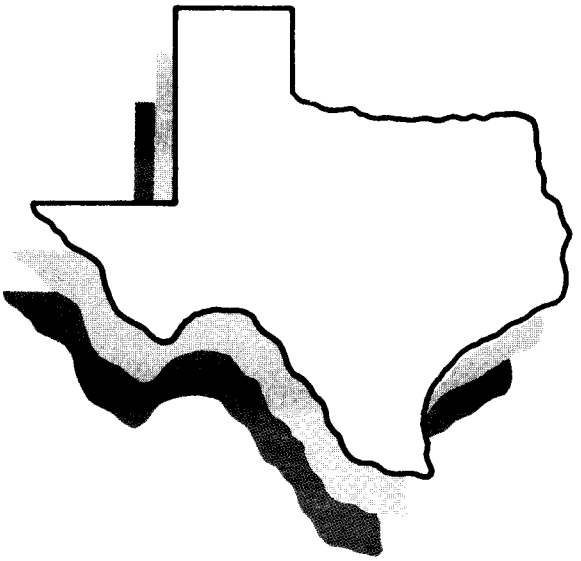
# A STATISTICAL ANALYSIS OF THE TENSILE STRENGTH OF BITUMINOUS MIXTURES

**DHT-23**

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16. Abstract

District 12 has sought to evaluate and reduce the potential for stripping or water sensitivity of bituminous mixtures. Using Test Method Tex-531-C, "Prediction of Moisture-Induced Damage to Bituminous Paving Mixtures Using Molded Specimens," the District tested 312 samples in 1988 and 1989. Liquid anti-strip chemicals were added to most of these samples.

Statistical analysis of the test results for tensile strength ratio as well as indirect tensile strength indicate over 80 percent of the samples which passed minimum strength ratio have a minimum conditioned tensile strength greater than 60 psi.

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# A Statistical Analysis of The Tensile Strength of Bituminous Mixtures

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The contents of this report reflect the views of the author, who is responsible for the facts and the accuracy of the data presented in the report. The contents do not necessarily reflect the official views or policies of the State Department of Highways and Public Transportation. This report does not constitute a standard, specification or regulation.

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Test Method Tex-531-C, "Prediction of Moisture-Induced Damage to Bituminous Paving Mixtures Using Molded Specimens," has been used in the Houston district for six years. We have sought to evaluate and reduce the stripping potential or water sensitivity of the bituminous mixture.[1] This report presents the statistical analysis of the test results for tensile strength ratio, as well as the indirect tensile strength of 312 mixtures used in 1988 and 1989.

Liquid anti-strip chemicals were added to most of these 312 samples to reduce stripping potential. As shown in Figure I and Table I, sixty-four percent (or 201) of the samples tested passed the minimum tensile strength ratio of 0.70. Sixteen percent (51 samples) of the mixtures tested had a tensile strength ratio between 0.60 and 0.70. The number of mixtures having a tensile strength ratio between 0.50 and 0.60 and those having a tensile strength ratio between 0.40 and 0.50 are 36 samples, or twelve percent, and 21 samples, or seven percent, respectively. Only three samples (one percent of the mixtures) had a tensile strength ratio below 0.40.

Table II is a statistical analysis of the actual indirect tensile strength of the 201 samples (sixty-four percent) which passed the minimum tensile strength ratio requirement. Of these samples, 80.6% (162 samples) had a conditioned tensile strength greater than 60 psi. The remaining 39 samples (19.4%) had conditioned tensile strengths less than 60 psi. Figure II and Figure III show the maximum, minimum and mean tensile strengths of the bituminous paving mixtures.

In conclusion, statistics indicate that over eighty percent of our mixtures which passed the minimum strength ratio have a minimum conditioned tensile strength greater than 60 psi. Because the higher indirect tensile strength of the bituminous mixtures will provide better performance, it appears that our specification should indicate a minimum conditioned tensile strength in addition to the minimum strength ratio.

## Test Method Tex 531-C Results
### In 1988 & 1989
### 312 Total Samples Tested

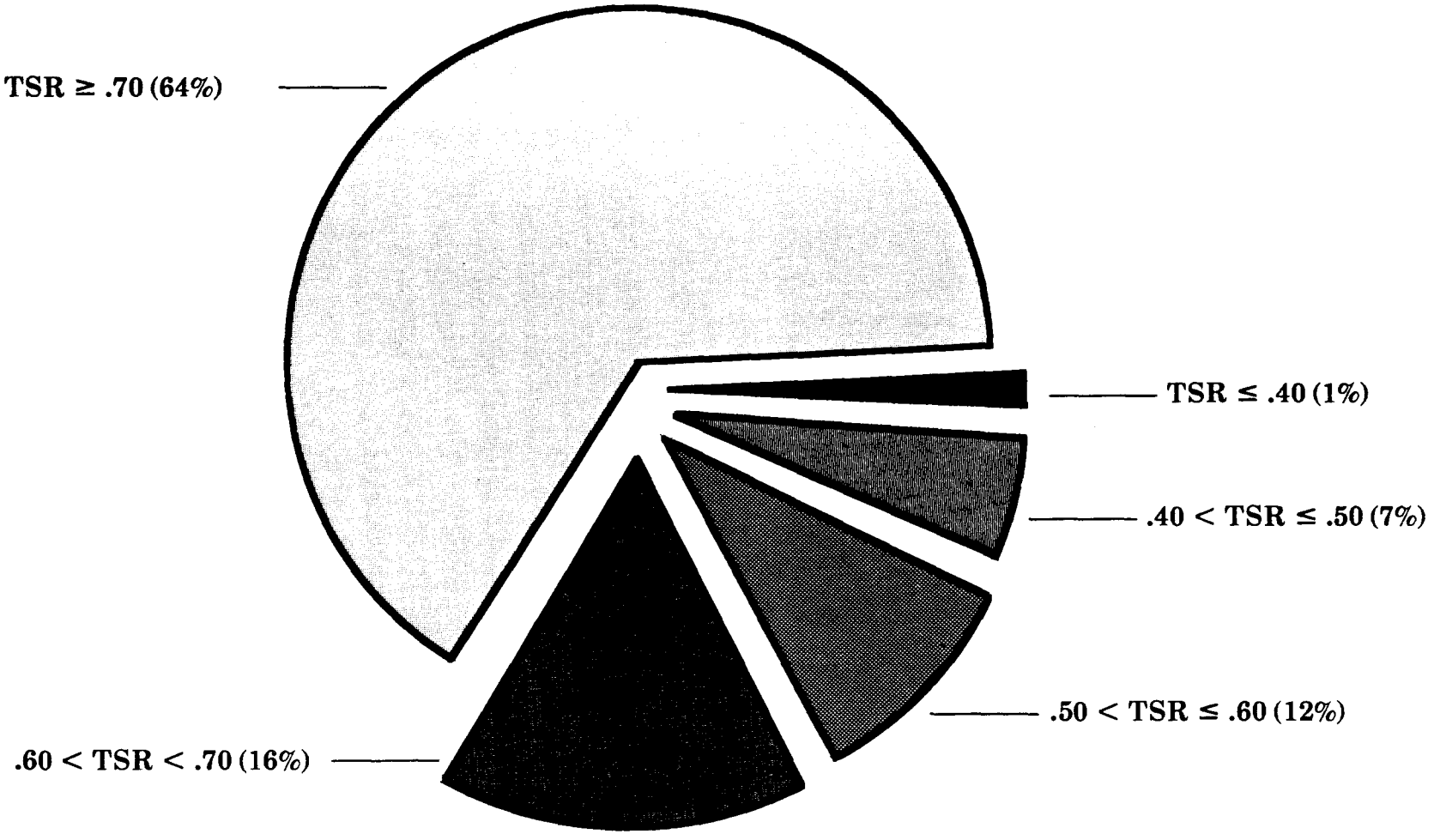



Figure I

**Test Method Tex-531-C Results Data**

**Jan. 1988 — Dec. 1989**

Total Samples: 312 Samples

201 Samples with T.S.R.** ≥ 0.70

111 Samples with T.S.R. < 0.70

- 51 Samples (0.60 ≤ T.S.R. < 0.70)
- 36 Samples (0.50 ≤ T.S.R. < 0.60)
- 21 Samples (0.40 ≤ T.S.R. < 0.50)
- 3 Samples (T.S.R. < 0.40)

Minimum Passing T.S.R. = 0.70
** Tensile Strength Ratio

Table I

**Test Method Tex-531-C Results Data**

**Jan. 1988 — Dec. 1989**

| Condition | No. of Samples | % |
|---|---|---|
| Total Samples | 312 | 100 |
| * T.S.R. ≥ 0.70 | 201 | 64.4 |
| T.S.R. ≤ 0.70 | 111 | 35.6 |
| ** Wet ITS ≥ 60 psi and TSR ≥ 0.70 | 162 | 80.6 |
| Wet ITS ≤ 60 psi and TSR ≤ 0.70 | 39 | 19.4 |

With 312 samples in these data, the 531-C passed with:

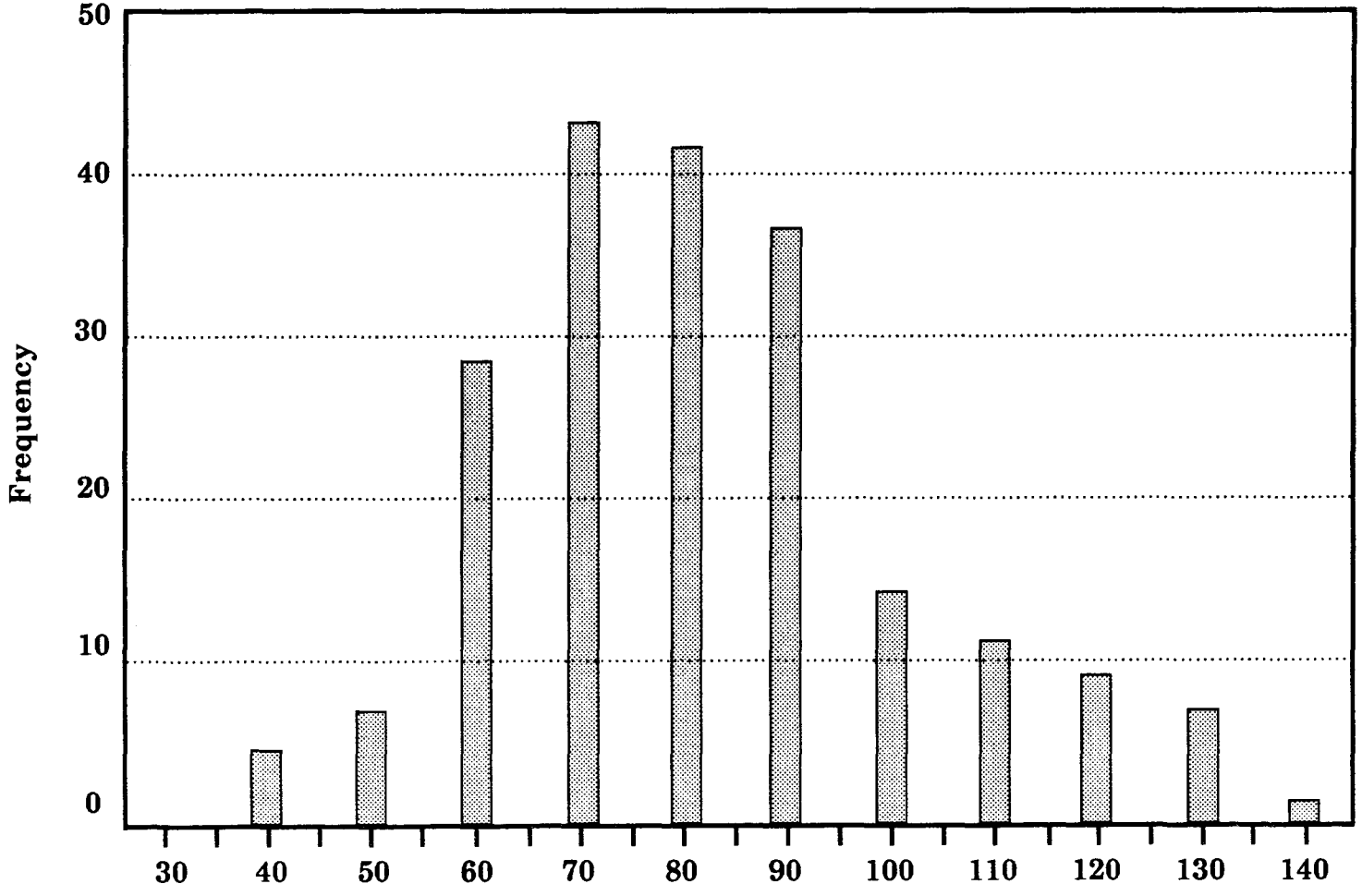
1. TSR ≥ 0.70 ..... 201 samples passed
2. Wet ITS ≥ 60 psi ..... 162 samples passed
3. Wet ITS < 60 psi ..... 39 samples passed

* TSR = Tensile Strength Ratio

** ITS = Indirected Tensile Strength

Table II

**Frequency of Conditioned I.T.S.**
**With Passing Ratios ( T.S.R. ≥ 0.70)**

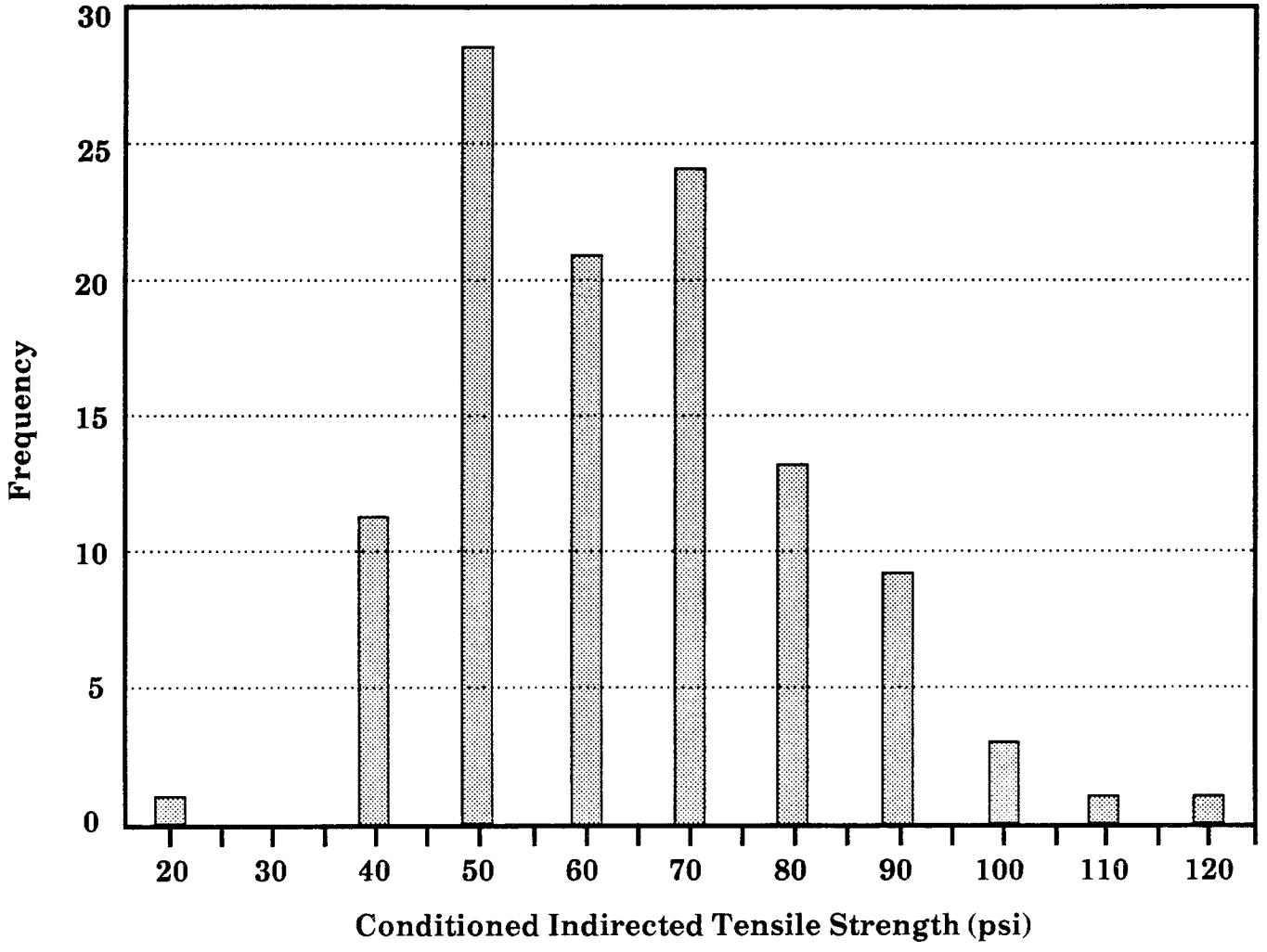



**Total: 201 Samples**

| Min. | Max. | Mean |
|---|---|---|
| 40 | 140 | 77 |

Figure II

**Frequency of Conditioned I.T.S.**
**With Failed Ratios ( T.S.R. < 0.70)**




**Total: 111 Samples**

| Min. | Max. | Mean |
|---|---|---|
| 20 | 120 | 58 |

Figure III

## Reference

1. Michael K. Ho, "The Effect of Anti-Stripping Agents on the Tensile Strength of Bituminous Mixtures." Department Information Exchange, DHT-5, State Dept. of Highways & Public Transportation, Austin, Texas.