Pavement Roughness Studies (A Progress Report)

Rolands L. Rizenbergs
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MEMO TO:  A. O. Neiser  
Assistant State Highway Engineer

The attached report, "Pavement Roughness Studies," by Rolands L. Rizenbergs, Research Engineer Associate, is a progress report on research performed in this field during 1961. Possibly the most significant effort has been the evaluation of three segments of new Interstate pavement opened to traffic during the year. A separate plot of the roughness index values for Interstate pavements has been prepared and is shown in Fig. 6, page 18.

Roughness index values for component layers of Clark County, I-64-5(7)93, are shown in page 16. These data indicate that through careful leveling, etc., significant reduction in roughness values can be accomplished. The roughness index values for Interstate pavements have been reported previously to the Construction Division. These data were requested for use in final pavement inspection prior to acceptance and before the projects had been opened to traffic.

Mr. Rizenbergs has described a pavement serviceability study that resulted in the rating of three pavements by methods used at the AASHO Road Test Project. We find, on a limited basis, that there is some correlation between the roughness index and present serviceability index.
We were invited to participate in a co-operative pavement roughness evaluation along with Michigan, Illinois, Indiana, AASHO Road Test Staff, and the Bureau of Public Roads in northern Indiana, in August, 1961. We have comparative values from methods in use by each of the groups for correlation with our values. Following this work, we have had inquiries indicating that the Indiana Joint Highway Research Project is considering obtaining roughness equipment patterned after the Kentucky unit. California has built two of these units.

We plan to continue evaluation of projects under study and to begin roughness measurements on major projects completed during the next year.

Respectfully submitted,

W. B. Drake
Director of Research

Enc.
cc: Research Committee Members
Bureau of Public Roads (3)
Commonwealth of Kentucky
Department of Highways

PAVEMENT ROUGHNESS STUDIES
(A Progress Report)

by

Rolands L. Rizenbergs
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Highway Materials Research Laboratory
Lexington, Kentucky
March, 1962
INTRODUCTION

Road roughness testing in Kentucky was first reported in 1949 (1). At that time, emphasis was placed on localized irregularities in pavement profiles detectable by a roller-type straight edge. The experience gained then pointed to the necessity for making a fast, continuous recording of characteristics of the road which would be more closely related to riding quality. Subsequent progress reports (2)(3) dealing with the development of triaxial acceleration as applied to the evaluation of pavement riding qualities emphasized riding comfort or discomfort. The accelerations monitored then were evaluated in terms of g's per second, or "jerk", which is considered by some authorities to be a more significant index of comfort. This earlier method of analysis was later reviewed, and the resultant report (4) in 1961, of which this report is a continuation, considered acceleration in g's to be the most practical parameter to use in describing pavement roughness. However, only the accelerations in the vertical direction are considered in the present method of analysis. The previous reports contain descriptions of instruments and methods of recording roughness and of determining roughness indexes.

Beginning in 1957, some 265 miles of bituminous pavements on 50 separate projects were tested for roughness in connection with a
"Re-Evaluation of Kentucky Flexible Pavement Design Criterion"(5).
Specific design information pertaining to each project was compiled at that time and is tabulated in Bulletin No. 52 of the Engineering Experiment Station, College of Engineering, University of Kentucky, June, 1959, which is a report on "Kentucky Flexible Pavement Design Studies". All of these roads were constructed between 1946 and 1956. All except eight are listed in Table 1 under "US and Ky. Routes."
Eight of these projects were re-surfaced soon after the 1957 study, and these are listed separately in Table 1 under "Re-surfacings."

Roughness measurements were also taken on these roads in 1959 and 1960. Additional bituminous paving projects have been included in the testing program, and these are listed in Table 1, under "Interstate, "Recent Construction," and "PCC Base with Bituminous Surface."

Likewise, Table 2 lists roughness measurements on Interstate portland cement concrete pavements, the year of their completion, and the year of roughness measurements. Other concrete pavements of interest and their respective roughness data are listed in Table 2 under "US Routes" and "Recent Construction."

Note: Tables 1 and 2, here, are continuations of Tables 1 and 2, included in the March, 1961 report on "Analysis of Pavement Roughness."
During 1961, the equivalent of about 800 lane-miles of pavement were tested and analyzed. The largest portion of this mileage was on completed Interstate projects. In November, three pavements selected by the Bureau of Public Roads for serviceability-index ratings (6) were tested; and these are discussed briefly in this report.

Periodic surveillance of the roughness of all of the roads presently listed in Tables 1 and 2 is contemplated. New primary and Interstate construction will be included in the future. Thus, each respective project may be eventually characterized by a history of roughness measurements.
RESULTS AND ANALYSES

All of the data applicable to the projects under study are shown in Tables 1 and 2. A map showing the approximate locations of the completed Interstate projects is presented in Fig. 1.

Rating of Primary and Secondary Roads

The roughness of portland cement concrete and bituminous pavements, both primary and secondary, were considered in a combined plot in Fig. 2. This data was subdivided into approximately equal quartiles (containing equal number of projects) which are indicated by the "word" classification given at the bottom of Fig. 2. An overlap was allotted to each quartile in order to avoid sharp distinction between pavements having nearly the same roughness indexes. The median roughness index of 600 was computed from all the available data without any distinction as to the types or ages of pavements. There are as many roads having roughness indexes greater than 600 as there are roads having less than this value. Accordingly, the median value was selected as the midpoint for the "word" classification. Hence, the first quartile to the left and right of the median were designated "good" and "fair" respectively, and the outer quartiles, in the same respective order, were designated as "excellent" and "poor". The inclusion of several additional roads has increased the median roughness over that of the previous year thereby, causing a shift in the quartile boundaries.
# TABLE 1

**BITUMINOUS CONCRETE PAVEMENTS**

<table>
<thead>
<tr>
<th>ROUTE</th>
<th>PROJECT NO.</th>
<th>COUNTY</th>
<th>LENGTH (FT)</th>
<th>REHAB</th>
<th>IN YEARS 1</th>
<th>IN YEARS 2</th>
<th>IN YEARS 3</th>
<th>IN YEARS 4</th>
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<tr>
<td>154-50(1)</td>
<td>Mt. Sterling—Winchester</td>
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<td>154-50(2)</td>
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<td>Clark</td>
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<td>154-50(3)</td>
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## INTERSTATE

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<th>IN YEARS 2</th>
<th>IN YEARS 3</th>
<th>IN YEARS 4</th>
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## US & KY ROUTES

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<th>IN YEARS 2</th>
<th>IN YEARS 3</th>
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TABLE 1 (Continued)

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<th>County</th>
<th>Acceptance Yr.</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>Ky. 50 SB</td>
<td>F 569 (L) 1955</td>
<td>Forksville - Leitchfield</td>
<td>Grayson</td>
<td>1957</td>
<td>1959</td>
</tr>
<tr>
<td>Ky. 50 SB</td>
<td>F 617 (S) 1951</td>
<td>Russell - springs - Breakfast</td>
<td>Pulaski</td>
<td>1957</td>
<td>1959</td>
</tr>
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<td>Ky. 50 SB</td>
<td>F 100 - 335 (L) 1955</td>
<td>Mountville - Breakfast</td>
<td>Clinton</td>
<td>1957</td>
<td>1959</td>
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<tr>
<td>Ky. 90 EN</td>
<td>F 10 (S) 1955</td>
<td>Mountville - Breakfast</td>
<td>Clinton</td>
<td>1957</td>
<td>1959</td>
</tr>
<tr>
<td>Ky. 90 EN</td>
<td>F 116 (S) 1955</td>
<td>Burkesville - Clinton</td>
<td>Cumberland</td>
<td>1957</td>
<td>1959</td>
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RESURFACINGS

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<td>Ky. 69 EN</td>
<td>F 137 (S) 1957</td>
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<td>Ky. 69 EN</td>
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- Resurfaced in 1959
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<th>STATE ROUTE NO,</th>
<th>COUNTY</th>
<th>LENGTH</th>
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<th>1937</th>
<th>1955</th>
<th>REMARKS</th>
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<td>US 25</td>
<td>28</td>
<td>Fayette</td>
<td>1.5</td>
<td>1/23</td>
<td>129</td>
<td>All lanes constructed in 1959</td>
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<td>Fayette</td>
<td>4.6</td>
<td>346</td>
<td>141</td>
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<td>US 27</td>
<td>30</td>
<td>Knox</td>
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<td>294</td>
<td>334</td>
<td>Constructed in 1959</td>
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<tr>
<td>US 27-28</td>
<td>31</td>
<td>Lincoln- Pulaski</td>
<td>15.1</td>
<td>194</td>
<td>448</td>
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<td>US 35</td>
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<td>33</td>
<td>Carter</td>
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<td>302</td>
<td>302</td>
<td>All lanes, constructed in 1961</td>
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<td>Mercer</td>
<td>3.5</td>
<td>302</td>
<td>302</td>
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<td>US 50</td>
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<td>Lincoln</td>
<td>5.8</td>
<td>405</td>
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<td>US 50</td>
<td>36</td>
<td>Pulaski</td>
<td>1.2</td>
<td>363</td>
<td>363</td>
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<td>US 50 &amp; Ky. 270</td>
<td>37</td>
<td>Logan</td>
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<td>All lanes, constructed in 1959, 1/3 rule</td>
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<td>Ky. 31</td>
<td>38</td>
<td>Boyle</td>
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### PCG BASE WITH BITUMINOUS SURFACE

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<td>Christian</td>
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<td>Hopkins</td>
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<tr>
<td>Garrard</td>
<td>2.97</td>
<td>1806</td>
<td>1806</td>
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<tr>
<td>Bath</td>
<td>3.0</td>
<td>1806</td>
<td>1806</td>
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<tr>
<td>Christian</td>
<td>4.5</td>
<td>1806</td>
<td>1806</td>
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<td>Hopkins</td>
<td>3.7</td>
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<td>LeCrone</td>
<td>2.5</td>
<td>1806</td>
<td>1806</td>
<td>1806</td>
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<tr>
<td>Graves</td>
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<td>1806</td>
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<td>Garrard</td>
<td>3.0</td>
<td>1806</td>
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</table>

All lanes, constructed in 1959
Sprayed in 1956, R.I. = 707
Before resurfacing
Sprayed in 1961, R.I. = 551
Before resurfacing
All lanes

- **PCG** (Portland Cement Gunite) Base with Bituminous Surfacing
- **R.I.** (Reflecting Immunity)
**TABLE 2**

PORTLAND CEMENT CONCRETE PAVEMENTS

<table>
<thead>
<tr>
<th>ROUTE NO.</th>
<th>PROJECT NO.</th>
<th>COUNTY</th>
<th>LENGTH IN MILES</th>
<th>ROUGHNESS INDEX 1950</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>I-64(36)</td>
<td>11190</td>
<td>Franklin</td>
<td>5.395</td>
<td>269</td>
<td>Completed in 1961</td>
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<tr>
<td>I-64(36)</td>
<td>11201</td>
<td>Shelby</td>
<td>5.200</td>
<td>266</td>
<td>Completed in 1960</td>
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<tr>
<td>I-64(36)</td>
<td>11201</td>
<td>Shelby</td>
<td>5.073</td>
<td>270</td>
<td>Completed in 1961</td>
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<tr>
<td>I-64(36)</td>
<td>11201</td>
<td>Shelby</td>
<td>6.253</td>
<td>288</td>
<td>Completed in 1961</td>
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<tr>
<td>I-64(36)</td>
<td>11201</td>
<td>Boone</td>
<td>3.201</td>
<td>300</td>
<td>Completed in 1961</td>
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<tr>
<td>I-64(36)</td>
<td>11201</td>
<td>Boone</td>
<td>4.646</td>
<td>309</td>
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<tr>
<td>I-64(36)</td>
<td>11201</td>
<td>Grant-Keaton</td>
<td>5.430</td>
<td>336</td>
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<td>Shelby-Jefferson</td>
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<td>Hardin</td>
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<td>351</td>
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<tr>
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<td>11201</td>
<td>Boone</td>
<td>4.045</td>
<td>354</td>
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<td>11201</td>
<td>Jefferson-Bullitt</td>
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<td>358</td>
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<td>I-64(36)</td>
<td>11201</td>
<td>Hardin</td>
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<td>I-64(36)</td>
<td>11201</td>
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<td>Franklin-Shelby</td>
<td>6.1200</td>
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<td>11201</td>
<td>Shelby</td>
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**US ROUTES**

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<th>LENGTH IN MILES</th>
<th>ROUGHNESS INDEX 1950</th>
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<td>US 25 S</td>
<td>Bourbonville</td>
<td>6.9</td>
<td>974</td>
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<td>US 25 N</td>
<td>Bell</td>
<td>2.8</td>
<td>731</td>
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RECENT CONSTRUCTION

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<th>PROJECT NO.</th>
<th>DATE OF</th>
<th>COUNTY</th>
<th>LENGTH</th>
<th>CONCEIVED DATE</th>
<th>REMARKS</th>
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<td>US 31M 40</td>
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<td>US 50</td>
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<td>US 62</td>
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Fig. 1. Map Showing Current Interstate Pavements Tested for Roughness, as of December, 1961.
Fig. 2. Roughness Distribution of Portland Cement Concrete and Bituminous Concrete, Primary and Secondary Pavements, and Their Classification According to 1960 and 1961 Records.
The completed Interstate projects include 18 miles of bituminous concrete and 114 miles of portland cement concrete. Scaled diagrams of the sections are given in Figs. 3, 4, and 5; roughness indexes obtained for each lane and other pertinent information is shown thereon. It can easily be seen that the degree of roughness often varied greatly within the same project; although some sections exhibited uniform roughness or smoothness throughout the project. Of course, dual-paved lanes came closer to having the same roughness, yet differences were noted in these companion lanes.

Large differences were found among the sections. A new low roughness index was obtained on I-64-3(6)47, roughness index 249, and a high of 414 was found on I-75-8(13)181. It was interesting to note that two of the smoothest projects, I-64-3(6)47 and I-64-3(9)37, were paved by the same contractor. Likewise, two of the roughest surfaces, I-64-3(10)42 and I-75-8(13)181, were paved by another contractor. It seems, therefore, that the practices, methods, and equipment, etc., employed by the respective contractors are contributing factors since the same specifications and tolerances applied to all alike.

The distribution of roughness within each project was obtained by plotting the number of 750-ft. sections in each roughness
### FRANKFORT-LOUISVILLE

<table>
<thead>
<tr>
<th>County</th>
<th>Length</th>
<th>Year Paved</th>
<th>Contractor</th>
<th>Combined</th>
<th>Roughness Index</th>
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<tbody>
<tr>
<td>FRANKLIN</td>
<td>5.356 mi.</td>
<td>1961</td>
<td>W.E. RINGWALD &amp; SONS</td>
<td>249</td>
<td></td>
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<tr>
<td>SHELBY</td>
<td>5.073 mi.</td>
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<td>R.B. TYLER CO.</td>
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<tr>
<td>SHELBY</td>
<td>6.253 mi.</td>
<td>1960</td>
<td>KELLY CONTR. CO.</td>
<td>288</td>
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<td>SHELBY-JEFFERSON</td>
<td>6.086 mi.</td>
<td>1960</td>
<td>KELLY CONTR. CO.</td>
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Note: All pavements portland cement concrete.

Fig. 3. Scaled Diagram, I-64, Frankfort-Louisville, Showing the Average Roughness Index for Each Lane within the Respective Projects and the Combined Averages for Each Dual-Lane Pavement and Project.
### WILLIAMSTOWN-COVINGTON

<table>
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<th>175-7(10)169</th>
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<td>421</td>
<td>417</td>
<td>299</td>
<td>302</td>
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<td>332</td>
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<th>Grant-Boone-Kenton</th>
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<tr>
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<td>7.367 mi.</td>
<td>5.41 mi.</td>
<td>4.045 mi.</td>
</tr>
<tr>
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Combined

Roughness Index: 379

<table>
<thead>
<tr>
<th></th>
<th>175-7(13)173</th>
<th>175-7(14)178</th>
<th>175-8(13)181</th>
<th>175-8(7)185</th>
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<tbody>
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<td>SB</td>
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<td>305</td>
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<td>465</td>
<td>394</td>
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<tr>
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<td>314</td>
<td>349</td>
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<table>
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<th>Boone</th>
<th>Kenton</th>
<th>Kenton</th>
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<tr>
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<td>4.646 mi.</td>
<td>3.201 mi.</td>
<td>4.548 mi.</td>
<td>2.785 mi.</td>
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Combined

Roughness Index: 329

<table>
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<tr>
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<th>US 42</th>
<th>US 42</th>
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<tbody>
<tr>
<td>300</td>
<td>414</td>
<td>364</td>
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</table>

Note: All pavements portland cement concrete.

Fig. 4. Scaled Diagram, I-75, Williamstown-Covington, Showing the Average Roughness Index for Each Lane within the Respective Projects and the Combined Averages for Each Dual-Lane Pavement and Project.
1 64

MT. STERLING-WINCHESTER

<table>
<thead>
<tr>
<th></th>
<th>164-5(8)100</th>
<th>164-5(7)93</th>
<th>164-5(9)90</th>
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<tr>
<td>EB</td>
<td></td>
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<td></td>
<td>254-286</td>
<td>316-297</td>
<td>378-348</td>
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<tr>
<td>WB</td>
<td>312-294</td>
<td>328-300</td>
<td>387-379</td>
</tr>
<tr>
<td></td>
<td>276</td>
<td>273</td>
<td>364</td>
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County: MONTGOMERY
Length: 8.396 mi.
Year Paved: 1961
Contractor: HINKLE CONTR. CORP.
Combined Roughness Index: 290

Contractor: CLARK
Year Paved: 1961
Combined Roughness Index: 299

Contractor: CLARK
Year Paved: 1961
Combined Roughness Index: 364

Note: All pavements Bituminous Concrete.

Fig. 5. Scaled Diagram, I-64, Mt. Sterling-Winchester, Showing the Average Roughness Index for Each Lane within the Respective Projects and the Combined Averages for Each Dual-Lane Pavement and Project.
category versus its corresponding roughness index. Also the vertical acceleration amplitude analysis in percent of the total amplitudes measured are presented. The plots are presented in the Appendix and are arranged there according to increasing roughness index. These plots portray the intensity of pavement roughness, its range, and distribution. Typically, the widest distribution was found on pavements with the higher combined roughness indexes, and the largest concentration was on pavements having the lower combined indexes. The amplitude distribution plots of the percent of .05-g accelerations correlates rather well with the roughness index.

The bituminous concrete pavement construction on I-64-5(7)93, Winchester to Mt. Sterling, was followed closely through the paving of each course. The following roughness indexes were obtained:

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Combined R.I.</th>
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<tbody>
<tr>
<td>First Base Course</td>
<td>512</td>
</tr>
<tr>
<td>Second Base Course</td>
<td>407</td>
</tr>
<tr>
<td>Binder Course</td>
<td>328</td>
</tr>
<tr>
<td>Surface Course</td>
<td>299</td>
</tr>
</tbody>
</table>

Each successive course improved the riding quality of the surface. The greatest improvement was noted on the second base course and the least on the surface course. This was expected since resurfacings usually produce the greatest improvements on the roughest surfaces. Perhaps some of the decrease in roughness might be attributed to the method of detecting depressions in each
course -- that is, with a 50-ft. string-line and patching them before the next course was applied. Since this procedure was followed throughout the project, it was not possible to say just how much, if any, of the improvement is attributable directly to the string-lining. This practice was continued on project I-64-5(8)100; and both surfaces displayed good riding qualities.

The completion of several Interstate projects established a rather definite pattern as to what may be anticipated from high-type construction with regard to pavement roughness. It is of interest to differentiate Interstate construction from all other types of construction and to establish a separate riding quality rating for them. Figure 6 is a plot of all of the Interstate projects thus far completed. As in Fig. 2, the projects were approximately divided into quartiles. However, due to the small size of the sample involved, some additional consideration was given to the range of roughness values.

By comparing Figs. 2 and 6, it becomes evident that even though some improvement in riding quality has been attained on Interstate highways, the degree of improvement is not appreciable. Only three Interstate projects were smoother than the smoothest primary roads. The bulk of the projects displayed about the same riding quality as most recently constructed primary roads.
Fig. 6. Roughness Distribution of Portland Cement Concrete and Bituminous Concrete Interstate Projects and their Classification According to 1961 Records.
Removal of Localized Surface Irregularities

Regardless of whether an Interstate project proved to be of good or poor riding quality, all of them apparently passed the state specifications of surface quality. On most portland cement concrete pavements this was possible only after a certain amount of localized high places were ground down to within required tolerances. The Kentucky Standard Specifications require that a 10-foot straight-edge be used in testing surface roughness. Any high spots indicated by a variation exceeding 1/8 inch from the straight-edge are to be removed by grinding or other means.

To test the effects of grinding, the southbound outer lane of project I-75-7(4)157 was tested soon after paving and after grinding of high places was finished. This lane was selected because of its high roughness, particularly the north end of the project. The resulting roughness index of 427 before, and 421 after grinding represents about 1.4 percent difference. This reduction in the index does not necessarily reflect the improvement made by grinding since the reliability of the roughness index, from the standpoint of reproducibility, appears to be within ±2 percent. Therefore, a visual inspection of the recorded acceleration traces was made and acceleration amplitudes at ground locations were measured.
Only in a few instances less acceleration resulted, which could be attributed to the deviation from previously-run wheel tracks. Likewise, the sections of pavement displaying the largest passenger accelerations were not the locations where most of the grinding was done, matter of fact, on the contrary.

It must be concluded then that grinding produced no detectable difference in the riding quality of this pavement. This was not at all surprising because localized irregularities, involving a distance of ten feet, have proportionally very little effect on riding quality. The vehicle dynamic characteristics tend to surpass the severity of surface irregularities which are of short wave length. A 10-foot straight-edge, while effective in detecting localized irregularities, quite easily permits construction of large waves in the roadway. These larger waves will determine the level of riding quality.

Rating of pavements According to Serviceability Index

The Bureau of Public Roads, at the request of the American Association of State Highway Officials' Committee on Highway Transportation, has undertaken the task of measuring the surface condition of pavements being considered for resurfacing by the states in 1962. Kentucky was one of the 34 participating states.
Accordingly, sections of two primary roads, US 31E, Nelson County, Bardstown-Hodgenville, and US 79, Todd County, Russellville-Guthrie, and a secondary road, Ky. 44, Bullitt County, Shepherdsville-Taylorsville, were selected for testing. When the rating team arrived, two additional roads were selected, US 68, Todd County, Elkton-Russellville, and Ky. 61, Bullitt County, Shepherdsville-Lebanon Jct. However, the testing was interrupted and discontinued after the completion of tests on US 31-E, Ky. 61 and Ky. 44.

The testing involved recording of roughness and structural defects on representative sections of the pavements. The roughness test was made with the CHLOE profilometer which electronically totalizes a slope-variance measurement (6-inch intervals) between two closely spaced wheels pulled in the outer or inner wheel tracks. The extent of patching, cracking and rutting constituted the structural failure testing. These measurements were then inserted into an equation to arrive at a serviceability index. This index rates the pavements ranging from 0 to 5 (the larger the index, the better the pavement).

The Research Division made roughness measurements of these pavements covering the full length of both lanes. The serviceability index testing calls for six 500-ft., one-lane sections on roads shorter than five miles and eight sections up to ten miles in length. The three tested roads were rated as follows:
Roughness Index

<table>
<thead>
<tr>
<th>Route No.</th>
<th>WB or NB</th>
<th>EB or SB</th>
<th>Combined</th>
<th>Test Section</th>
<th>PSI*</th>
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<tbody>
<tr>
<td>US 31-E, Bardstown-Hodgenville, Nelson Co.</td>
<td>974</td>
<td>934</td>
<td>954</td>
<td>945</td>
<td>1.86(SB)</td>
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<td>Ky. 44, Shepherdsville-Taylorsville, Bullitt Co.</td>
<td>690</td>
<td>756</td>
<td>723</td>
<td>633</td>
<td>2.25(WB)</td>
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<tr>
<td>Ky. 61, Shepherdsville-Lebanon Jct., Bullitt Co.</td>
<td>732</td>
<td>631</td>
<td>682</td>
<td>482</td>
<td>2.48(SB)</td>
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</table>

* Present Serviceability Index

A serviceability index value of 1.5 was considered on AASHO Road Test to be representative of a pavement that was no longer serviceable and was removed from further testing. This value is presumably too low for pavements in actual service, and the present study represents an attempt to arrive at a more practical terminal value.

The test sections, as rated by Kentucky's roughness index, pointed out that the 500-foot sections selected were not necessarily representative. This was particularly evident on Ky. 61 where a
large difference exists between the combined roughness and the actual test section index. The Kentucky roughness index rated the pavements in the same order as the serviceability index and may, therefore, be useful as an expression of serviceability index of a pavement. An alternative would be to combine the roughness index with other parameters described the pavement structural serviceability and to meld them into an index.
CONCLUSIONS

The completion of a number of Interstate projects has disclosed wide differences in roughness index. Between the smoothest and roughest project, a 66 percent difference in roughness was noted. However, it was possible to establish ratings for these pavements on a comparative basis. It may also be useful to arrive at some roughness index value which would describe the localized roughness of a short pavement length, such as 300 feet. In addition, the number of individual accelerations exceeding a certain magnitude may be used in describing or pointing out localized roughness in each project.

In this study it became quite evident that the present method of controlling surface roughness with a 10-foot straight-edge fails to insure good riding quality of the pavement.

Localized grinding of portland cement concrete pavements to meet the required surface tolerance produced no noticeable improvement in the roughness index.
REFERENCES


# APPENDIX
(Roughness Distribution Plots of Interstate Projects)

<table>
<thead>
<tr>
<th>Project No.</th>
<th>Mean Roughness Index</th>
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<td>I-64-3(9)37</td>
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164 - 2(4) 24
SHELBYVILLE LOUISVILLE
SHELBY COUNTY

Number of 750 Sections

Roughness Index

Mean 266

Percent of Amplitudes

Amplitude in g's
164 - 5(8)100

WINCHESTER - MT. STERLING

MONTGOMERY COUNTY

Number of 750' Sections

Roughness Index

Percent of Amplitudes

Amplitude in g's
MOUNT STERLING - WINCHESTER
CLARK COUNTY

Number of 750' Sections

Roughness Index

Percent of Amplitudes

Amplitude in g's

1 6 4 - 5(7)93
175 - 7(14) 178
WILLIAMSTOWN - COVINGTON
BOONE COUNTY

Roughness Index

Mean

Number of 750 Sections

Amplitude in g's
COVINGTON - WILLIAMSTOWN
GRANT - BOONE - KENTON COUNTIES

Number of 750' Sections

Roughness Index

Percent of Amplitudes

Amplitude in g's
165 - 4(6)78
ELIZABETHTOWN - UPTON
HARDIN COUNTY

Number of 750' Sections

Percent of Amplitudes

Roughness Index

Amplitude in g's
164 - 5(9)90
AT WINCHESTER
CLARK COUNTY

Number of 750' Sections

Roughness Index

Percent of Amplitudes

Amplitude in g's
164 - 3(10) 42
FRANKFORT - LOUISVILLE
FRANKLIN - SHELBY COUNTIES

![Histogram showing roughness index and amplitude in g's.](image)