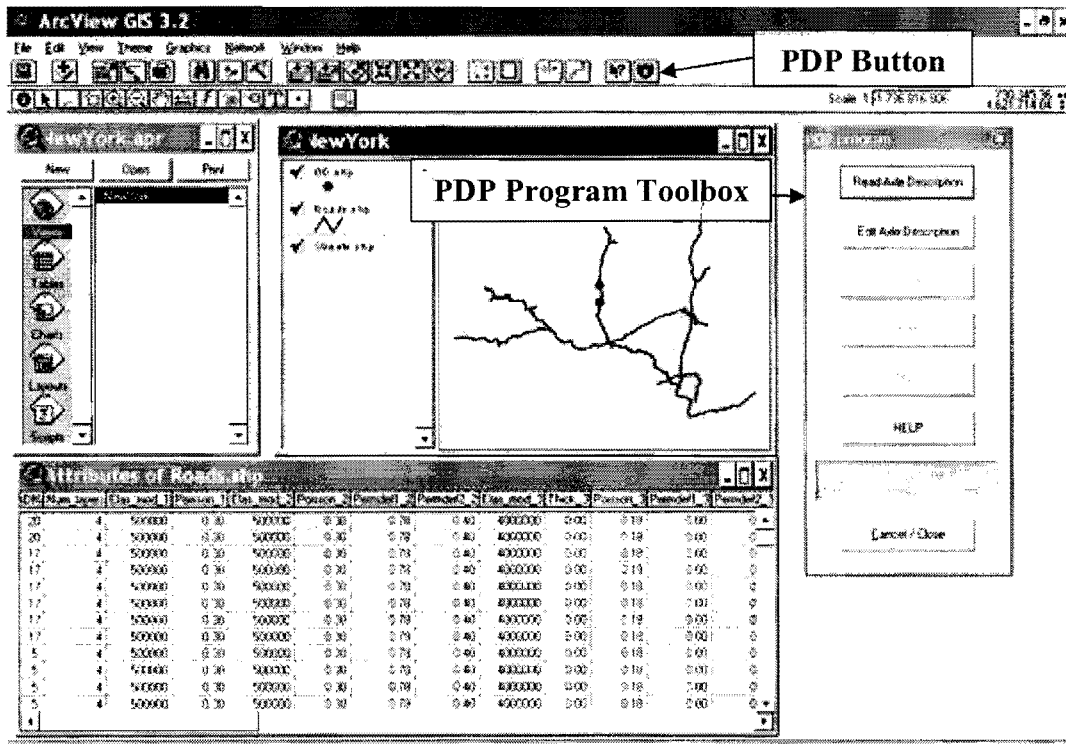


Figure 6 – PDP extension added.

The PDP toolbox contains seven command buttons and a panel that displays status messages, as shown on Figure 7.

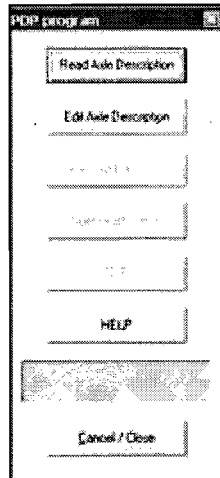


Figure 7 – PDP toolbox.

PAVEMENT DAMAGE PREDICTION

Selecting **Read Axle Description** button on the PDP toolbox displays a dialogue window, shown in Figure 8 requesting the user to a text file with axle information stored under the `\veh_lib\` folder. After selecting the text file, the user must select **Edit Axle Description** on the PDP toolbox to open another window that provides vehicle information from the selected text file as Figure 9 presents. The user has the option of editing the information and saving the axle description onto another file. A *Vehicle data saved* message will appear on panel.

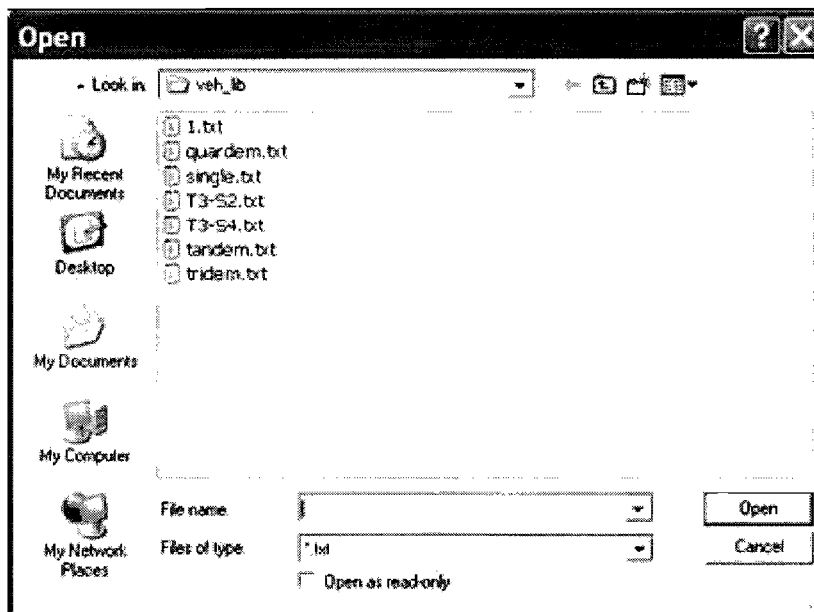


Figure 8 – Open dialog to select vehicle properties text file.

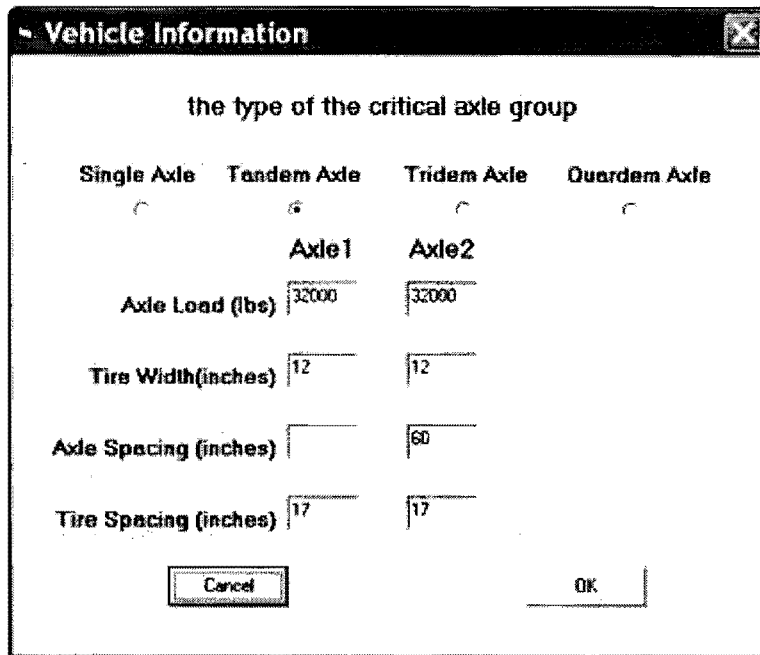


Figure 9 – Vehicle information.

The Origin and Destination points may be selected by two different methods.

- Draw points: OD theme is set as a working theme by clicking **OD.shp** tab on the New York view window. **Theme** → **Start Editing** is selected from main menu, this displays a dash line that appears around the check box of **OD.shp**. Using **Draw Point** button on tools bar displays a highway network as a thick blue line on map. Storing edits are performed through **Theme** → **Save edits** and **Theme** → **Stop editing**.
- Move existing points: OD theme must be made editable as explained above. Then, selecting **Pointer** button allows the existing point shown on map to be moved anywhere on map. Finally, edits must be saved and stopped on theme menu.

Figure 10 shows the main buttons used to perform this operation.

After editing the location of points, the **Clear Selected Features** must be selected to unselect points. The first point drawn is considered as an Origin while the last one as a Destination point. **Select Path Points** on PDP toolbox allows the program read OD information. Help files are available on the PDP toolbox under **Help**. In order to exit PDP, **Cancel/Close** must be selected. This closes dynamic data exchange between ArcView and PDP.

Selecting **PDP** on **PDP toolbox**, displays a save dialogue that prints the final report. The default directory is under *\reports* as shown on Figure 11. Afterwards, another window titled **Analysis Parameters** is shown on screen. Both temperature and standard vehicle type (T3-S2 or T3-S4) must be defined by user. Figure 12 shows this window. Configuration of standard vehicle also can be defined and modified in Vehicle Information form by clicking on **Edit Axle Description**.

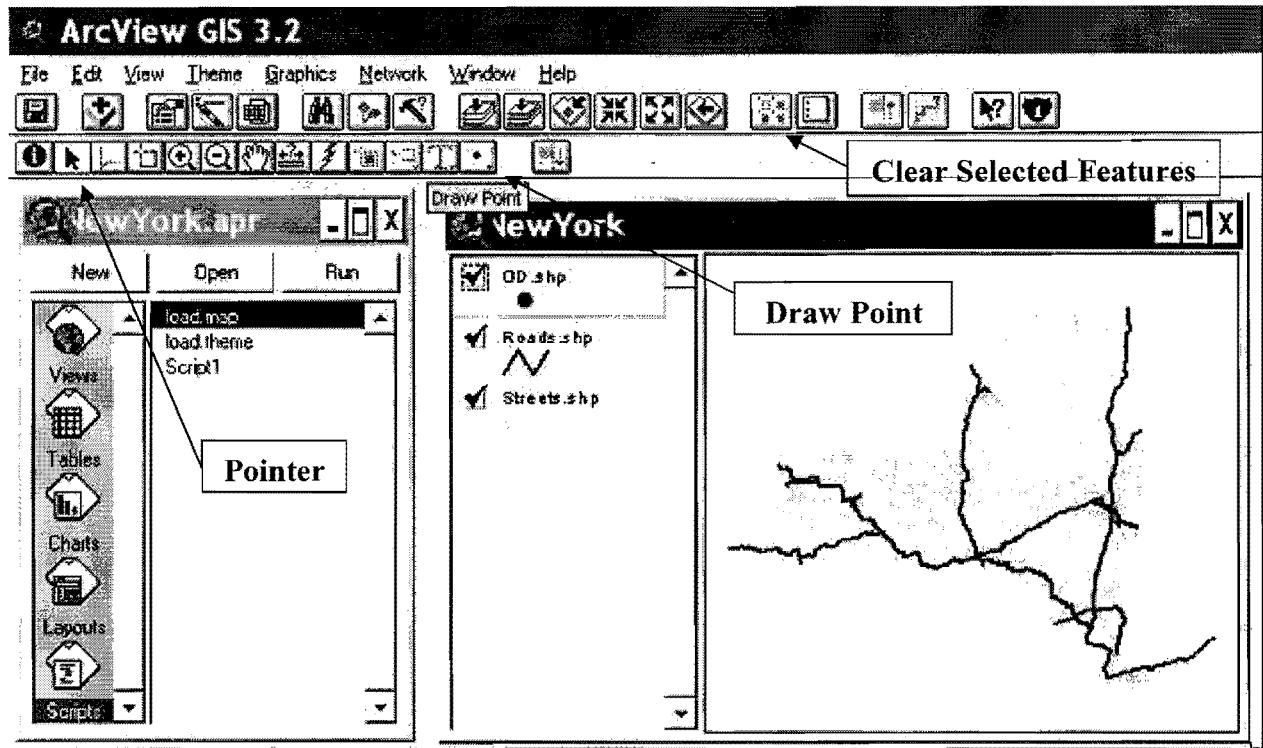


Figure 10 – Defining Origin and Destination points.

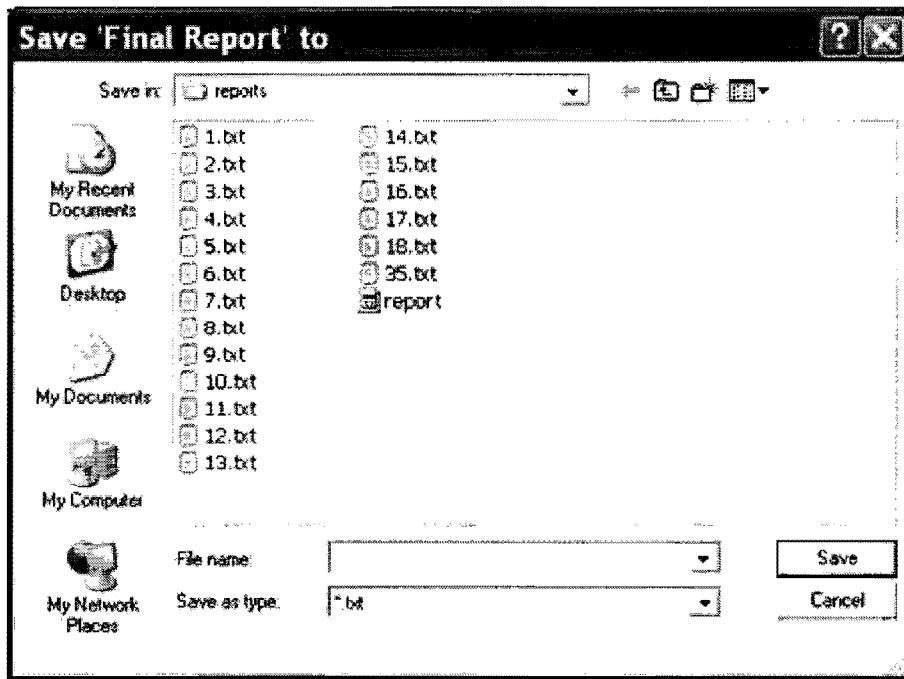


Figure 11 – Save final report dialog.

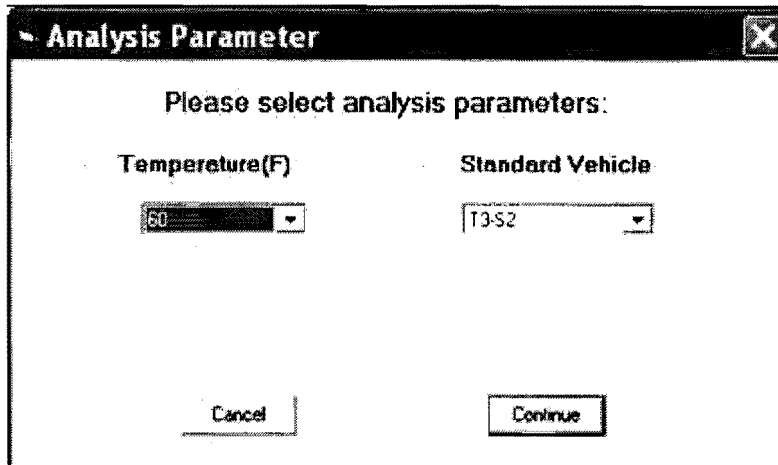


Figure 12 – Standard vehicle and temperature defined.

After all this information is incorporated into the model by the user, the PDP program will find a shortest path. A thicker red line representing the shortest path connecting both Origin and Destination points is displayed on map, and a *Path* theme will appear on Table of Contents, as shown in Figure 13.

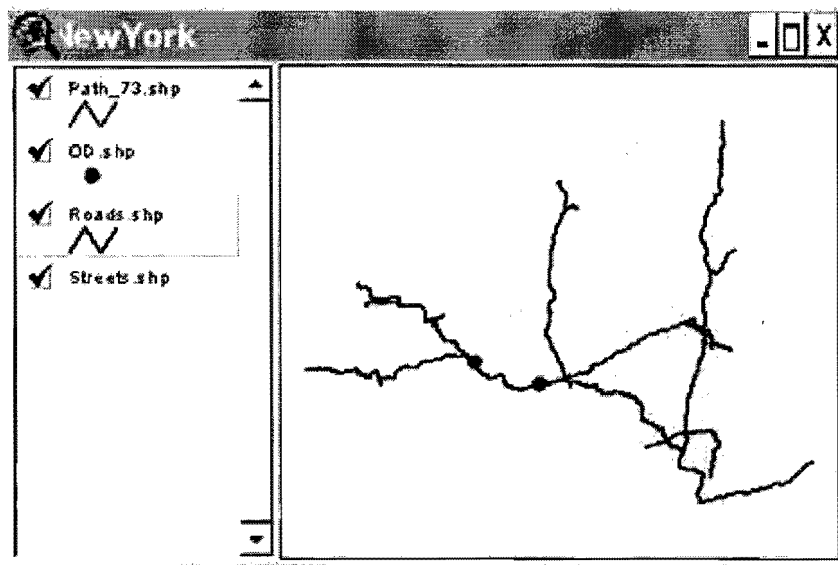


Figure 13 – Shortest route found between Origin and Destination points

Furthermore, it also generates a **Progressive Report** that displays pavement properties along the shortest path found. For the time being, pavement information for every road link is assumed to be identical unless the database is updated for every link. Figure 14 presents the Progressive Report window.

Progressive Report

Please check the route information and pavement properties below:

Stnum	Route	Pavement	Num_layers	Top_thick	Binder_thick	Concrete_thick	Base_thick	Subbase_thick	Subgrade_thick
67-2	17	Asphalt	4	1.5	1.5	0	12	0	40
56-5	17	Asphalt	4	1.5	1.5	0	12	0	40
70-6	17	Asphalt	4	1.5	1.5	0	12	0	40
70-6	17	Asphalt	4	1.5	1.5	0	12	0	40
53-5	17	Asphalt	4	1.5	1.5	0	12	0	40
67-4	17	Asphalt	4	1.5	1.5	0	12	0	40
67-4	17	Asphalt	4	1.5	1.5	0	12	0	40
63-5	17	Asphalt	4	1.5	1.5	0	12	0	40
5207	17	Asphalt	4	1.5	1.5	0	12	0	40
5207	17	Asphalt	4	1.5	1.5	0	12	0	40
48-3	17	Asphalt	4	1.5	1.5	0	12	0	40
94-16	17	Asphalt	4	1.5	1.5	0	12	0	40
84-2	17	Asphalt	4	1.5	1.5	0	12	0	40
53-5	17	Asphalt	4	1.5	1.5	0	12	0	40
84-2	17	Asphalt	4	1.5	1.5	0	12	0	40
55-5	17	Asphalt	4	1.5	1.5	0	12	0	40
56-5	17	Asphalt	4	1.5	1.5	0	12	0	40
64-15	17	Asphalt	4	1.5	1.5	0	12	0	40
55-5	17	Asphalt	4	1.5	1.5	0	12	0	40
67-2	17	Asphalt	4	1.5	1.5	0	12	0	40
69-5	17	Asphalt	4	1.5	1.5	0	12	0	40
358	17	Asphalt	4	1.5	1.5	0	12	0	40
5207	17	Asphalt	4	1.5	1.5	0	12	0	40
5207	17	Asphalt	4	1.5	1.5	0	12	0	40
46-3	17	Asphalt	4	1.5	1.5	0	12	0	40
94-15	17	Asphalt	4	1.5	1.5	0	12	0	40

Cancel Continue

Figure 14 – Complete shortest path links pavement properties

Clicking **Continue** accepts the information displayed on Progressive Report, and PDP calls the finite element program to analyze pavement permanent deformation for every road link. As said before, each link will be analyzed twice: one analysis for the standard vehicle, another one for truck to be compared with. Then, the relative damage will be obtained through a damage ratio between the specified truck generated rutting to that of the standard vehicle. Last, a final report will be written and displayed with the input information for each truck, and the obtained damage ratio.

An excerpt is presented below from a sample final report showing vehicle description, route description and relative damage for the route between origin and destination points.

```

***           Vehicle Description and Pavement Properties
***

           Algorithm: Shortest Path

---Super Heavy Vehicle Critical Axles Group Description---

           Super Heavy Vehicle:      TANDEM

Number of axles      2

```

Axle load(lbs)	Tire width(in)	Axle spacing(in)	Tire spacing(in)
32000	12	000	17
32000	12	060	17

---Standard Vehicle Critical Axles Group Description---

Standard Vehicle: T3-S2

Number of axles	2			
Axle load(lbs)	Tire width(in)	Axle spacing(in)	Tire spacing(in)	
18000	12	000	17	
18000	12	060	17	

-----Analysis Parameter Description-----

Temperature = 60

----- Route Description -----

Stop	Geographic Coordinates (Degrees)	
	Longitude	Latitude
0	315156	4684420
1	395166	4656310

Starting from Stop 0
 Turn right onto 86
 Travel on 86 for 20.96 mi
 Continue straight onto 17
 Travel on 17 for 45.61 mi
 Turn right into Stop 1

Total distance traveled is 66.58 mi

----- Asphalt Pavement Damage Description -----

Num	Shnum	Top	Binder	Concrete	Base	Subbase
Subgrade	Total					
01	67-2	Relative Damage =		1.8		
T3-S2		-0.0003	0	0	0.0066	0
.0831						
TANDEM		-0.0006	0	0	0.0118	0
.1477						

02	55-5	Relative Damage =		1.8		
T3-S2		-0.0003	0	0	0.0066	0
.0831						
TANDEM		-0.0006	0	0	0.0118	0
.1477						

03	70-6	Relative Damage =		1.8		
T3-S2		-0.0003	0	0	0.0066	0
.0831						
TANDEM		-0.0006	0	0	0.0118	0
.1477						

04	70-6	Relative Damage =		1.8		

T3-S2		-0.0003	0	0	0.0066	0	0.0768
.0831							
TANDEM		-0.0006	0	0	0.0118	0	0.1365
.1477							

05	53-5	Relative Damage =		1.8			
T3-S2		-0.0003	0	0	0.0066	0	0.0768
.0831							
TANDEM		-0.0006	0	0	0.0118	0	0.1365
.1477							

06	67-4	Relative Damage =		1.8			
T3-S2		-0.0003	0	0	0.0066	0	0.0768
.0831							
TANDEM		-0.0006	0	0	0.0118	0	0.1365
.1477							

07	67-4	Relative Damage =		1.8			
T3-S2		-0.0003	0	0	0.0066	0	0.0768
.0831							
TANDEM		-0.0006	0	0	0.0118	0	0.1365
.1477							

08	53-5	Relative Damage =		1.8			
T3-S2		-0.0003	0	0	0.0066	0	0.0768
.0831							
TANDEM		-0.0006	0	0	0.0118	0	0.1365
.1477							
