EVALUATION
OF
COLORADO'S FLEXIBLE PAVEMENT
BASE DESIGN METHODS

FINAL REPORT

MAY 1970

Prepared by

STATE DEPARTMENT OF HIGHWAYS
DIVISION OF HIGHWAYS-STATE OF COLORADO

PLANNING AND RESEARCH DIVISION

In Cooperation With
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

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ABSTRACT

Twenty-seven flexible pavement projects 15 to 16 years old were investigated to correlate performance with moisture, traffic, soil, and designed conditions. The general conclusions were as follows:

1. Base and subbase material used on almost all projects in Colorado is reusable for widening or rebuilding new projects. There is practically no degradation or adulteration of base and subbase aggregates after 15 to 20 years use under a flexible pavement in this dry climate.
2. Loss of serviceability is due mainly to hardening and cracking of the asphalt mat. Only one of the 27 projects was rutted to any extent.
3. In-place California Bearing Test values on subgrade materials were almost twice as high as Laboratory CBR tests performed on soaked samples 15 to 20 years ago for the design of this project.
4. Traffic volumes for these projects predicted 15 to 20 years ago were reasonably accurate for 20 out of 27 of the projects investigated. Five of the projects were estimated at about one-half of the actual 1968 volume, and only two projects were badly overestimated.
5. Two-thirds of the densities taken in the subgrades were between 95% and 100% of the AASHO T-99 Standard. Low density subgrades can be associated with wet clayey subgrades.
6. Longitudinal cracking near the edges of mats is associated with narrow shoulders and steep embankment slopes. Blowsands and loose rock fills should be widened in Colorado to provide better lateral support.
7. Almost all weak spots observed on the 27 flexible pavement projects were associated with local areas of poor drainage. This was usually in the form of ditches which had filled up from backslope debris in cut areas.
8. Deflection data may provide a fair guide to the amount of useful life remaining in a roadway, but it does not correlate well with performance of low-traffic roadways in Colorado.

IMPLEMENTATION

This study provided a means for comparing the AASHO Design Procedure with flexible pavement performance in Colorado. The Colorado Highway Design Committee has now adopted the AASHO method of design with minor revisions listed in Appendix B of this report. Hveem Stabilometer values will be used to determine Soil Support Values in place of soaked CBR tests.

The findings of this study provided a basis for determining the structural adequacy of Colorado highways by means of Serviceability Index values. The estimated savings from the new procedure will be approximately $10,000 every other year.

It is difficult to estimate savings in maintenance of future roadways which may come as a result of the recommendations to the Design and Construction Divisions of the Highway Department as a result of this study. However, wider shoulders, better drainage, and earlier rejuvenation of brittle mats should eventually result in considerable savings to the Department.

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EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT BASE DESIGN METHODS

INTRODUCTION

The Colorado Highway Sufficiency Study has brought up a serious question on the durability of roadways. When predicting needs costs for a 20 year period, there is doubt whether to plan for rebuilding or whether to plan for widening certain sections. There is also a question whether the existing subbase should be replaced or used as a foundation for the new or widened roadway.

These problems are interwoven with other problems which continuously arise regarding the strength of dissimilar layers of material (particularly open-graded materials) under a pavement and the adequacy of the present Colorado Highway Design procedure for flexible pavements.

In 1951, the Colorado Highway Department initiated a Flexible Pavement Performance Study in an attempt to find the cause of differing performances of base courses and flexible pavements on a statewide basis. Twenty-three projects were chosen to correlate performance with moisture, traffic, and soil conditions. By 1953, five of the original 23 sites had been taken out of service, and within 10 years, nine of the original sites had failed because of inferior foundation materials or subsurface drainage problems. The remaining nine sites had good service records. The general conclusions were as follows:

1. Moistures and density values vary considerably and seasonally throughout the individual projects. Spring moisture values were no higher than fall moisture values for projects which had good service records. Subgrades on projects with bad service records had generally high moisture values during the entire period of investigation.
2. The total thickness of subbase, base and surfacing as found in the test holes was generally of less thickness than the total cover required by using the CBR values of the underlying soil.

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3. The quality of the base course material used in some parts of Colorado was generally lower than necessary to support thin asphalt mix mats. Where crushed rock was not locally available it appeared that local sands would have to be treated with some type of additive before they would be suitable for use directly below an asphalt mat.

In the fall of 1968, a request was made for a new project to evaluate the performance, materials, and design of roadways constructed between 1952 and 1953, to determine the adequacy of the roadway structure. Out of 113 projects constructed in those two years, 23 have been rebuilt to some higher standard (such as Interstate).

Twenty-seven projects were finally selected for detailed analysis. A plan for the study of these projects was presented to the Bureau of Public Roads in September 1968 and approved by the Regional Office shortly thereafter.

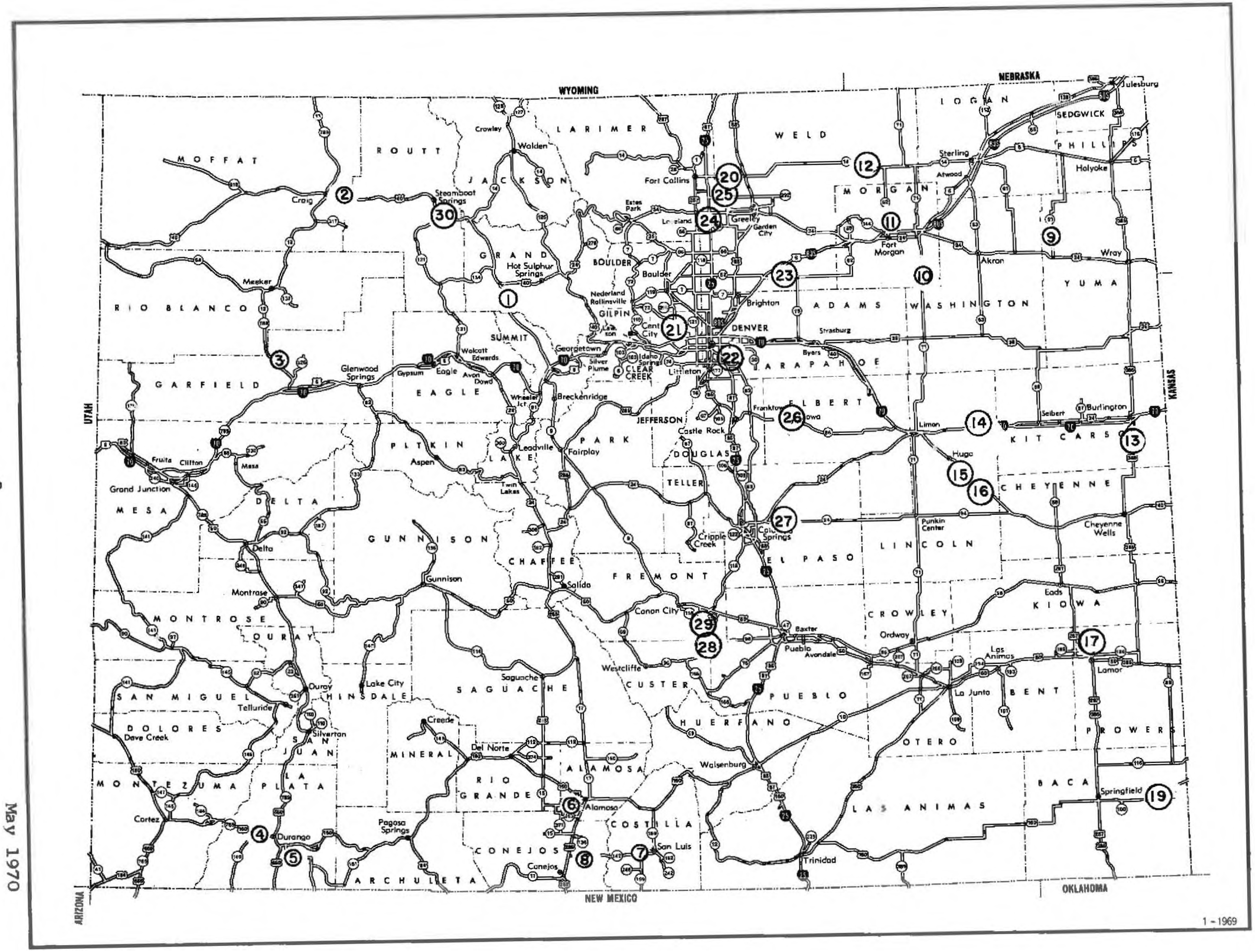
FIELD INVESTIGATIONS

The twenty-seven projects were selected on the basis of their basic structure having remained unchanged throughout the last 15 years. Most of them had been sealed and chipped, but shoulder width and structure thickness had been unaltered. As shown on Figure 1, they generally represented elevation and climatic conditions found throughout the State of Colorado.

The items selected for investigation are shown on Figure 2. They were selected in an attempt to obtain the information necessary for the study at a cost which would not be prohibitive. Although the actual cost of the field investigation did not exceed expectations, the cost of the Laboratory tests was considerably higher than anticipated, and it was necessary to revise the funds budgeted for the project upward from $12,000 to $16,000 during the course of the project.

Field investigation began with the measurements of smoothness using the CHLOE Profilometer. Data on the width and extent of the cracking, patching, drainage, and rutting was obtained at the same time. Deflection data was obtained next by means of the Benkelman Beam and the Dehlen Curvature Meter.

The samples for thickness, gradation, moisture content, permeability, stability, etc., were taken with a core drill where possible and by hand


WYOMING
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OKLAHOMA
NEW MEXICO
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LOGAN
SEDGWICK
PHILLIPS
MORGAN
RIO BLANCO
GRAND
BOULDER
GILPIN
ADAMS
WASHINGTON
YUMA
GARFIELD
SUMMIT
EAGLE
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HINSDALE
SAGUACHE
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HUERFANO
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Sterling
Atwood
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Craig
Steamboat Springs
Fort Collins
Estes Park
Loveland
Greeley
Garden City
Fort Morgan
Akron
Wray
Meeker
Hot Sulphur Springs
Boulder
Nederland
Rollinsville
Brighton
Central City
DENVER
Strasburg
Byers
Georgetown
Silver Plume
Idaho Springs
Littleton
Glenwood Springs
Gypsum
Eagle
Avon
Dowd
Wolcott
Edwards
Wheeler Jct
Breckenridge
Castle Rock
Limon
Seibert
Burlington
Fruita
Clifton
Mesa
Grand Junction
Aspen
Leadville
Fairplay
Twin Lakes
Hugo
Delta
Cripple Creek
Colo Springs
Punkin Center
Cheyenne Wells
Gunnison
Salida
Montrose
Canon City
Eads
Baxter
Pueblo
Avondale
Ordway
Las Animas
Lamar
Westcliffe
Saguache
Ouray
Lake City
Telluride
La Junta
Silverton
Dove Creek
Creede
Del Norte
Walsenburg
Alamosa
Springfield
Cortez
Durango
Pagosa Springs
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when necessary. Field CBR tests were made prior to drilling into subgrade material in the fall of 1968, in the summer of 1969, attempted in the winter of 1969-1970 and in the spring of 1970.

The field investigation work began in September of 1968, and most of the work was completed by a crew of five men in November before the frost set in. Data on traffic, precipitation, temperature, etc., was accumulated in December.

The Laboratory test data for the samples brought in from the field was assembled in February 1969. From this information, it was possible to compute structural numbers, thickness indices, soil support values, etc.

FIELD DATA

Data described in Figure 2 was obtained at 54 different locations on the 27 projects. The attempt was made to sample a typical cut area and a typical fill area from each project.

The Appendix to this report contains the summary of the data obtained in 1968 and 1969 and where possible the corresponding data for 1952, 1953, and 1954 (or whenever the project was constructed). Most of the projects were 15 years old in 1968.

As may be noted from Figure 2 or the data sheets in the Appendix, the data is listed according to PERFORMANCE, SURFACING, BASE COURSE, SUBBASE, SUBGRADE, AND STRUCTURAL STRENGTH of the roadway.

Certain special information concerning condition or performance of the roadway has been added under REMARKS to assist in analyzing the results.

ANALYSIS OF DATA

One of the first tasks in analyzing the data was to determine a reliable performance value for each section, since a correlation of all other factors was to be made with roadway performance using a computer to perform regression analysis. Slope variance values from CHLOE Profilometer readings together with cracking and rutting data can be analyzed through several formulas [(1) (2) (3)] to obtain Serviceability Index Values which are generally understood and considered reliable. However, this project appeared to present an opportunity to correlate human expressions with AASHO CHLOE Profilometer evaluations, so a team consisting of an Area Engineer from the Bureau of Public Roads, the Assistant Staff Materials

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. Colorado Const. No. LOCATION Proximity of Town or City SITE NO. ____

PERFORMANCE

	Stations
Pres.Service.Index	(0 to 5) AASHO
Ave Pavement Deflection	In Inches
Radius of Curvature	From Dehlen-ft.
Avg Rut Depth	In Inches
Cracking(Cl II & III)	Ft.per 1000 ft^2
Patching(ft^2/1000ft^2)	Ft^2 per 1000 ft^2
Bleeding	None-Light-Heavy
Accum.18^k EWL($X10^3$)	In Thousands
Years of Service	Since Construction
Design Avg.Daily Traffic	15 years ago
Present ADT	From 1968 Records
Avg Yearly Precipitation	Weather Bureau
Avg Annual Temperature	Weather Bureau
Freezing Index	Degree days below 32°
Elevation	Above Mean Sea Level
Drainage	Good, Fair, or Bad
Regional Factor	0 to 5 (AASHO)

SURFACING

	Stations
Asphalt Type	Pen,MC,SC, etc.
Thickness (Design)	In Inches
Core Thickness (1968)	In Inches
R Value of Design Mix	Hveem & S Value
Seal Coat Thickness	In Inches
% Asphalt (1953)	Wt.Asph/Total Weight
% Asphalt (1968)	Wt.Asph/Total Weight
Density During Const.	#per cu.ft. from old records
Density (1968)	#per cu.ft. from 1968 Sample
Penetration (1953)	AASHO T49
Penetration (1968)	AASHO T49-64

BASE

	Stations
Additive	Asphalt,Cement,Lime etc.
Thickness (Design)	In Inches
Thickness (1968)	In Inches
Hveem "R" Value (1953)	Internal Friction
Hveem "R" Value (1968)	AASHO T190-61
Permeability (ft/day)	Feet per day
Sand Equivalent (1953)	Similar to T176
Sand Equivalent (1968)	AASHO T176-65
Liquid Limit (1953)	AASHO T89
Liquid Limit (1968)	AASHO T89-60
Plasticity Index (1953)	AASHO T90
Plasticity Index (1968)	AASHO T90-61
% Moisture (1968)	Wt water/wt dry soil
Shoulder Width	In Feet

SUBBASE

	Stations
Thickness(Design)	In Inches
Thickness (1968)	In Inches
Hveem "R" Value(1953)	Internal Friction
Hveem "R" Value(1968)	AASHO T190-61
Permeability(ft/day)	Feet per day
Sand Equivalent(1953)	Similar to T 176
Sand Equivalent(1968)	AASHO T176-65
Soil Classification('68)	AASHO M-145
Liquid Limit(1953)	AASHO T-89
Liquid Limit(1968)	AASHO T89-60
Plasticity Index(1953)	AASHO T-90
Plasticity Index(1968)	AASHO T90-61
Specific Gravity	AASHO T100-60
%Moisture	Wt water/ Wt dry particle

SUBGRADE

	Stations
Calif Bearing Ratio '53	Colo Lab Method
Field CBR in 1968	Corps of Engrs Method
Wet Density (1968)	AASHO T204-64
Dry Density (1968)	AASHO T204-64
% Moisture Top (1968)	Wt water/wt dry soi
% Moisture Avg (1968)	Wt water/wt dry "
Soil Classification '53	AASHO M-145
Soil Classification '68	AASHO M-145
% Rock in 1968	Wt rock/wt total
Opt Moist.without Rock	AASHO T99-61
Max Density w/o Rock	AASHO T99-61
Liquid Limit (1953)	AASHO T89
Liquid Limit (1968)	AASHO T89-60
Plasticity Index (1953)	AASHO T90
Plasticity Index (1968)	AASHO T90-61
"R" Value at 400 psi	AASHO T190-61
"R" Value at 300 psi	AASHO T190-61
Soil Support Value	AASHO Design
% Relative Compaction	Density/Max Density T99

STRENGTH

	Stations
Thickness Index	AASHO Design
Structural Number	AASHO Design
Weighted Str.Number	AASHO Design
Performance Index	NCHRP Report 2A
Period of Most Failure	Early, Late or Gradual
Years of Maint-Free Serv	Years without Maintenance
PSI from Sufficiency Rpt	Based on Correlation
Cut or Fill Section	Cut or Fill

Remarks:

FIGURE 2

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Engineer, the Staff Planning and Research Engineer, and the Research and Special Studies Engineer inspected each of the 27 projects for appearance and durability. After an inspection of each project by the rating team, a serviceability value based on the following rating system was agreed upon for the cuts and fills on each project:

Pavement Condition	Present Serviceability Index Values
Outstanding	4.5 - 5.0
Excellent	4.1 - 4.5
Very Good	3.7 - 4.1
Good	3.3 - 3.7
Fair	2.5 - 3.3
Poor-In need of Repair	2.0 - 2.5
Beyond Repair	1.5 - 2.0

In addition to the rating determined by the inspection team, the field Maintenance Engineer (or District Engineer) and personnel who took the field samples expressed their opinion on the serviceability of the roadway. A listing of these various ratings is found on Table I.

It appears that Present Serviceability Index Values derived from the CHLOE, rutting and patching are very much in line with values determined independently by both Research and Maintenance personnel. The main differences seem to stem from two conditions:

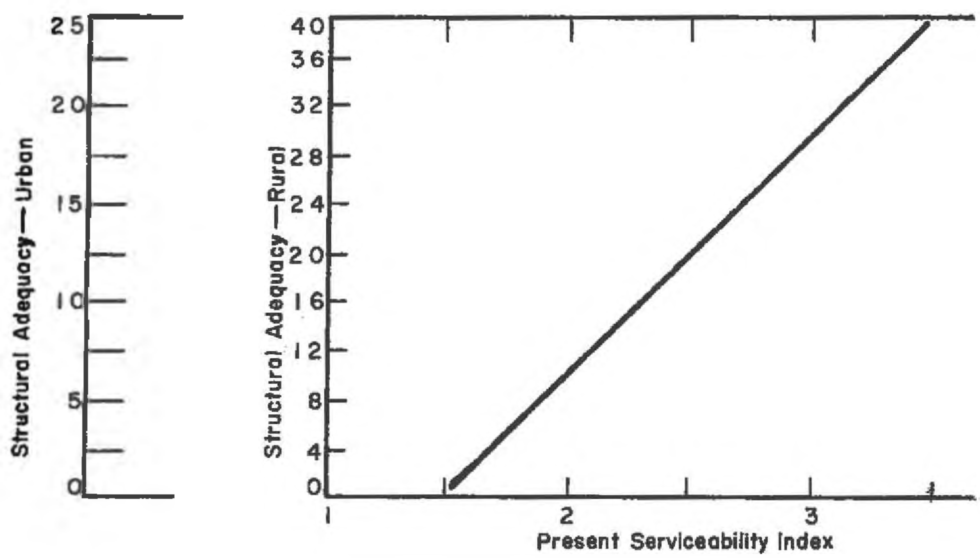
1. When the mat shows considerable alligator cracking but is not rough, the CHLOE formula appears to show a higher serviceability rating than this rating given by observers. Examples of this are the sites at Yuma, Fort Morgan, Burlington, and Lamar.

2. When the mat has been sealed with asphalt and coarse stone screenings, the CHLOE AASHO formula appears to show a lower serviceability rating than the rating given by observers. Examples of this are the sites at Hudson and Steamboat Springs.

The average rating by the CHLOE (AASHO), the Research team and the District personnel is very nearly the same as the average of the overall weighted averages for each project. It is not known why the sampling crew tended to rate projects higher than the other teams, but it may be that the hard digging, associated with each project, convinced the sampling crew that in spite of the appearance of each project, all of the roadways, which survived after 15 years of use, were in quite good condition below the surface.

The statistical analysis was based on the Present Serviceability Index, (AASHO forumla $PSI = 5.03-1.91 \log (1 + \overline{SV})$) as the independent variable and 79 selected roadway characteristics as the dependent variables. Table II shows a total of 3160 linear correlation coefficients.

The serviceability values derived from Structural Adequacy values in the Colorado Sufficiency Study and shown in Table I, were based on correlations made some time ago. They appear to be a little low. Based on the information now available, it appears that the best relationship of Structural Adequacy and Present Serviceability Index is as shown below:



This bit of information may be quite valuable in that it can be used to statistically determine structural adequacy for the Colorado Sufficiency Report when the Present Serviceability Index Value is known. Recent developments indicate that the PSI can be determined with the CHLOE or the Colorado Accelerometer and thereby make it possible to get Structural Adequacy by a mechanical means rather than by human judgment in 1971 when the next evaluation is made.

Summarizing the analysis of the performance data, then, it may be said that the weighted averages appear to be reliable expressions of the condition

TABLE I

PSI RATING

Site Number	Location	CHLOE (AASHO)	Research Team	District Personnel	Converted Sufficiency Rating	Sampling Crew	Weighted Average
1	Kremmling	2.7	2.9	2.7	2.6	2.9	2.8
2	Craig	2.9	2.6	2.9	2.4	3.1	2.7
4	Durango	2.0	2.0	2.0	2.2	2.6	2.1
5	Ignacio	2.4	2.5	2.0	2.2	3.2	2.5
6	Alamosa	2.5	2.7	2.6	2.4	3.6	2.6
7	San Luis	2.7	2.6	2.6	3.0	3.5	2.7
8	Romeo	2.5	3.0	3.0	2.3	3.5	2.9
9	Yuma	3.0	2.2	2.3	1.5	3.0	2.3
10	Brush	3.4	3.3	3.3	2.8	3.4	3.2
11	Fort Morgan	3.0	2.3	2.4	2.6	2.7	2.4
12	Buckingham	2.7	2.9	2.8	2.5	3.2	2.8
13	Burlington	3.7	2.8	2.8	2.8	3.1	2.9
14	Arriba	2.5	2.6	2.7	2.5	3.2	2.6
15	Hugo	2.3	2.0	2.3	2.3	3.0	2.1
16	Hugo	3.0	3.0	3.0	2.6	3.2	3.0
17	Lamar	3.7	2.6	3.0	2.6	3.4	2.7
19	Walsh	2.5	2.4	2.4	2.5	3.4	2.4
20	Fort Collins	2.9	2.6	2.6	2.6	3.6	2.7
21	Eldorado Springs	3.0	3.0	2.9	2.9	2.3	2.9
23	Hudson	2.2	3.3	3.0	2.6	3.2	3.2
24	Loveland	2.5	3.1	2.8	2.6	3.4	3.0
25	Windsor	2.8	3.0	2.8	2.3	3.2	2.9
26	Elizabeth	2.5	2.4	2.4	2.6	3.4	2.5
27	Colorado Springs	2.3	2.3	2.3	2.2	3.4	2.3
28	Wetmore	2.4	2.7	2.6	2.6	3.3	2.6
29	Florence	2.3	2.4	2.4	2.3	3.0	2.4
30	Steamboat Springs	2.3	3.0	3.0	2.8	3.2	2.9
	Average Values	2.69	2.67	2.65	2.49	3.18	2.67

of each project. These average Serviceability Index Values closely approximate the mechanical value obtained from the AASHO formula which takes into consideration the roughness, the rut depth, and the cracking and patching values. There is a fairly high correlation value (.66) between the PSI obtained by the AASHO formula and the values obtained from an average of human evaluations. (See the Linear Correlation Tabulation Table II on page 10.)

Sonar Correlation
Coefficients

Matrix - Al. Plate?

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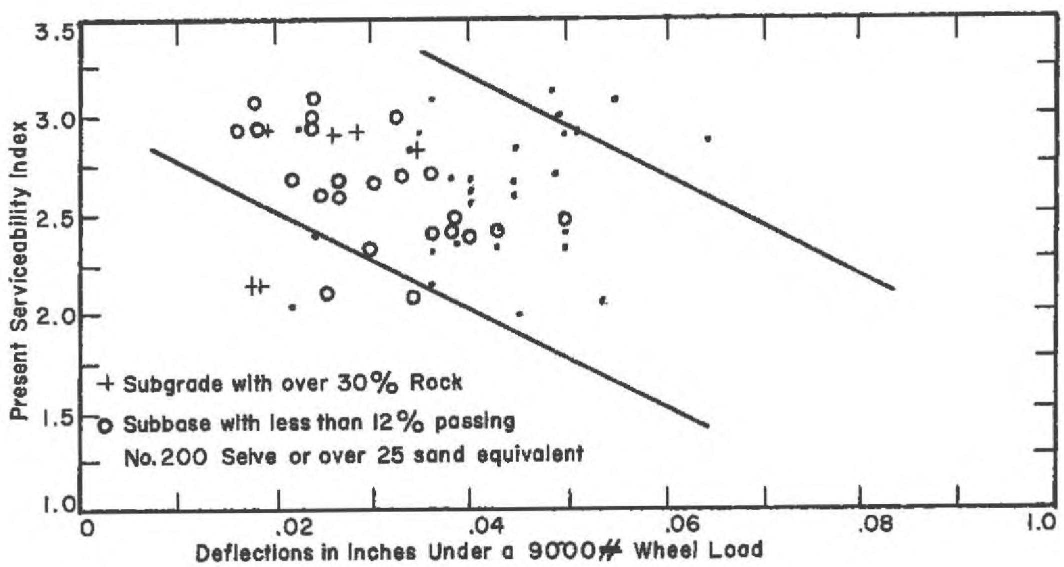
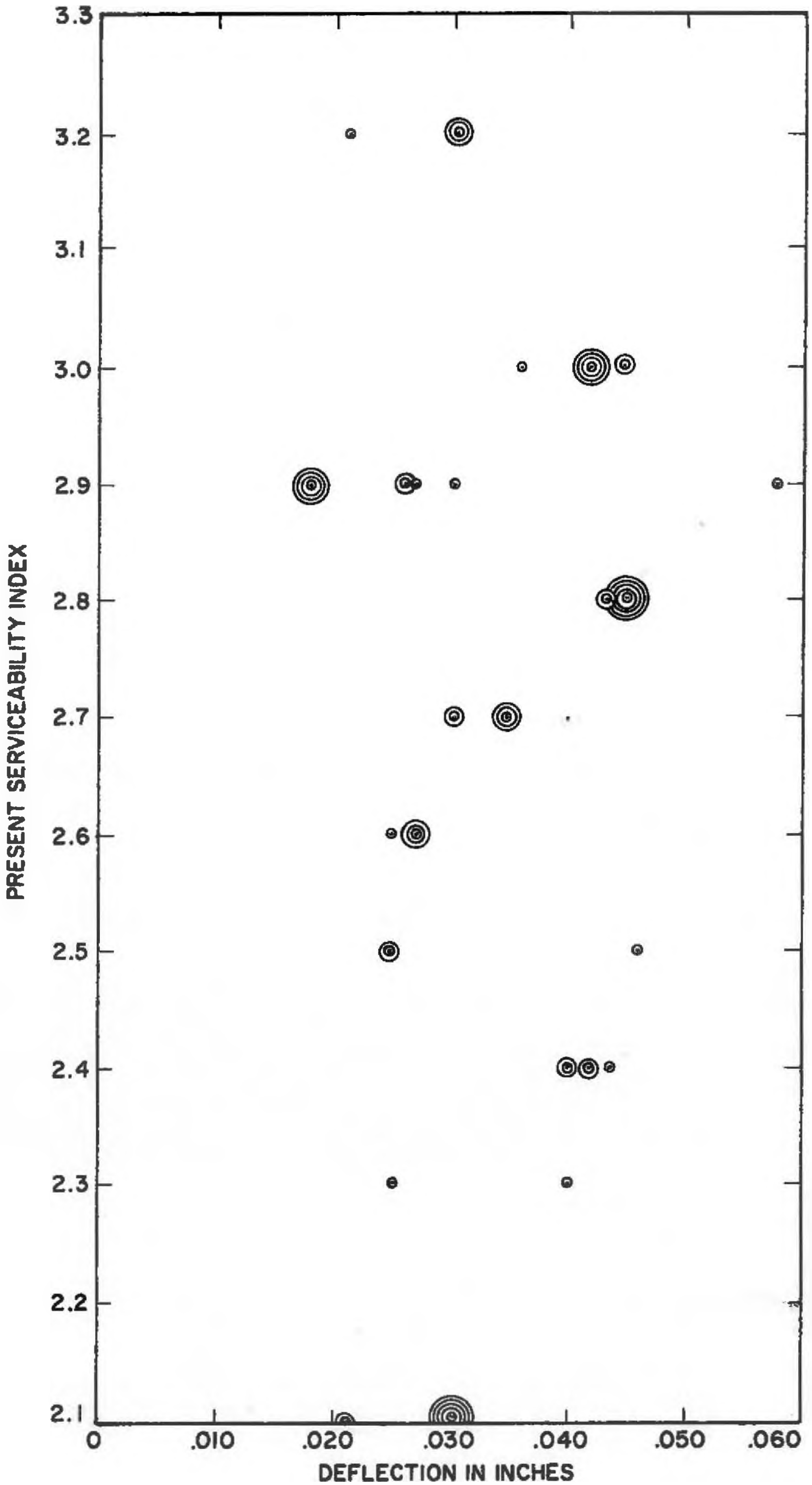
ANALYSIS OF DATA - Effect of Variables on the Present Condition of the Roadway

Deflection

Deflection was measured with the Benkelman Beam under a 9000 pound wheel load. A linear correlation coefficient of 0.3 was found between pavement deflection and Present Serviceability Index. This is not a high correlation as shown by the scatter on the graph below. In fact, a negative correlation appears just as appropriate, and is more along the line of engineering thinking, since higher deflections are generally associated with poorer conditions of a roadway.



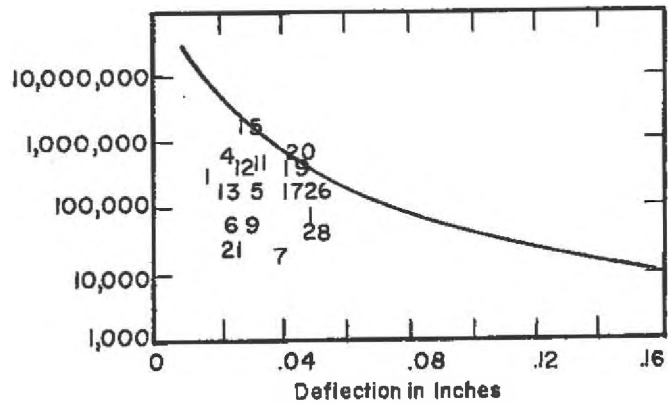
No particular trend is apparent except that roadways with granular subbase and subgrades (A-1 and A-2 type soils) and high rock contents generally have lower deflections as indicated by the 0.38 correlation between deflection and % subbase material passing the 200 sieve, and the -0.38 correlation between deflection and the % rock in the subgrade. There is also fairly good correlation (-0.35) between the deflection and the present density of the subgrade. At first it was suggested that the lack of correlation between deflection and PSI might be due to the loadings. However, the graph on the following page shows that there is poor correlation for all roadways regardless of the amount and type of traffic.



Graph showing the poor correlation of deflection with roadway performance on both heavy and on light traffic roadways.

Each circular ring = 200,000 18K load.

AASHO Road Test findings are shown on the adjoining figure. The number of 18K repetitions to reduce a flexible pavement to the 2.5 PSI condition is shown at the left for a corresponding deflection. Points from data gathered in the Colorado Flexible Pavement Study are superimposed on the graph as site numbers. Most roadways investigated for this Colorado study were structurally weaker than the AASHO Road Test designs and only 1/3 of them were down to the 2.5 PSI level, so most of the points on the graph fall below the AASHO line.

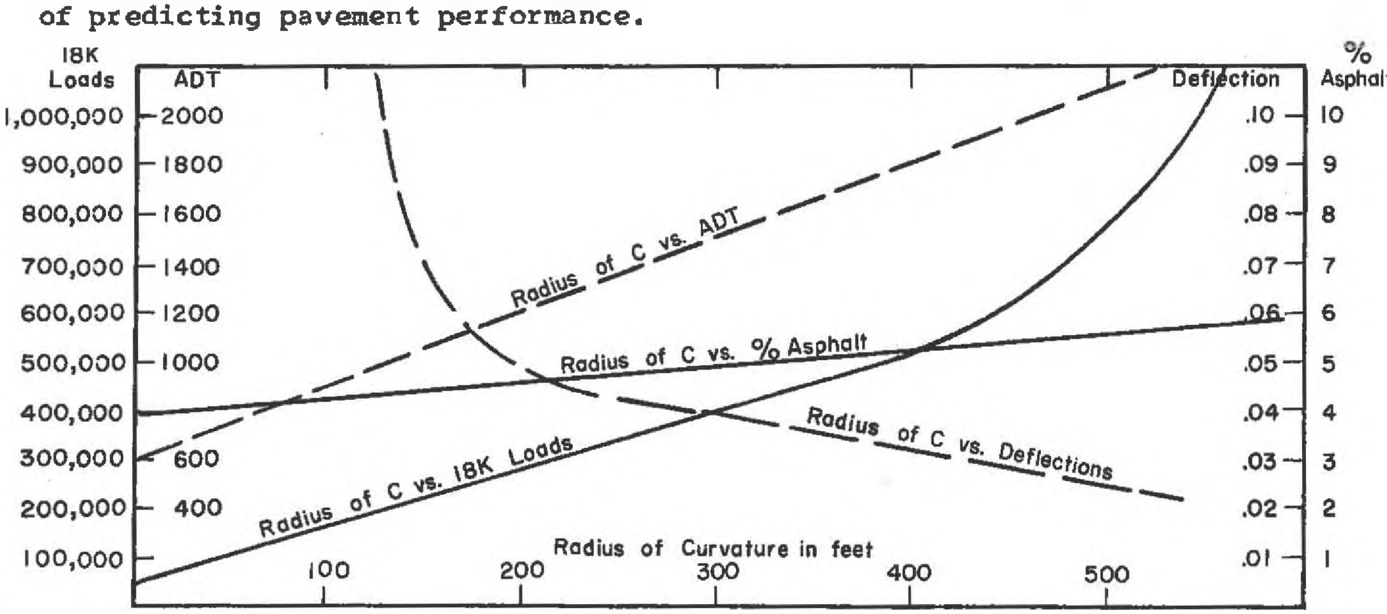


Radius of Curvature

Radius of Curvature readings are made with the Dehlen curvature meter under a 9000 pound wheel load.

The radius of curvature appears to have better correlation with the deflection than either the radius of curvature or the deflection appears to have with anything else. In addition, the radius of curvature correlates well with the accumulated 18K loads, the average daily traffic, and the % asphalt in the mat.

Curvature readings have been observed to vary much more with temperature changes than the statistical data implies, and in the past, curvature data has not been considered particularly reliable or valuable as a means of predicting pavement performance.



Rut Depth, Cracking, Patching, and Bleeding

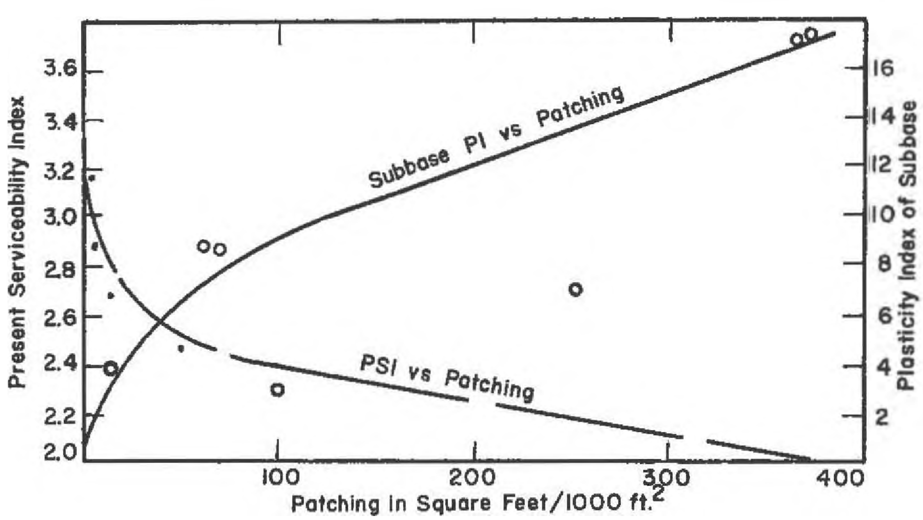
There appears to be little if any correlation of rut depth cracking, patching, or bleeding with the performance of the 16 year old pavements evaluated for this study.

The most longitudinal rutting was visible on the project east of Hugo (Site No. 15). This roadway has undergone the greatest number of 18K load repetitions of any of the other projects evaluated. A possible conclusion may be that rutting is not a significant factor in the deterioration of Colorado roadways until the loading has reached over a million 18K wheel loads.

Cracking would appear to be a very important indication of roadway performance, but this study did not verify this theory. In fact, when several maintenance engineers were confronted with questions about certain sections of cracked pavement, their reply was to the effect that cracks in old flexible pavements are not particularly objectionable unless they lead to a complete disintegration of the pavement. Gradual cracking is expected as a pavement surface oxidizes and hardens with continued exposure to the elements. The best examples of cracked pavements are the projects south of Steamboat Springs and south of Kremmling where a PSI of 2.9 was assigned to the condition of these 16 year old highways by the evaluation team.

None of the original mats placed 16 years ago showed any bleeding in 1969.

Patching showed very good correlation with the average of the various evaluations of serviceability index, and with the Plasticity Index of the subbase. The relationship is shown on the graph below:



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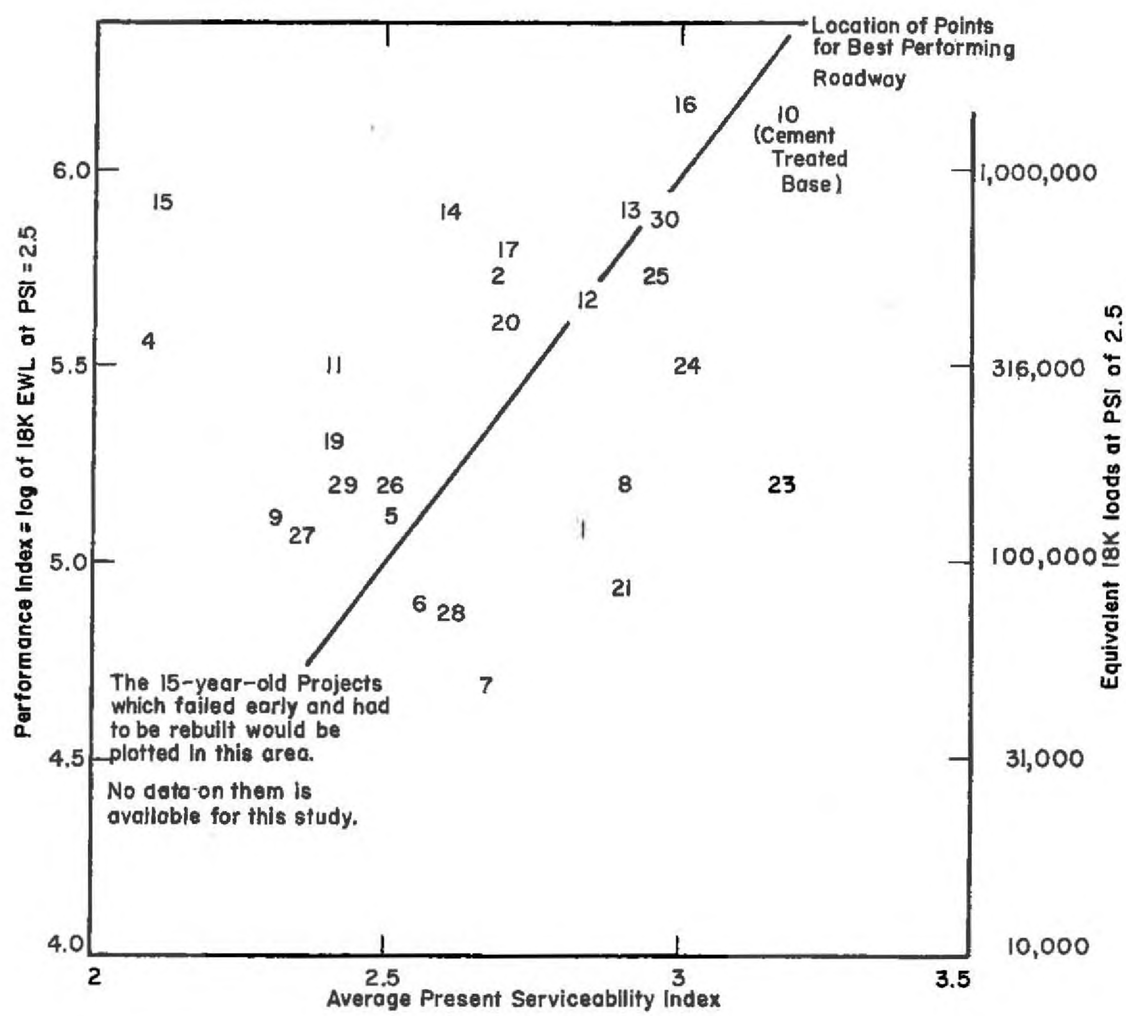
Accumulated 18K Equivalent Wheel Loads

Of course the computer analysis shows excellent correlation between both the Designed Average Daily Traffic and the Present ADT with the accumulated 18K Equivalent Wheel Loads. The Performance Index also correlates well with the 18K loads because the Performance Index is the logarithm of the number of accumulated equivalent 18K axle load applications at the time when the roadways serviceability index is at 2.5.

In fact, it may be that the Performance Index is a better indication of the service provided by a roadway than the condition of the roadway at the end of 15 or 16 years of service. The graph below shows how the 27 projects appear in both respects. The location of each project is related to the site number on page 3 of this report.



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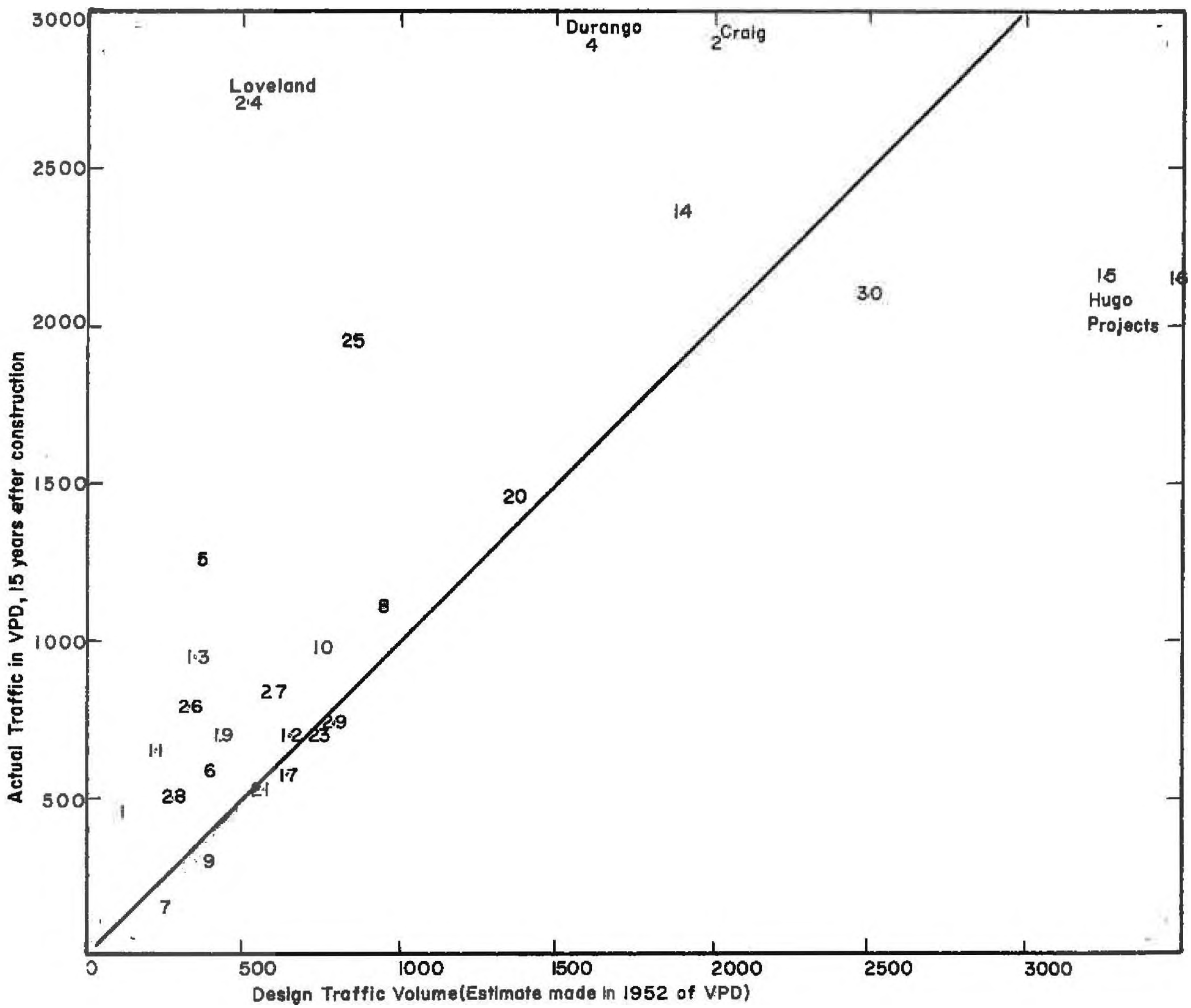
Traffic Data - Accuracy of the 1952 Estimate

The graph below illustrates the relationship between the estimate made of the 20 year-hence traffic in 1952 and the actual traffic 16 years later. The design values appear to be reasonably accurate for 20 out of the 27 projects investigated. Five of the projects were estimated at what appears to have been approximately one-half of the actual traffic that developed in 1968. The traffic estimate in vpd for the two projects east of Hugo was a little too high, but the traffic estimate for Loveland, Durango, and Craig was much too low.



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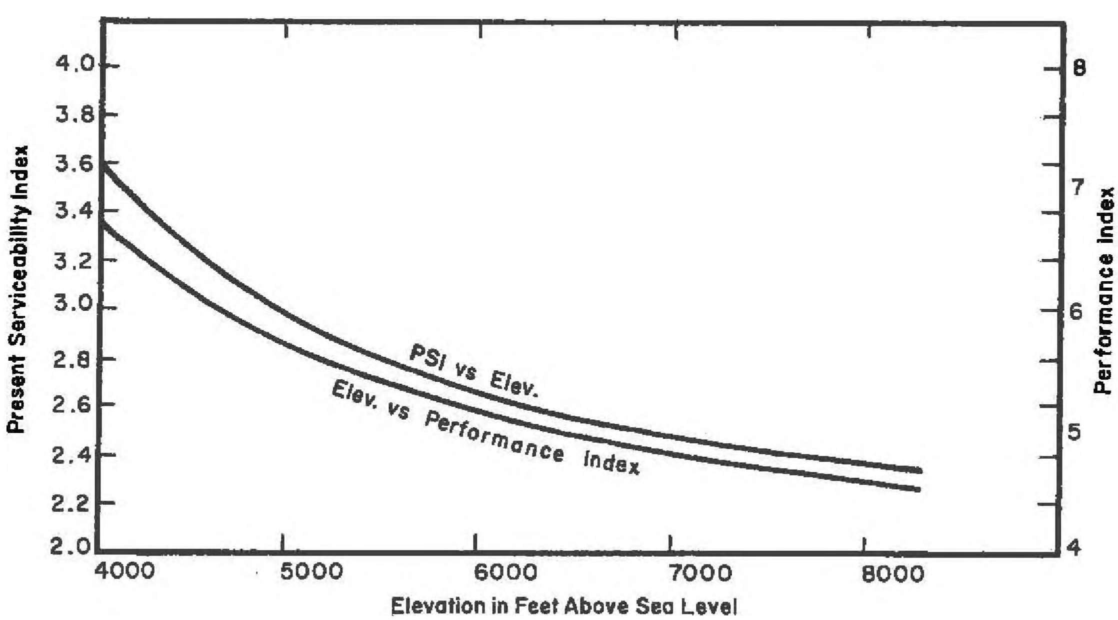
Annual Precipitation, Average Annaul Temperature, and Freezing Index

As might be expected, the annual precipitation correlates well with the regional factor and the drainage. No special significance is attached to these relationships except that it is quite apparent that the 27 projects in this study are in relatively dry areas compared with many other areas of the United States. The range is from 6" to 24" per year. This may be one reason why these 27 projects survived some 16 years of use while others did not.

Average daily temperature correlates well with the freezing index and elevation, but no special significance is attached to this correlation.

The freezing index correlated well with elevation and average daily temperature, but nothing else.

Elevation varied inversely as the performance index and present serviceability index values, and directly with the regional factor. This relationship helps to verify the AASHO design procedure which calls for consideration of the elevation to compute regional factors. The Colorado Division of Highways has accepted ELEVATION as a factor in the new design of roadways. (See Appendix B of this report.)



Drainage

Although it was not evident from the computer analysis, members of the human evaluation team expressed the opinion that there were many indications of the relationship between good drainage and good roadway performance for the 27 projects investigated in this study. The following is an extract from a memorandum summarizing the feelings of the evaluation team:

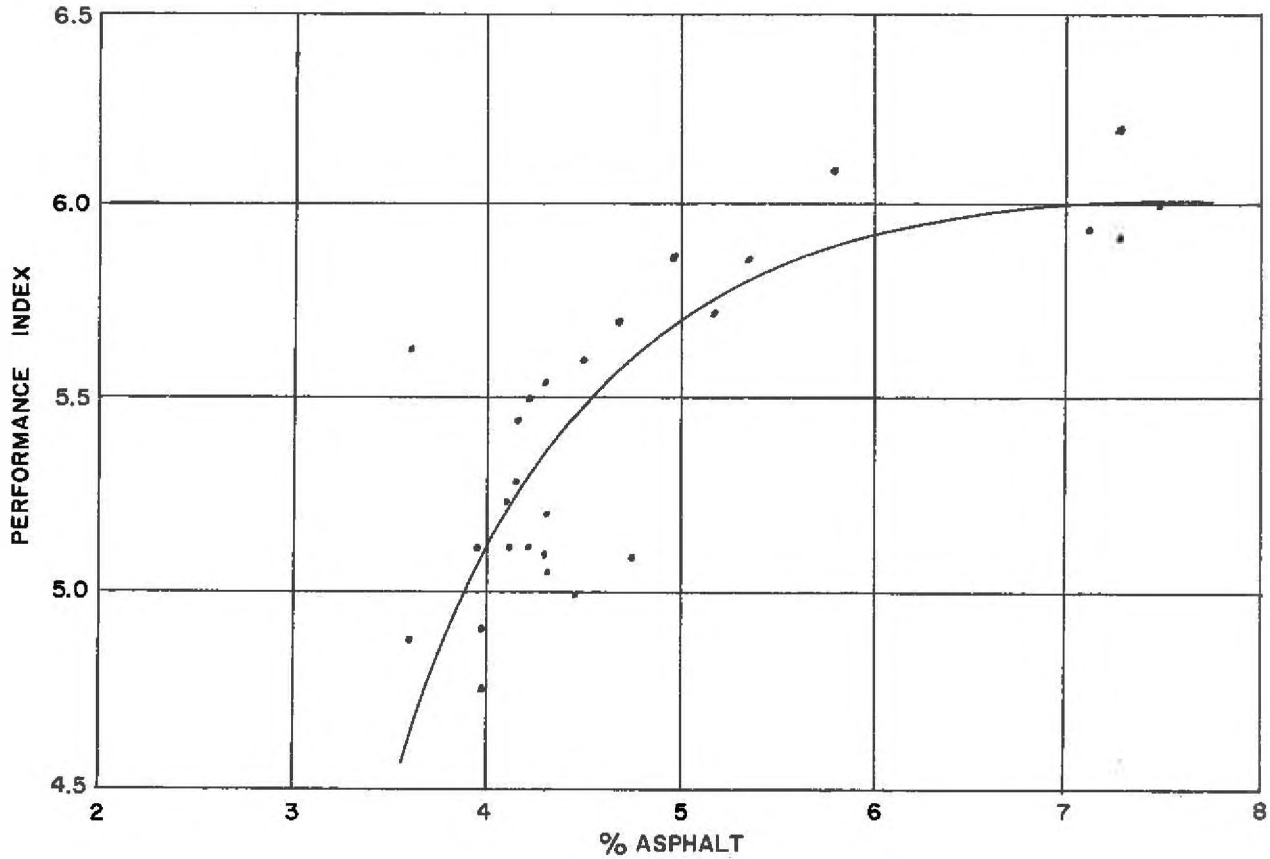
> "Drainage in cuts appeared to be one of the most important items for the concern of future design and maintenance. Roadways that had narrow ditches poorly maintained through cuts, invariably had low serviceability index values and poor riding characteristics. In the future, if it becomes possible to save money on subbase materials by a more realistic design, a portion or all of this savings should be used to widen ditches through cuts (so that they are more easily maintained) and to flatten fill slopes."

Asphalt Type, Quantity, Thickness, Strength, Density, and Penetration

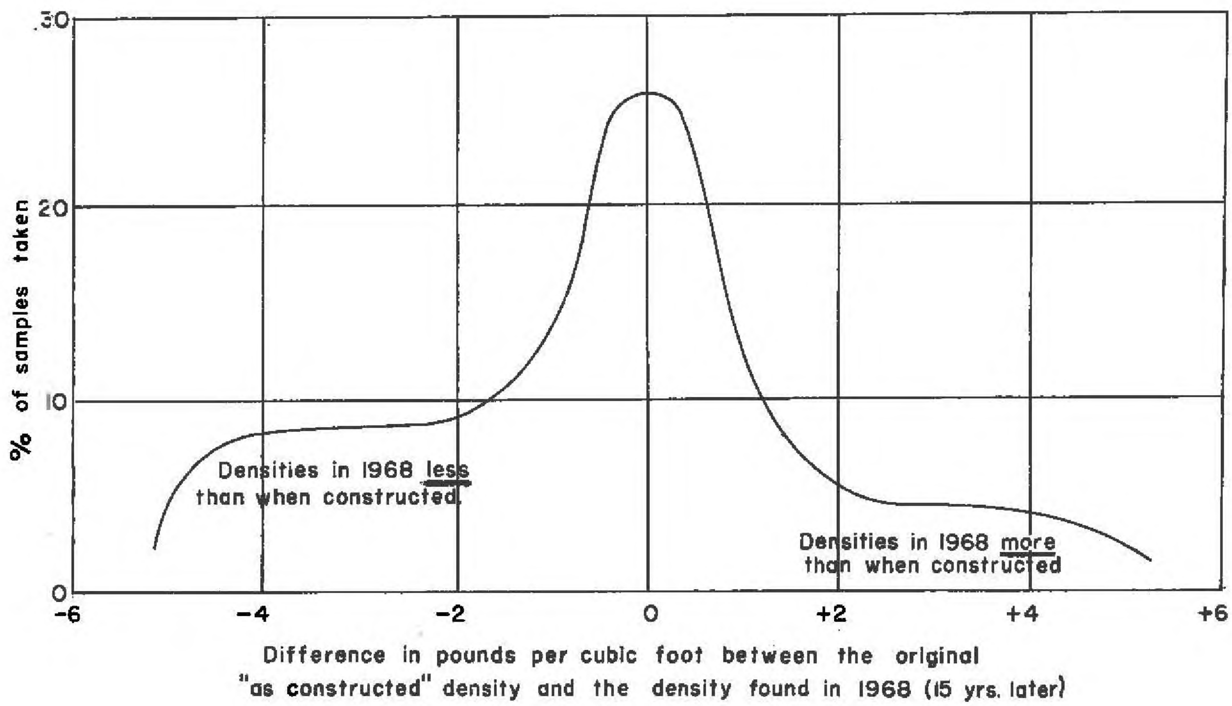
Out of the 27 projects investigated, only E. of Craig, (PSI = 2.7), E. of Arriba (PSI = 2.9), E. of Hugo (PSI = 2.1 and 3.0) and S. of Steamboat Springs (PSI = 2.9) were paved with asphalt cement. All other pavements were made of mixes with cut back asphalts.

The Computer Analysis is meaningless because of the lack of asphalt types other than the Penetration and MC-3 types, but members of the Inspection Review team were impressed by the good condition of most of the old MC-3 mats. Laboratory Engineers generally give the credit for good performance of the MC-3 to low heating (200°-250°F) during construction. Field Engineers generally give the credit for good performance of road mix pavements to the chance occurrence of dry weather during the laydown operation.

While the asphalt content (% asphalt) did not correlate well with the present condition of the roadways, the regression analysis did show fairly good correlation of asphalt content with performance index.



Mat thickness was expressed by both the DESIGNED THICKNESS and by the CORE THICKNESS. There was a high correlation between these two values (0.72), of course, but little correlation of either of these values with anything else except mat density. There was considerable evidence that after 15 years of service, thick mats are less dense than thin mats. However, there was no indication that the denser mats were associated with better roadway performance. This does not mean that good relative compaction of an asphalt mat is not essential to good performance. For the most part, it means that mats made of heavy aggregates (basalt and granite) do not appear to be any more serviceable than mats made out of lightweight aggregates such as dolomite and sandstone. Reliable data on the relative compaction of the asphalt mats at the time of construction was not available, but a bell graph of the reported construction density compared to the density as determined in 1968 is shown on the following page.



The penetration value of the asphalts as found in 1968 showed good correlation only with the thickness of the overlay. This good correlation is easy to understand because the thicker the overlay the greater the availability of fresh asphalt having the original penetration value.

Correlation of Variables with Present Condition of the Roadway

Base Course

With additives in only three of the 27 projects investigated, there is little chance for a correlation study. However, all three projects having additives showed Serviceability Index values above a value of 3, and all three projects had a good performance index.

The project south of Brush had 5% cement in the base course and only a 1½" mat. Heavy truck traffic in the Little Beaver Oil Field area immediately after construction pushed the mat off the fine grain base, but a thicker overlay has lasted well.

The base course on one of the sections east of Hugo was treated with 3% Cottrell Dust, and this treatment appears to have improved the performance of this particular section of the roadway over the performance of the sections of untreated roadway on each side of the treated section.

The blowsand base course east of Hudson was treated with 5% asphalt in 1953. It has served well. Similar blowsand was used for a base course east of Colorado Springs without the use of an additive. The performance of this untreated blowsand as a base course was disappointing. In 1968 the PSI east of Colorado Springs was 2.3, and the roadway only provided 5 years of maintenance free service. It appears that some treatment is necessary if blowsand is to be used for base course materials.

In like manner, there was not a large number of different base thicknesses for correlation with performance. They ranged from 2" to 6", with 4" being the most common thickness by far. The designed thickness correlated with the actual thickness by a factor of 0.883, which indicates good field control. Base thickness correlated with the average PSI value by a factor of 0.5 for some significance.

Apparently there were too many variables in the performance of the 27 different projects for high correlation coefficients to show up with the other properties of the base courses such as Hveem R value, permeability, sand equivalent, Atterburg Limits, and field moisture. Certain natural correlations between each other were apparent, but good correlation of these variables with actual roadway performance values such as PSI and Performance Index was not found.

Subbase Course

Subbase thicknesses varied from 0" to 36". There were a number of negative correlations, showing that roadway performance increased as thickness of the subbase decreased. Occasional negative correlations occur as a matter of chance where there is poor correlation, but the situation shown in the table below suggests that, on this study, the roadway performance did not tend to increase with increasing thickness of the subbase.

	Designed Thickness	Actual Thickness
PSI by CHLOE	-.041	-.094
PSI by CHLOE plus Human Evaluation	-.097	-.212
Maintenance-free Service	-.394	-.326

Of course, increasing thickness of subbase suggests that soils of a more clayey nature are being encountered, and clayey soils are usually characterized by distressed roadways. All of which means that the linear correlation coefficients show no clear cut trends on subbase material for thickness, or for any of the other characteristics such as quality (as indicated by the Hveem R value), permeability, sand equivalent, Atterburg Limits, moisture content or gradation.

Disregarding the computer data, and using the basic data on pages 38 to 64, it will be noted that the material characteristics of the subbase in 1968 were very nearly the same as when constructed for all projects except the Burlington project. This project showed a slight gain in clayey particles as indicated by a decrease in sand equivalent value and an increase in Plasticity Index value. However, the thickness was virtually the same in 1968 as when constructed, and the Hveem R value was the same in 1968 as in 1953.

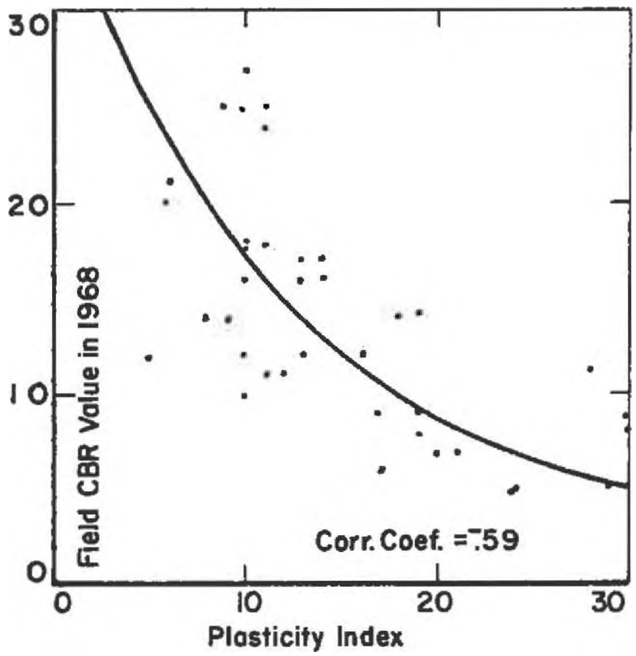
One of the main objectives of this study was to determine whether the service of a roadway in Colorado after 15 to 20 years resulted in a blending of the subgrade with the subbase material. If there is no adulteration of the granular subbase material, designers of an improved roadway on the same alignment can save a considerable amount of time and money by reusing a part or all of the existing subbase. This study clearly indicates that the average subbase material in Colorado is not damaged by use. An exception to the cases studied in this investigation might be a very open graded gravel or crushed rock placed over a very moist clayey or silty subgrade. However, the Colorado Division of Highways has generally specified sand and well graded pit-run gravels of the type found on these 27 projects investigated.

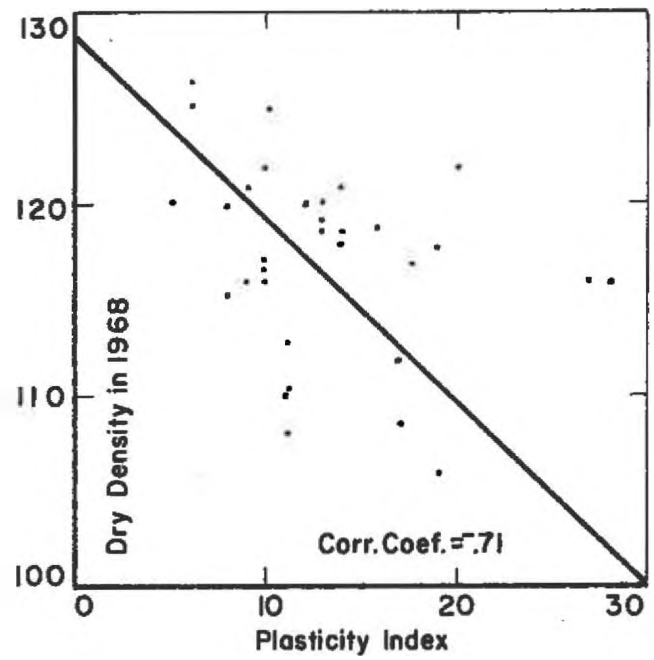
Subgrade

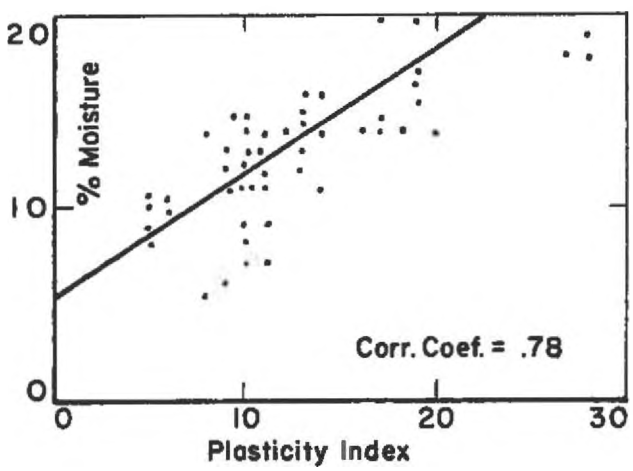
Due to efforts by highway designers and field engineers to provide adequate cover over various types of subgrade, and because of the variations in the subbase and surfacing materials placed on top of the subgrades, little or no correlation exists between subgrade characteristics and roadway performance.

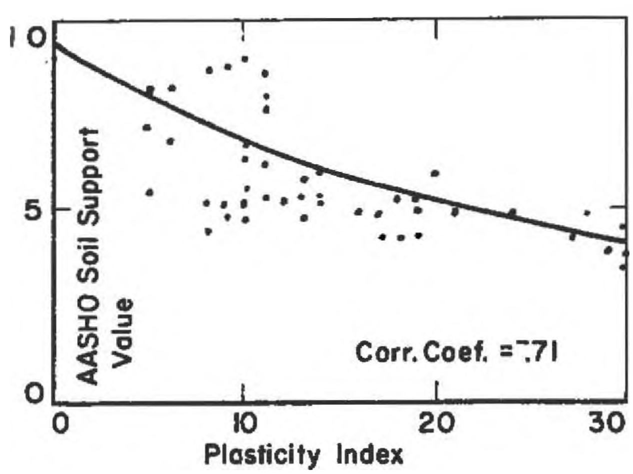
There are striking correlations between characteristics of the subgrade soils, however. Graphs on the following pages show correlation which may be of greatest interest.

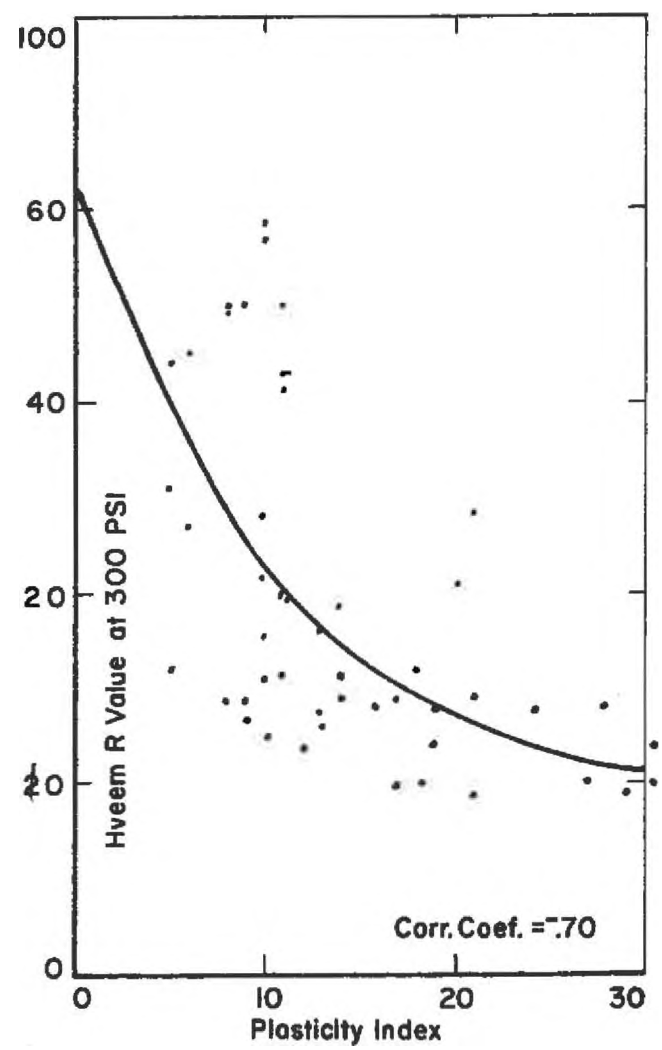
Page 23 shows correlation of the Plasticity Index with various properties of the subgrades. There is a strong trend for the supporting


30
20
10
0
Field CBR Value in 1968
Corr. Coef. = -.59
0
10
20
30
Plasticity Index


130
120
110
100
Dry Density in 1968
Corr. Coef. = -.71
0
10
20
30
Plasticity Index


20
10
0
% Moisture
Corr. Coef. = .78
0
10
20
30
Plasticity Index


10
5
0
AASHO Soil Support Value
Corr. Coef. = -.71
0
10
20
30
Plasticity Index


100
60
40
20
20
0
Hveem R Value at 300 PSI
Corr. Coef. = -.70
0
10
20
30
Plasticity Index

strength of the subgrades, as measured by the field CBR test, to fall off rapidly with increasing plasticity. With the large variety of subgrades making up the 27 projects, the correlation is not perfect, but there is no doubt that roadways with highly plastic subgrades (PI greater than 25) will eventually provide a Field CBR value of 5 or less, a Hveem R value of 20 or less, and an AASHO soil support value of 4 or less. Equilibrium moisture values for these plastic soils are almost certain to be above 20% as indicated by the graph on page 25 and the graph on page 26 which shows how moistures found on these 27 projects compare with equilibrium moisture values found from a previous study of moisture under pavements throughout the State of Colorado.

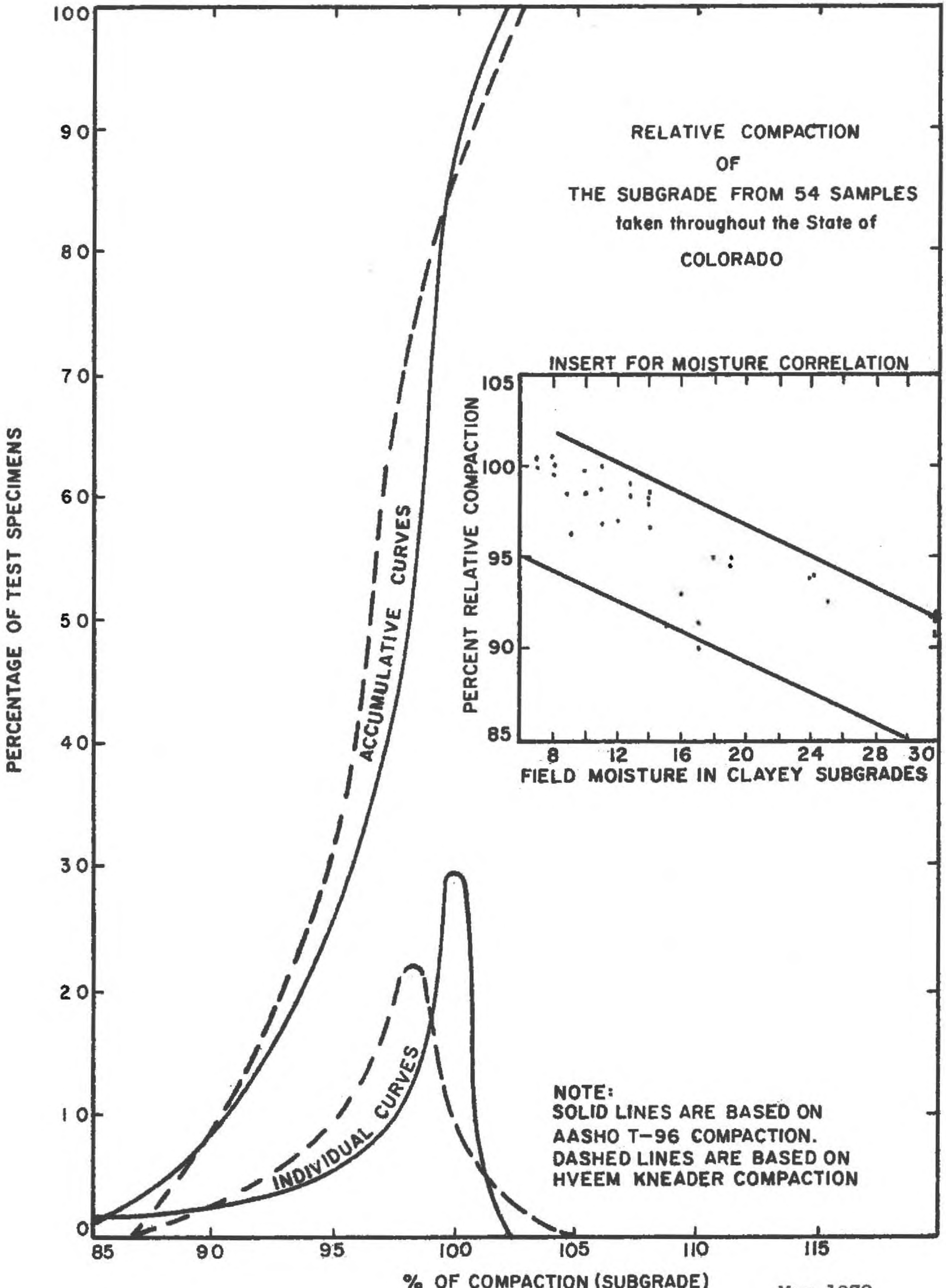
The graphs on page 27 show additional correlation of the Field CBR with the various properties of the subgrades. Of greatest interest may be the correlation of Field CBR with Laboratory Soaked CBR values. It appears that soils showing Lab Soaked CBR values between 2 and 7 may have Field CBR values ranging from 3 to 20. The data scatter where the Field CBR values are above 20 is bad due to the contribution from the rocky soils. In general, however, Field CBR values appear to be double the Lab Soaked CBR values.

When the relationship between Field CBR values and the Lab CBR values was first noted, there was a feeling that the Field CBR equipment gave different readings compared to the Lab equipment. A comparison of the two CBR devices on identically prepared samples showed almost perfect agreement between the two, however.

Page 28 shows a comparison of CBR values for the Lab tests in 1952 and the Field CBR values found in 1968 and 1969. The scatter of Field CBR values is large, but in almost all cases the Field CBR values is two to three times the designed CBR value. There appears to be more variation of CBR values within a project than there is from season to season.

An interesting correlation developed between the Hveem R value test results performed at 300 psi and at 400 psi. There has been some question as to which test to use for design purposes. It appears that the correlation between test values on the two types of compaction is very high. The equation for the relationship is $R_{300} = .8R_{400}$, and there is a correlation coefficient of 0.936.

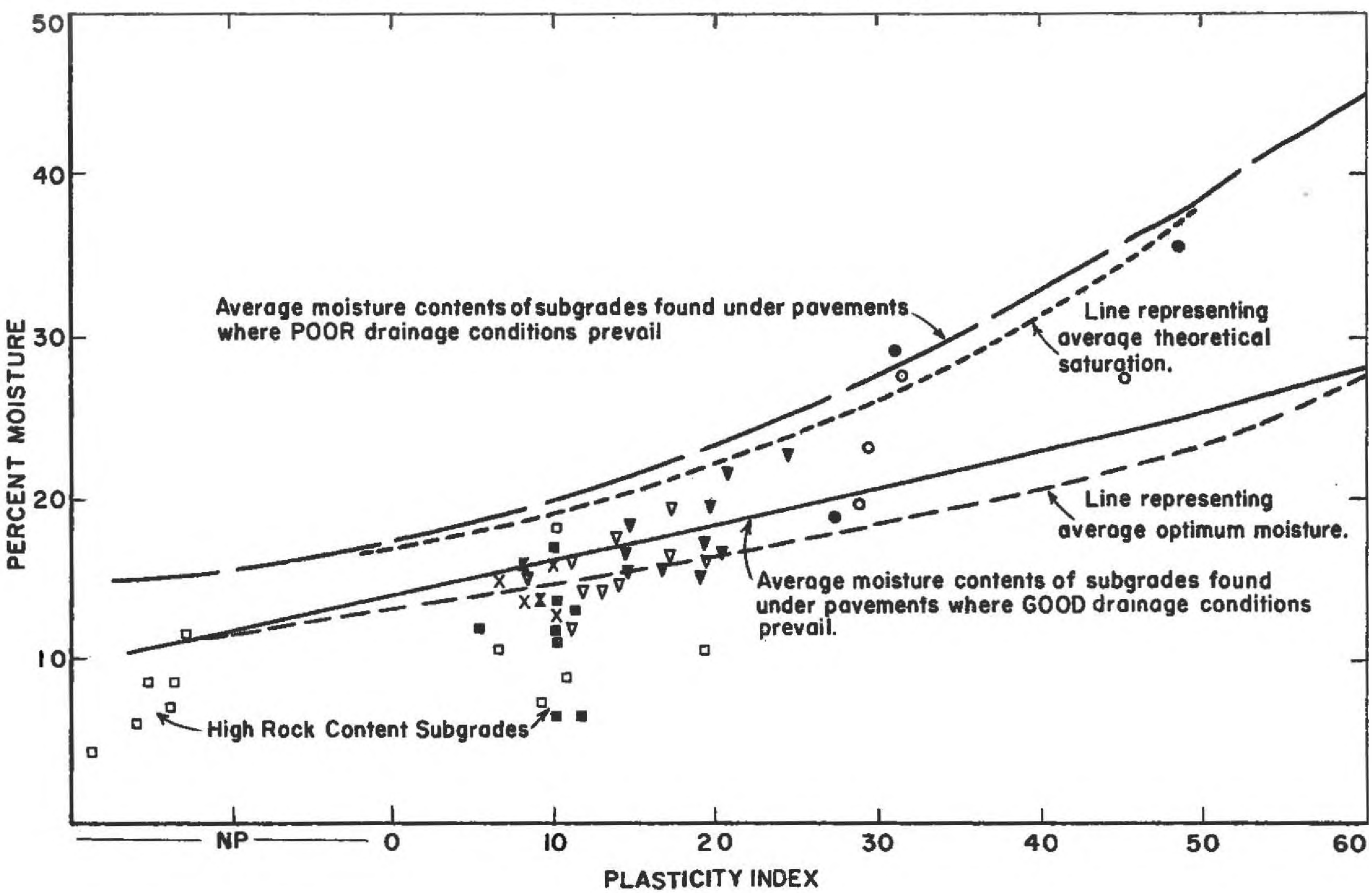
May 1970

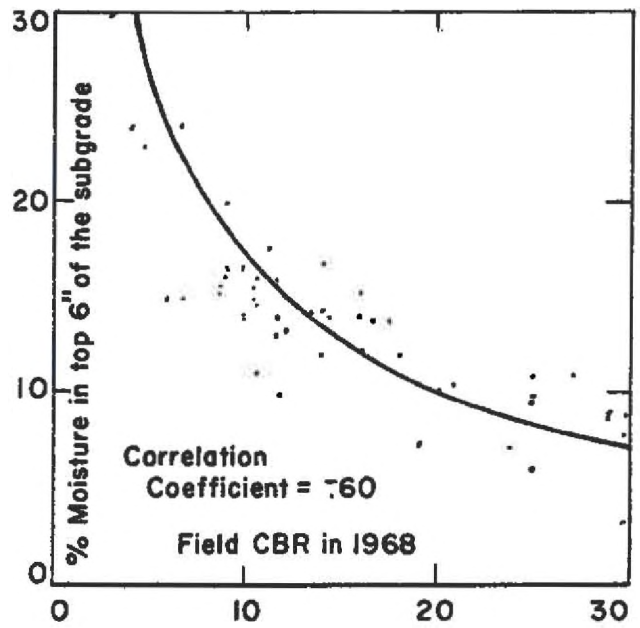

RELATIVE COMPACTION
OF
THE SUBGRADE FROM 54 SAMPLES
taken throughout the State of
COLORADO
INSERT FOR MOISTURE CORRELATION
PERCENT RELATIVE COMPACTION
FIELD MOISTURE IN CLAYEY SUBGRADES
ACCUMULATIVE CURVES
INDIVIDUAL CURVES
NOTE:
SOLID LINES ARE BASED ON
AASHO T-96 COMPACTION.
DASHED LINES ARE BASED ON
HVEEM KNEADER COMPACTION
PERCENTAGE OF TEST SPECIMENS
% OF COMPACTION (SUBGRADE)

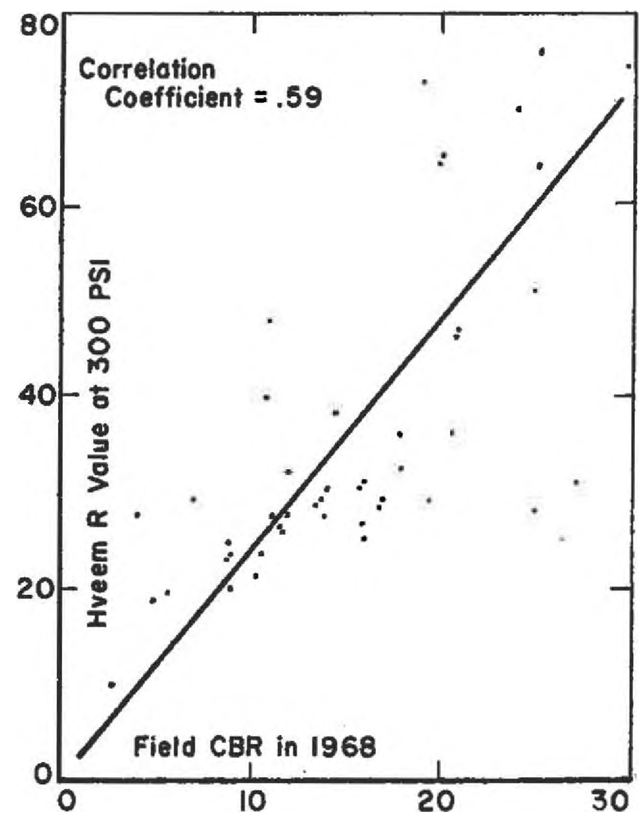
May 1970

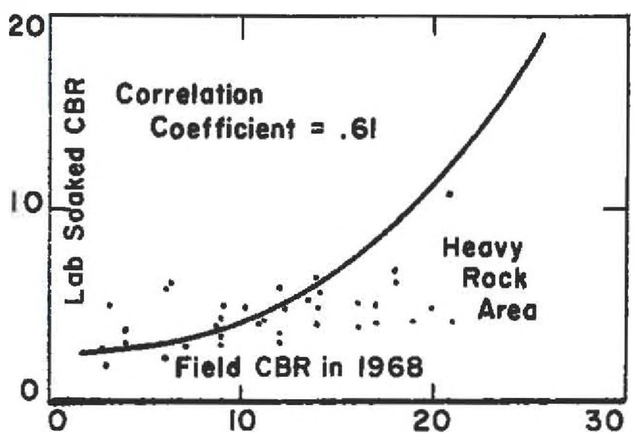
SUMMATION OF DATA FOR THE STUDY OF MOISTURE UNDER COLORADO PAVEMENTS

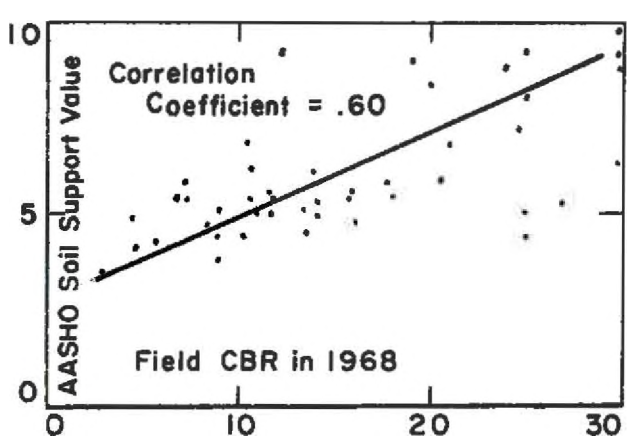
Fill	Cut or at grade	
□	■	A/2 and A/1 Soil
X	Ⅹ	A/4 Soil
▽	▼	A/6 Soil
o	●	A/7 Soil

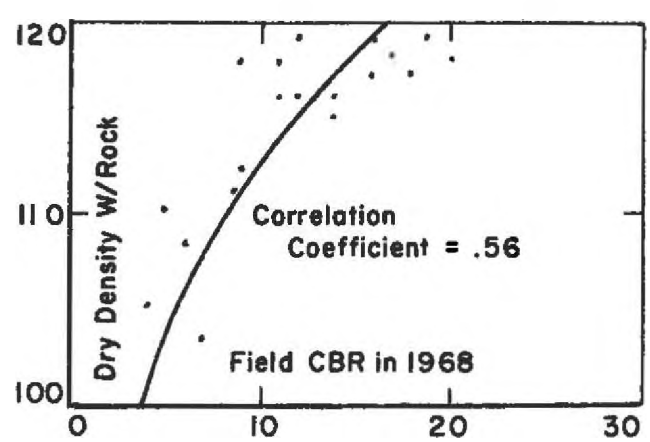



% Moisture in top 6" of the subgrade
Correlation
Coefficient = -.60
Field CBR in 1968
0
10
20
30


Hveem R Value at 300 PSI
Correlation
Coefficient = .59
Field CBR in 1968
0
20
40
60
80
10
30


Lab Soaked CBR
Correlation
Coefficient = .61
Heavy
Rock
Area
Field CBR in 1968
0
10
20
30


AASHO Soil Support Value
Correlation
Coefficient = .60
Field CBR in 1968
0
5
10
20
30


Dry Density W/Rock
Correlation
Coefficient = .56
Field CBR in 1968
100
110
120
0
10
20
30

May 1970

CALIFORNIA BEARING RATIOS
Field CBRs

Site No.	Location	Soil Classification	Lab Designed CBR in 1952	Fall 1968	Summer 1969	Spring 1970
1	Kremmling	A-4(8)	2 - 5	20, 6 & 3	6	4 & 10
2	Craig	A-7-6	7 - 11	5 & 27	29 & 27	4 & 6
3	*Rio Blanco	-	-	-	-	-
4	Durango	A-6(9)	6 - 7	14,31 & 25	24 & 19	19
5	Ignacio	A-6(9)	3	9 & 11	10	7 & 13
6	Alamosa	A-1-b(0)	4	32	30	53
7	San Luis	A-2-4(0)	11	21	30	19
8	Romeo	A-2-4(0)	-	32 & 33	39 & 27	16 & 12
9	Yuma	A-4(7)	4 - 5	16 & 14	24 & 7	15 & 5
10	Brush	A-7-6	3	7 & 5	7 & 5	6
11	Ft. Morgan	A-4(8)	5	14 & 9	10 & 9	16 & 7
12	Buckingham	A-6(3)	6	12 & 18	10 & 12	11 & 14
13	Burlington	A-6(10)	4	11 & 25	15 & 33	16 & 15
14	Arriba	A-6(5)	5	10 & 9	4 & 10	10
15	Hugo	A-2-6(1)	3 - 6	19 & 24	9 & 17	9
16	Hugo	A-7-6(20)	2	6 & 4	6 & 4	16 & 20
17	Lamar	A-6(10)	2	10 & 12	33 & 6	5 & 8
18	*Pritchett	-	-	-	-	-
19	Walsh	A-6(9)	5	26 & 14	22 & 10	13 & 9
20	Ft. Collins	A-4(4)	4 - 6	8 & 17	6 & 13	14 & 20
21	Eldorado Springs	A-7-6	3 - 4	17 & 11	7 & 9	14 & 17
22	*Havana Street	-	-	-	-	-
23	Hudson	A-6(7)	5 - 7	16 & 16	15 & 17	11 & 13
24	Loveland	A-6(5)	4 - 5	30 & 21	20 & 12	13 & 12
25	Windsor	A-2-4(0)	7 - 14	36 & 32	27 & 8	15 & 12
26	Elizabeth	A-2-4(0)	23	25 & 30	33 & 17	12 & 11
27	Colorado Springs	A-7-6(12)	3	8 & 9	32 & 7	13 & 4
28	Wetmore	A-6(12)	3	14 & 4	14 & 3	17 & 10
29	Florence	A-6(10)	3 - 5	12 & 12	15 & 10	11
30	Steamboat Springs	A-1-b(0)	4	30 & 25	+30 & Rock	Rock

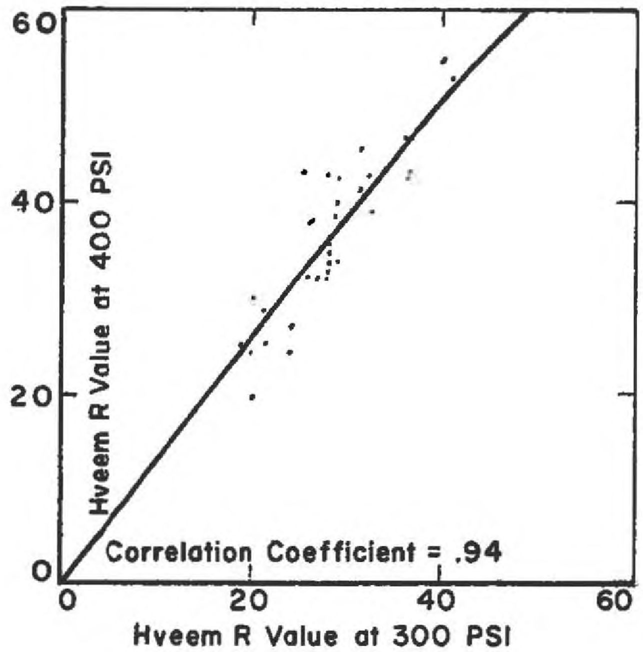
* Roadway rebuilt between the time of planning for this project and actual Field investigation.

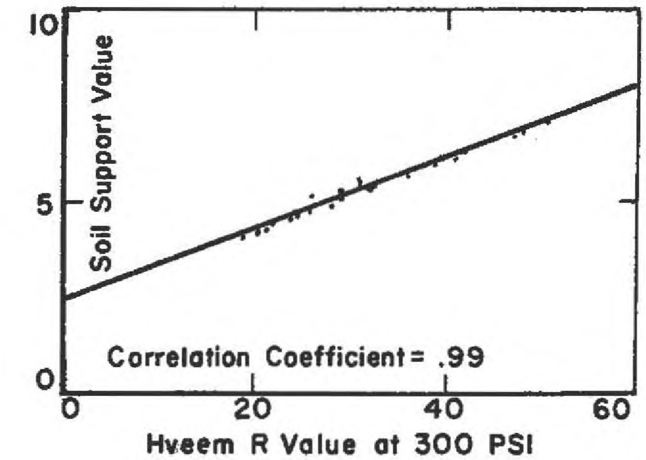
Attempts to obtain Field CBR values during the winters of 1968 and 1969 resulted in CBR values over 100% due to the frozen subgrade.

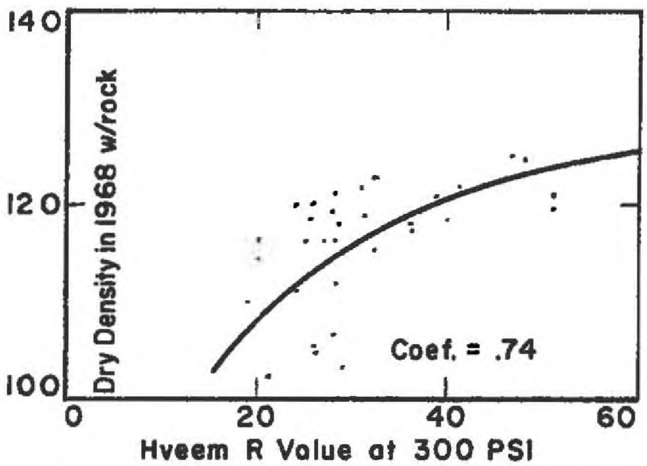
May 1970

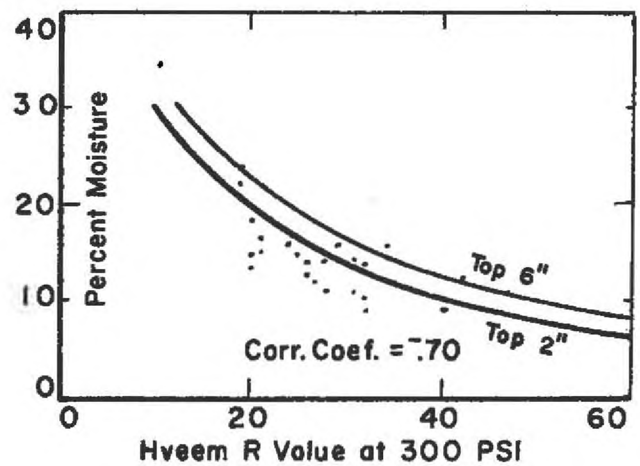
Another interesting correlation is the R_{300} value versus Soil Support shown on page 30. Soil Support values were obtained by use of the AASHO Design Chart, so they were directly dependent on the R_{300} value. This Soil Support versus R_{300} was a check on the computer analysis. After using the chart to obtain the Soil Support value, to a reasonable degree of accuracy, coding and key punching, computer analysis, etc., the resulting correlation was 99%. Theoretically it should have been 100%. Apparently the computer analysis for this study was reliable. Also, the fact that the correlation coefficient of R_{400} with the Soil Support value was 0.95, means that the Hveem Stability at 400 PSI was found to be almost proportional to the Hveem Stability at 300 PSI which correlated at a value of 0.99.

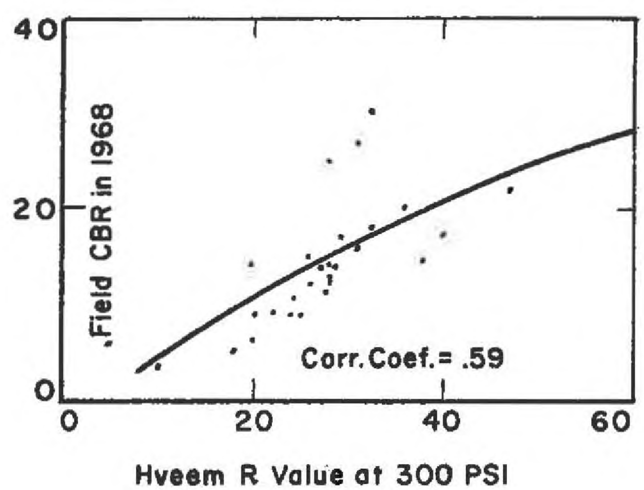
The chart on page 25 shows how field densities compared to compaction by the AASHO T-99 method and by the Hveem Kneader Compaction method. The INDIVIDUAL curves show that about 29% of the samples had 100% compaction as judged by T-99. The ACCUMULATIVE curves show that about 30% of the samples had less than 95% compaction, while about 70% had more than 95% compaction. The soils which showed low compaction were clays having high moisture contents as shown by the moisture table inserted on the same page.

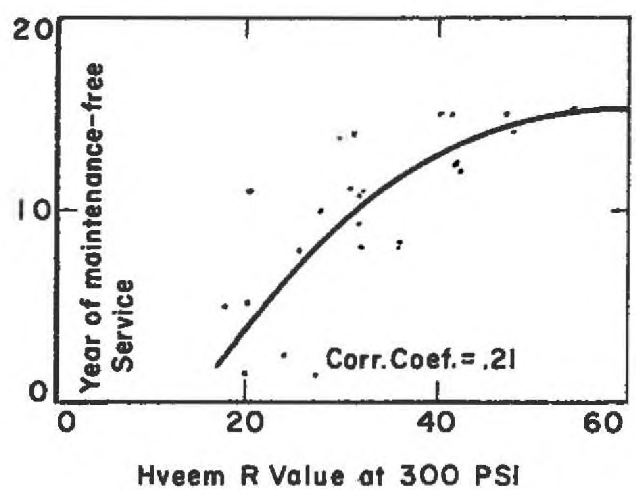

Hveem R Value at 400 PSI
60
40
20
0
Correlation Coefficient = .94
0
20
40
60
Hveem R Value at 300 PSI


Soil Support Value
10
5
0
Correlation Coefficient = .99
0
20
40
60
Hveem R Value at 300 PSI


Dry Density in 1968 w/rock
140
120
100
Coef. = .74
0
20
40
60
Hveem R Value at 300 PSI


Percent Moisture
40
30
20
10
0
Top 6"
Top 2"
Corr. Coef. = -.70
0
20
40
60
Hveem R Value at 300 PSI

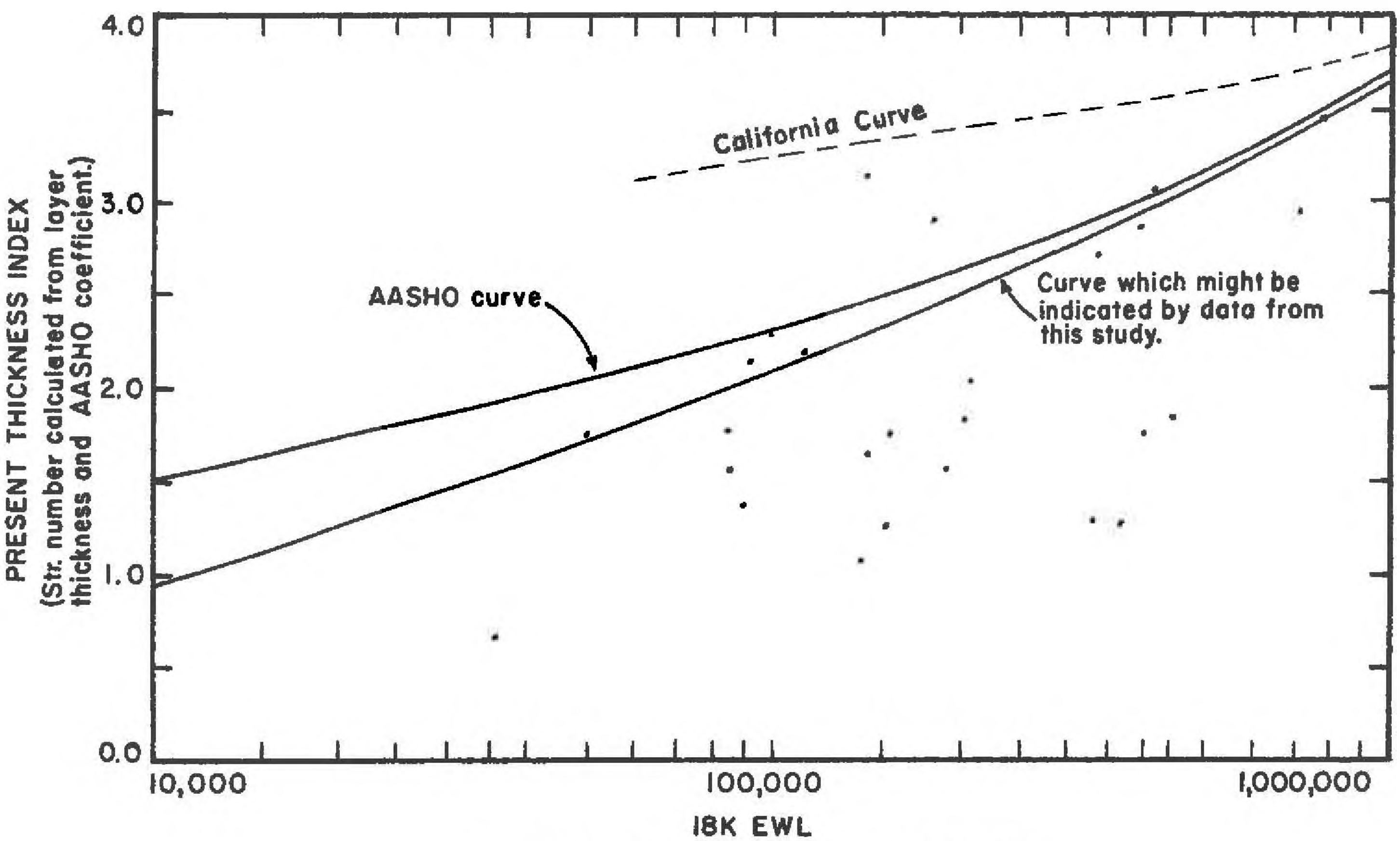

Field CBR in 1968
40
20
0
Corr. Coef. = .59
0
20
40
60
Hveem R Value at 300 PSI


Year of maintenance-free Service
20
10
0
Corr. Coef. = .21
0
20
40
60
Hveem R Value at 300 PSI

COMPARISON OF COLORADO DATA WITH AASHO ROAD TEST FINDINGS

AASHO Road Test findings have been expressed by many formulas and graphs. Perhaps the most direct expression is the one shown below upon which have been plotted the points from this Colorado Flexible Pavement Study.

The AASHO curve appears to provide a design which will insure satisfactory performance of roadways in Colorado. In general it appears to provide a slight over-design in the low traffic region (left side of the graph), and a slight lowering of the line on the left side might be indicated by data from this study. However, because of the findings during the visual inspection, the design review team would not favor any reduction in the asphalt mat thickness.



AASHO Design Curve vs Colorado Results

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COST ANALYSIS

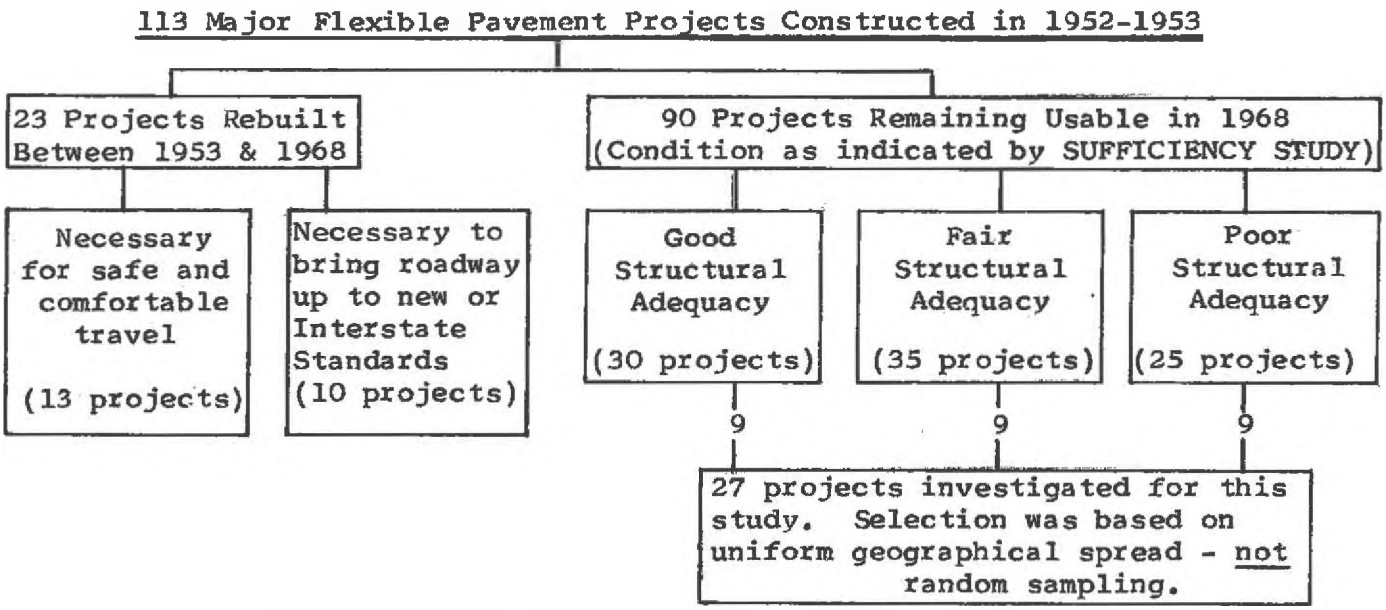
The following Table shows the cost per mile for construction of the pavement structure on each of the following projects including S 0080(1) which was constructed by Larimer County.

Project	Nearest Town	PSI	Cost Per Mile					Ratio Cost PSI $\times 10^4$
			Subbase	Base	Mat	Seal	Total	
S 0107(5)	Kremmling	2.8	4,293	2,800(est)	5,379	2,800	15,272	0.55
F 005-2(9)	Craig	2.7	5,155	2,815	10,241		18,211	0.67
F 002-1(3)	Durango	2.1	9,334	3,151	10,665	1,892	25,032	1.19
S 0154(4)	Ignacio	2.5	7,434	3,758	9,924	1,832	22,948	0.92
S 0120(1)	Alamosa	2.6	3,110(est)	None	5,328	1,111	9,549	0.37
S 0114(1)	San Luis	2.7	4,340	2,906	5,179	1,229	13,654	0.51
S 0112(1)	Romeo	2.9	4,356	5,706	9,494	1,865	21,421	0.74
S 0007(1)	Yuma	2.3	4,861	2,234	6,412	703	14,210	0.62
S 0021(1)	Brush	3.2	15,009	Incl.	6,000	1,816	22,825	0.71
S 0029(2)	Ft.Morgan	2.4	4,572	2,395	5,067	247	12,281	0.51
S 0024(8)	Buckingham	2.8	12,117	None	6,722	715	19,554	0.70
S 0001(9)	Burlington	2.9	4,733	2,543	9,051		16,327	0.56
FI 005-5(1)	Arriba	2.6	11,687	None	18,475		30,162	1.16
C33-0008-15	Hugo	2.1	12,698	None	14,676		27,374	1.30
C33-0008-20	Boyero	3.0	10,891	4,095	15,031	13,000	43,017	1.43
S 0175(1)&(2)	Lamar	2.7	9,683	2,175	5,472	1,409	18,739	0.69
S 0002(12)	Walsh	2.4	6,034	None	5,346	511	11,891	0.50
S 0024(3)	Ft.Collins	2.7	6,978	3,807	6,121	1,067	17,973	0.67
S 0014(1)	Eldorado Springs	2.9	4,500(est)	2,500(est)	6,727	249	13,976	0.48
S 0030(2)	Hudson	3.2	5,893	Incl.	12,075	1,426	14,394	0.61
S 0080(1)	Loveland	3.0	Larimer County Forces				16,800	0.56
S 0034(2)	Windsor	2.9	4,364	2,905	7,126	1,277	15,672	0.54
S 0028(3)	Elizabeth	2.5	4,450	None	6,000	561	11,011	0.44
S 0020(3)	Colorado Springs	2.3	5,782	None	6,995	470	13,247	0.58
S 0081(1)	Wetmore	2.6	2,932	2,299	4,981	1,202	11,414	0.44
S 0081(2)	Florence	2.4	5,749	2,293	5,860		13,902	0.58
F 005-2(6)	Steamboat Springs	2.9	5,797	5,255	12,232	1,261	24,545	0.85

An analysis of the Secondary Highway Projects (for a comparable basis of construction) shows the total cost generally between $10,000 and $20,000 per mile for the pavement structure. There is considerable variation even on projects which are relatively close to each other. For instance, the Ignacio and the Alamosa projects are not far apart but the cost was $23,000 per mile for the Ignacio project, and $9,549 for the Alamosa project (where sand and gravel of such good quality was available that no base course was necessary).

CONCLUSIONS

(1) This study of flexible pavement performance was carried out with some uncertainty as to how representative the 27 projects would be of the overall performance of flexible pavement projects in Colorado. The following diagram is an attempt to illustrate how the 27 projects fit into the 113 major projects constructed in 1952 and 1953.



The 27 projects studied were probably as representative of the 90 surviving projects as can be found. On the other hand, these projects reveal very little about the cause of the failures of the 13 projects which had to be rebuilt for safe and comfortable travel. These 13 rebuilt projects may be placed in the following categories:

Unexpected heavy traffic damaged roadway	Poor drainage softened subgrade	Wet, plastic base gave way	Wet mat gave way
(2 projects)	(3 projects)	(4 projects)	(4 projects)

The failure of the last 11 projects was caused by water. However, when good drainage <u>is</u> provided, and then the mat or base absorbs an unusual amount of moisture, the failure probably would be more appropriately attributed to a hydrophilic or highly absorptive aggregate. Since 1953, this type of aggregate has been quite well identified, and is excluded from use in roadway construction wherever possible.

(2) For the 27 projects investigated, there was no real sign of

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degredation or adulteration of the subbase or base course material. It would be safe to say that base and subbases used on most old projects in Colorado are reusable for widening and rebuilding.

(3) One of the questions that it was hoped would be answered by this study was how well the different layers of material comprising the roadways in Colorado were providing the stability for which they were designed. The answer appears to rest with the fact that only 13 out of the 113 projects had to be rebuilt within a 15 year period, and the roadways which are still in service are in at least a fairly satisfactory condition illustrated by the Present Serviceability Index Values on page 8. Seventy-four percent of the projects investigated have a PSI value of 2.5 or above. The failures, which were responsible for PSI values below the 2.5 level, appeared to be due to:

a. Softening of the subgrade (which is not really a constructed layer of the roadway structure) in local sections of cut areas (poor drainage).
b. Hardening and cracking of the mat after 15 years of service.

Ruts over 0.2" deep were found in only one project. At Hugo where there had been well over a million accumulated 18K wheel loads, the ruts may have indicated a slight failure in the base or subbase layers, but that might have been expected from the results of the AASHO tests.

The lowest field CBR value (CBR = 3) was found in the weathered Pierre Shale type of subgrade east of Hugo. All other field CBR values were found to be well above the original design value.

<u>The conclusion would have to be that, on almost every project, the subgrade is providing more support for the layered system than had been anticipated in the design.</u> <u>For this condition, at least, the base and subbase layers have provided adequate stability.</u> What may be lacking to some extent is mat thickness and flexibility which can only be provided by asphalts having a penetration value above 30 or so. On most projects it appeared that as long as the mat had been fogged, seal coated, or otherwise rejuvenated, there was no problem surface wise.

(4) The results of the California Bearing Ratio performed in the field and the CBR values determined on soaked specimens in the laboratory were so drastically different, that there is wonder that the two were ever associated at all. The design of Colorado roadways is now based on a new premise.

(5) The Hveem Stabilometer value run on a sample compacted at either 300 PSI or 400 PSI will provide a good measure of the internal stability of a subgrade material. The relationship between the two values is $R_{300} = 0.8\ R_{400}$ for normal Colorado soils, and both values correlate well with other soil characteristics. This test should provide a good, rapid, and inexpensive stability test for the determination of soil support values in the AASHO Design Method.

(6) Deflection data may provide a good guide to the amount of useful life remaining in a roadway, but it does not correlate well with past performance of low traffic roadways in Colorado. Many of the roadways with very good service records had more than .040" deflection, and many of the roadways judged to be in poor condition had deflections less than .040".

(7) Although statistics and computer analysis did not reveal a great deal regarding drainage, the human evaluation team expressed great concern about this item. Almost all weak spots, ruts and patches observed on the 27 flexible pavement projects were associated with local areas of poor drainage. This was usually in the form of ditches which had filled up from backslope debris in cut areas.

(8) Another question that it was hoped would be answered by this study was how well the AASHO Design Procedure agrees with flexible pavement performance in Colorado. Computer correlation and visual analysis of the data presented in Appendix A suggests no wide variation between the necessary Structural Number and the Thickness Index (term used to designate a Structural Number determined from layer thickness and type coefficients). During 1969, a committee from the Colorado Roadway Design Division worked out minor variations between AASHO type coefficients and coefficients which seemed best suited to Colorado conditions. The results are included in this report as Appendix B.

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(9) Longitudinal cracking did occur on several projects near the edge of the mat on fill sections where 1½:1 or 2:1 slopes were used. It appears that lack of lateral support due to narrow width, coupled with steep embankment slopes caused this cracking and also produced a rough ride. Either a wider roadway or flatter slopes would probably have prevented this cracking and rough ride. Subgrade soils where this occurred were clay or clay mixed with rock, plus the blowsand east of Colorado Springs which appears to need at least 3:1 embankment slopes.

(10) Traffic values used for design purposes 15 years ago appear to be reasonably accurate for 20 out of 27 projects investigated. Five of the projects were estimated at what appears to be about one-half of the actual traffic volume in 1968. The traffic estimate, in VPD, for the two projects in Hugo was a little too high, but an AASHO design based on the equivalent 18K load of 175 in 1968 is equivalent to the design used in 1953 for Site No. 16. The original design used for Site No. 15 would be considered inadequate by 1968 AASHO standards.

(11) The AASHO T-99 test for maximum compaction and optimum moisture appears to provide very realistic values. Two-thirds of the densities taken were between 95 and 100% of this standard maximum density. No change in the use of these standards is recommended.

(12) The overall value of using a computer to assist in the analysis of data from such an evaluation project as this is questionable. While it is possible that a regression analysis saved time by eliminating relationships that were worthless, it was expensive and time consuming to initiate. Good correlations were sometimes masked by the horde of variables that were used. There is a feeling that the use of the computer was not a mistake on this particular project since it led to a better understanding of its value and possibilities, but the use of a computer on another similar evaluation project should be in a somewhat different manner. Certainly the variables should be selected with greater care to avoid wasted correlation between variables (such as shoulder width and asphalt type for instance).

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APPENDIX A

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0107(5) LOCATION S of Kremmling PSI=2.8 SITE NO. 1

		Stations 322	317	255
PERFORMANCE	Pres.Service.Index	2.7	2.7	2.9
	Avg Pavement Deflection	.042	.058	.043
	Radius of Curvature	180	164	164
	Avg Rut Depth	0.1	0.1	0.1
	Cracking(Cl II & III)	16	16	16
	Patching($ft^2/1000ft^2$)	18.8	18.8	8.0
	Bleeding	—	—	—
	Accum. 18^k EWL ($X10^3$)	94,300	94,300	94,300
	Years of Service	16.2	16.2	16.2
	Design Avg Daily Traffic	115	115	115
	Present ADT	470	470	470
	Avg Yearly Precipitation	15.3	15.3	15.3
	Avg Annual Temperature	40.9	40.9	40.9
	Freezing Index	1216	1216	1216
	Elevation	7560	7560	7560
	Drainage	Good	Good	Good
	Regional Factor	1.00	1.00	1.00
SURFACING	Asphalt Type	MC-3	MC-3	MC-3
	Thickness (Design)	2.0	2.0	2.0
	Core Thickness (1968)	2.1	2.0	2.2
	R Value of Design Mix	90	90	90
	Seal Coat Thickness	0.1	0.1	0.2
	% Asphalt (1953)	4.9	4.9	4.9
	% Asphalt (1968)	3.8	4.0	3.7
	Density During Const.	139.8	139.8	139.8
	Density (1968)	139.2	139.2	139.2
	Penetration (1953)	190	190	190
	Penetration (1968)	29	25	26
BASE	Additive	—	—	—
	Thickness (Design)	4.0	4.0	4.0
	Thickness (1968)	3.0	2.5	4.0
	Hveem "R" Value (1953)	80	80	80
	Hveem "R" Value (1968)	82	82	83
	Permeability (ft/day)	0.93	0.07	0.01
	Sand Equivalent (1953)	44	44	49
	Sand Equivalent (1968)	18	25	28
	Liquid Limit (1953)	NV	NV	NV
	Liquid Limit (1968)	20	NV	NV
	Plasticity Index (1953)	NP	NP	NP
	Plasticity Index (1968)	3	NP	NP
	% Moisture (1968)	2.3	3.7	3.4
	Shoulder Width	3'	3'	3'

		Stations 322	317	255
SUBBASE	Thickness(Design)	10.0	10.0	10.0
	Thickness (1968)	19.0	10.5	4.0
	Hveem "R" Value(1953)	80	80	80
	Hveem "R" Value(1968)	79	78	83
	Permeability(ft/day)	0.45	0.19	70.01
	Sand Equivalent(1953)	25	25	17
	Sand Equivalent(1968)	18	18	17
	Soil Classification('68)	A-1-a	A-1-a	A-1-a
	Liquid Limit(1953)	NV	NV	21
	Liquid Limit(1968)	20	19	17
	Plasticity Index(1953)	NP	NP	NP
	Plasticity Index(1968)	4	2	1
	Specific Gravity	2.62	2.62	2.62
	%Moisture	7.5	4.0	3.6
SUBGRADE	Calif Bearing Ratio '53	4.9	2.1	5.0
	Field CBR in 1968	20.0	5.8	33.3
	Wet Density (1968)	138.9	121.5	145.3
	Dry Density (1968)	126.2	108.5	129.3
	% Moisture Top (1968)	10.1	12.3	12.1
	% Moisture Avg (1968)	14.0	13.7	8.2
	Soil Classification '53	A-4(1)	A-6(6)	A-4(8)
	Soil Classification '68	A-4(0)	A-6(7)	A-1-a
	% Rock in 1968	18	3	46
	Opt Moist.without Rock	10.1	14.2	8.9
	Max Density w/o Rock	126.2	118.0	130.3
	Liquid Limit (1953)	24	27	27
	Liquid Limit (1968)	22	32	NV
	Plasticity Index (1953)	8	13	10
	Plasticity Index (1968)	6	17	NP
	"R" Value at 400 psi	65	30	86
	"R" Value at 300 psi	65	20	82
	Soil Support Value	8.3	4.3	9.8
	% Relative Compaction	97.8	92.4	96.1
STRENGTH	Thickness Index	2.91	2.12	1.40
	Structural Number	1.25	2.30	1.00
	Weighted Str.Number	1.25	2.30	1.00
	Performance Index	5.05	5.05	5.14
	Period of Most Failure	Grad	Grad	Grad
	Years of Maint-Free Serv	5	5	5
	PSI from Sufficiency Rpt	2.6	2.6	2.6
	Cut or Fill Section	Fill	Fill	Cut

Remarks: Cuts have held up better than the fills.

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PROJECT NO. F 005-2(9) LOCATION E. of Craig PSI=2.7 SITE NO. 2

PERFORMANCE

	Stations 68+00	Stations 142+50
Pres.Service.Index	2.9	2.4
Avg Pavement Deflection	.022	.037
Radius of Curvature	360'	200'
Avg Rut Depth	0.1	0.1
Cracking(Cl II & III)	3	3
Patching($ft^2/1000ft^2$)	96	96
Bleeding	0	0
Accum.18^k EWL(X10^3)	400,000	400,000
Years of Service	16	16
Design Avg Daily Traffic	2000	2,000
Present ADT	2900	2900
Avg Yearly Precipitation	13.1	13.1
Avg Annual Temperature	42.6	42.6
Freezing Index	1127	1127
Elevation	6250	6250
Drainage	Good	Good
Regional Factor	1	1

SURFACING

	68+00	142+50
Asphalt Type	AC	AC
Thickness (Design)	2"	2
Core Thickness (1968)	2.1"	2.0
R Value of Design Mix	91	91
Seal Coat Thickness	0.1"	0.1"
% Asphalt (1953)	4.8	4.4
% Asphalt (1968)	4.6	4.5
Density During Const.	141	143
Density (1968)	147	148
Penetration (1953)	170	170
Penetration (1968)	34	39

BASE

	68+00	142+50
Additive	None	None
Thickness (Design)	3	3
Thickness (1968)	7	3
Hveem "R" Value (1953)	81	81
Hveem "R" Value (1968)	85	85
Permeability (ft/day)	.03'	.03'
Sand Equivalent (1953)	28	28
Sand Equivalent (1968)	24	23
Liquid Limit (1953)	NV	NV
Liquid Limit (1968)	20	20
Plasticity Index (1953)	NP	NP
Plasticity Index (1968)	3	1
% Moisture (1968)	4.7	3.6
Shoulder Width	4'	4'

SUBBASE

	Stations 68	Stations 142+50
Thickness(Design)	6"	7"
Thickness (1968)	15"	9"
Hveem "R" Value(1953)	79	79
Hveem "R" Value(1968)	85	85
Permeability(ft/day)	.03'	.03'
Sand Equivalent(1953)	28	28
Sand Equivalent(1968)	24	23
Soil Classification('68)	A-1-a	A-1-a
Liquid Limit(1953)	NV	NV
Liquid Limit(1968)	20	20
Plasticity Index(1953)	NP	NP
Plasticity Index(1968)	3	1
Specific Gravity	2.7	2.7
%Moisture	3.1	3.6

SUBGRADE

	68	142+50
Calif Bearing Ratio '53	11	7
Field CBR in 1968	25	27
Wet Density (1968)	136	135
Dry Density (1968)	116	122
% Moisture Top (1968)	17.5	11
% Moisture Avg (1968)	18	10
Soil Classification '53	A-7-6(17)	A-4(2)
Soil Classification '68	A-7-6(16)	A-4(2)
% Rock in 1968	2%	10%
Opt Moist.without Rock	17	12
Max Density w/o Rock	111	123
Liquid Limit (1953)	48	22
Liquid Limit (1968)	45	26
Plasticity Index (1953)	28	NP
Plasticity Index (1968)	27	10
"R" Value at 400 psi	20	48
"R" Value at 300 psi	20	31
Soil Support Value	4.3	5.2
% Relative Compaction	100	97

STRENGTH

	68	142+50
Thickness Index	3.51	2.25
Structural Number	2.99	2.68
Weighted Str.Number	2.99	2.68
Performance Index	5.67	5.67
Period of Most Failure	late	late
Years of Maint-Free Serv	11	11
PSI from Sufficiency Rpt	2.9	2.8
Cut or Fill Section	cut	High fill

Remarks: Considerable chicken wire and longitudinal type cracking.

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PROJECT NO. F 022-1(6) LOCATION West of Durango PSI=2.1 SITE NO. 4

		Station 172	Station 176	Station 280
PERFORMANCE	Pres.Service.Index	2.0	2.2	2.1
	Avg Pavement Deflection	.045	.019	.018
	Radius of Curvature	180	450	257
	Avg Rut Depth	.1	.1	.1
	Cracking(Cl II & III)		201	
	Patching($ft^2/1000ft^2$)		364	
	Bleeding	None	None	None
	Accum.18^k EWL ($X10^3$)		458,741	
	Years of Service		15	
	Design Avg Daily Traffic		1600	
	Present ADT		2900	
	Avg Yearly Precipitation		18.9	
	Avg Annual Temperature		46.9	
	Freezing Index		46.5	
	Elevation		6930	
	Drainage	Fair	Good	Good
	Regional Factor		1.25	
SURFACING	Asphalt Type		MC-3	
	Thickness (Design)		2.5"	
	Core Thickness (1968)	2.6	4.9	2.7
	R Value of Design Mix		94	
	Seal Coat Thickness	.1	2.4"	.2
	% Asphalt (1953)		4.8	
	% Asphalt (1968)	4.2	4.6	4.4
	Density During Const.	140	140	140
	Density (1968)	140	140	140
	Penetration (1953)	190	190	190
	Penetration (1968)	38	80	56
BASE	Additive	None	None	None
	Thickness (Design)	3"	3"	3"
	Thickness (1968)	3"	3"	3"
	Hveem "R" Value (1953)		80	
	Hveem "R" Value (1968)	83	81	85
	Permeability (ft/day)	.01'	.01'	.01'
	Sand Equivalent (1953)	19	19	18
	Sand Equivalent (1968)	17	18	19
	Liquid Limit (1953)	NV	NV	22
	Liquid Limit (1968)	27	27	24
	Plasticity Index (1953)	NP	NP	NP
	Plasticity Index (1968)	8	9	5
	% Moisture (1968)	4.7	5.5	4.9
	Shoulder Width	3'	3'	3'

		Station 172	Station 176	Station 280
SUBBASE	Thickness(Design)	9"	9"	7"
	Thickness (1968)	9"	8"	8"
	Hveem "R" Value(1953)	63	63	54
	Hveem "R" Value(1968)	70	81	81
	Permeability(ft/day)	.1	.5	.2
	Sand Equivalent(1953)	16	16	17
	Sand Equivalent(1968)	16	18	18
	Soil Classification('68)	A-2-4	A-2-4	A-2-4
	Liquid Limit(1953)	34	34	30
	Liquid Limit(1968)	27	27	25
	Plasticity Index(1953)	18	18	11
	Plasticity Index(1968)	8	9	8
	Specific Gravity	2.54	2.54	2.54
	%Moisture	5.8	6.7	6.7
SUBGRADE	Calif Bearing Ratio '53	6	7	6
	Field CBR in 1968	14	31	25
	Wet Density (1968)	128	120	119
	Dry Density (1968)	116	108	110
	% Moisture Top (1968)	12	12	11
	% Moisture Avg (1968)	12	9	8
	Soil Classification '53	A-4-(7)	A-4	A-6(9)
	Soil Classification '68	A-4(7)	A-2	A-6(9)
	% Rock in 1968	7	50	8
	Opt Moist.without Rock	14	12	14
	Max Density w/o Rock	117	120	116
	Liquid Limit (1953)	31	27	27
	Liquid Limit (1968)	27	28	28
	Plasticity Index (1953)	10	NP	NP
	Plasticity Index (1968)	9	11	11
	"R" Value at 400 psi	35	70	70
	"R" Value at 300 psi	27	62	62
	Soil Support Value	4.9	8.0	8.0
	% Relative Compaction	98	95	95
STRENGTH	Thickness Index	1.91	1.80	1.80
	Structural Number	2.86	2.32	1.84
	Weighted Str.Number	3.08	2.40	1.90
	Performance Index	5.51	5.52	5.55
	Period of Most Failure	late	late	late
	Years of Maint-Free Serv	10	10	10
	PSI from Sufficiency Rpt	1.9	1.9	1.9
	Cut or Fill Section	Cut	Fill	Fill

Remarks: Seal coats have preserved the project by enlivening the asphalt.
Base is good.

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PROJECT NO. S 0154(4) LOCATION NW of Ignacio PSI=2.5 SITE NO. 5

		263+65	272+00
PERFORMANCE	Pres.Service.Index	2.4	2.2
	Avg Pavement Deflection	.024	.025
	Radius of Curvature		257
	Avg Rut Depth		.1
	Cracking(Cl II & III)	14	
	Patching($ft^2/1000ft^2$)		.257
	Bleeding		None
	Accum.18^k EWL($X10^3$)	156.398	
	Years of Service		16
	Design Avg Daily Traffic		375
	Present ADT	1250	
	Avg Yearly Precipitation	14.4	
	Avg Annual Temperature	46	
	Freezing Index	498	
	Elevation	6610	6570
	Drainage		Good
	Regional Factor		.75
SURFACING	Asphalt Type	MC-3	
	Thickness (Design)	2"	
	Core Thickness (1968)	2.1	2.9
	R Value of Design Mix	77	77
	Seal Coat Thickness	0.1	0.9
	% Asphalt (1953)	4.1	4.1
	% Asphalt (1968)	3.5	3.8
	Density During Const.	140	140
	Density (1968)	139	140
	Penetration (1953)	190	190
	Penetration (1968)	35	25
BASE	Additive	None	
	Thickness (Design)	3"	3"
	Thickness (1968)	3"	3"
	Hveem "R" Value (1953)	77	77
	Hveem "R" Value (1968)	82	80
	Permeability (ft/day)	4.5'	1.8'
	Sand Equivalent (1953)	37	37
	Sand Equivalent (1968)	20	17
	Liquid Limit (1953)	NV	NV
	Liquid Limit (1968)	22	24
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	5	6
	% Moisture (1968)	4.6	4.1
	Shoulder Width	2'	2'

		263+65	272+00
SUBBASE	Thickness(Design)	18"	8"
	Thickness (1968)	18"	9"
	Hveem "R" Value(1953)	64	64
	Hveem "R" Value(1968)	82	78
	Permeability(ft/day)	1.1'	0.2'
	Sand Equivalent(1953)	20	20
	Sand Equivalent(1968)	20	19
	Soil Classification('68)	A-1-a	A-1-a
	Liquid Limit(1953)	26	26
	Liquid Limit(1968)	23	25
	Plasticity Index(1953)	4	4
	Plasticity Index(1968)	5	7
	Specific Gravity	2.56	2.56
	%Moisture	5.6	5.5
SUBGRADE	Calif Bearing Ratio '53	3	3
	Field CBR in 1968	9	10.5
	Wet Density (1968)	117	140
	Dry Density (1968)	111	120
	% Moisture Top (1968)	15.5	17.0
	% Moisture Avg (1968)	14	14.0
	Soil Classification '53	--	--
	Soil Classification '68	A-6(9)	A-6(5)
	% Rock in 1968	8	20
	Opt Moist.without Rock	13.7	14.9
	Max Density w/o Rock	116	117.5
	Liquid Limit (1953)	--	--
	Liquid Limit (1968)	35	32
	Plasticity Index (1953)	--	--
	Plasticity Index (1968)	19	12
	"R" Value at 400 psi	27	31
	"R" Value at 300 psi	24	24
	Soil Support Value	4.7	5.3
	% Relative Compaction	94	99
STRENGTH	Thickness Index	2.08	1.45
	Structural Number	2.42	2.20
	Weighted Str.Number	2.28	2.07
	Performance Index	5.16	5.09
	Period of Most Failure	Early	
	Years of Maint-Free Serv	1	
	PSI from Sufficiency Rpt		2.6
	Cut or Fill Section	Cut	Fill

Remarks: Heavy truck traffic early in roadway life caused early failure, but tapering off of traffic and maintenance has stabilized condition now.

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EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0120(1) LOCATION S W of Alamosa PSI=2.6 SITE NO. 6

		Stations 250+00
PERFORMANCE	Pres. Service. Index	2.5
	Avg Pavement Deflection	0.025
	Radius of Curvature	180'
	Avg Rut Depth	0.1"
	Cracking(Cl II & III)	100
	Patching($ft^2/1000ft^2$)	44
	Bleeding	None
	Accum. 18^k EWL($X10^3$)	85,749
	Years of Service	16
	Design Avg Daily Traffic	390
	Present ADT	570
	Avg Yearly Precipitation	6.1"
	Avg Annual Temperature	42^o
	Freezing Index	1142
	Elevation	7570
	Drainage	Fair
	Regional Factor	1
SURFACING	Asphalt Type	MC-3
	Thickness (Design)	2"
	Core Thickness (1968)	3.25"
	R Value of Design Mix	85
	Seal Coat Thickness	0.35
	% Asphalt (1953)	4.9
	% Asphalt (1968)	4.9
	Density During Const.	130.3
	Density (1968)	129.7
	Penetration (1953)	190
	Penetration (1968)	50
BASE	Additive	None
	Thickness (Design)	0
	Thickness (1968)	0 subbase serving
	Hveem "R" Value (1953)	82 as base
	Hveem "R" Value (1968)	81
	Permeability (ft/day)	5'
	Sand Equivalent (1953)	56
	Sand Equivalent (1968)	34
	Liquid Limit (1953)	NV
	Liquid Limit (1968)	NV
	Plasticity Index (1953)	NP
	Plasticity Index (1968)	NP
	% Moisture (1968)	7.5
	Shoulder Width	4'

		Stations 250+00
SUBBASE	Thickness(Design)	8"
	Thickness (1968)	4"
	Hveem "R" Value(1953)	82
	Hveem "R" Value(1968)	81
	Permeability(ft/day)	7'
	Sand Equivalent(1953)	56
	Sand Equivalent(1968)	34
	Soil Classification('68)	A-1-a
	Liquid Limit(1953)	NV
	Liquid Limit(1968)	NV
	Plasticity Index(1953)	NP
	Plasticity Index(1968)	NP
	Specific Gravity	2.60
	%Moisture	7.5
SUBGRADE	Calif Bearing Ratio '53	40
	Field CBR in 1968	32
	Wet Density (1968)	144
	Dry Density (1968)	131
	% Moisture Top (1968)	9.2
	% Moisture Avg (1968)	8
	Soil Classification '53	A-1-6
	Soil Classification '68	A-1-6
	% Rock in 1968	11
	Opt Moist.without Rock	12.7
	Max Density w/o Rock	129
	Liquid Limit (1953)	NV
	Liquid Limit (1968)	NV
	Plasticity Index (1953)	NP
	Plasticity Index (1968)	NP
	"R" Value at 400 psi	81
	"R" Value at 300 psi	81
	Soil Support Value	9.8
	% Relative Compaction	100
STRENGTH	Thickness Index	1.53
	Structural Number	1.00
	Weighted Str.Number	1.00
	Performance Index	4.93
	Period of Most Failure	very gradual
	Years of Maint-Free Serv	16
	PSI from Sufficiency Rpt	2.8
	Cut or Fill Section	fill

Remarks: Surface appears too hard and cracked for Reclamite, but an overlay would hold well because the base is good.

Project overlayed as of June 1969.

May 1970

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0114(1) LOCATION W. of San Luis PSI=2.7 SITE NO. 7

		Stations 378+00
PERFORMANCE	Pres.Service.Index	2.7
	Avg Pavement Deflection	0.040
	Radius of Curvature	180
	Avg Rut Depth	0.1
	Cracking(Cl II & III)	200
	Patching($ft^2/1000ft^2$)	2
	Bleeding	None
	Accum.18^k EWL($X10^3$)	36,377
	Years of Service	15
	Design Avg Daily Traffic	260
	Present ADT	170
	Avg Yearly Precipitation	7.0"
	Avg Annual Temperature	42.3
	Freezing Index	906
	Elevation	7750
	Drainage	Fair
	Regional Factor	1.0
SURFACING	Asphalt Type	MC-3
	Thickness (Design)	1.5"
	Core Thickness (1968)	1.5"
	R Value of Design Mix	79
	Seal Coat Thickness	0.1"
	% Asphalt (1953)	5.1
	% Asphalt (1968)	4.8
	Density During Const.	145
	Density (1968)	142
	Penetration (1953)	190
	Penetration (1968)	25
BASE	Additive	None
	Thickness (Design)	4"
	Thickness (1968)	5"
	Hveem "R" Value (1953)	80
	Hveem "R" Value (1968)	85
	Permeability (ft/day)	1.3'
	Sand Equivalent (1953)	33
	Sand Equivalent (1968)	22
	Liquid Limit (1953)	NV
	Liquid Limit (1968)	NP
	Plasticity Index (1953)	NV
	Plasticity Index (1968)	NP
	% Moisture (1968)	4.6
	Shoulder Width	4'

		Stations 378+00
SUBBASE	Thickness(Design)	0
	Thickness (1968)	0 No Subbase
	Hveem "R" Value(1953)	
	Hveem "R" Value(1968)	
	Permeability(ft/day)	
	Sand Equivalent(1953)	
	Sand Equivalent(1968)	
	Soil Classification('68)	
	Liquid Limit(1953)	
	Liquid Limit(1968)	
	Plasticity Index(1953)	
	Plasticity Index(1968)	
	Specific Gravity	
	%Moisture	
SUBGRADE	Calif Bearing Ratio '53	11
	Field CBR in 1968	21
	Wet Density (1968)	138
	Dry Density (1968)	125
	% Moisture Top (1968)	10.5
	% Moisture Avg (1968)	8.5
	Soil Classification '53	A-2-4(0)
	Soil Classification '68	A-2-4(0)
	% Rock in 1968	12
	Opt Moist.without Rock	11.8
	Max Density w/o Rock	121
	Liquid Limit (1953)	NV
	Liquid Limit (1968)	23
	Plasticity Index (1953)	NP
	Plasticity Index (1968)	6
	"R" Value at 400 psi	62
	"R" Value at 300 psi	47
	Soil Support Value	6.7
	% Relative Compaction	100
STRENGTH	Thickness Index	0.65
	Structural Number	1.39
	Weighted Str.Number	1.39
	Performance Index	4.64
	Period of Most Failure	Gradual
	Years of Maint-Free Serv	15
	PSI from Sufficiency Rpt	3.2
	Cut or Fill Section	Fill

Remarks: Too badly cracked to be saved by a seal. Needs overlay.

May 1970

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0112(1) LOCATION E of Romero PSI=2.9 SITE NO. 8

PERFORMANCE

	Stations 69+00	75+00
Pres.Service.Index	2.5	2.5
Avg Pavement Deflection	.029	.020
Radius of Curvature	300	360
Avg Rut Depth	0.1	
Cracking(Cl II & III)	1	
Patching($ft^2/1000ft^2$)	4	
Bleeding	None	
Accum.18^k EWL($X10^3$)	153,989	
Years of Service	15	
Design Avg Daily Traffic	950	
Present ADT	1100	
Avg Yearly Precipitation	7.04	
Avg Annual Temperature	42.3	
Freezing Index	906	
Elevation	7750	
Drainage	Good	
Regional Factor	0.5	

SURFACING

	69+00	75+00
Asphalt Type	MC-3	
Thickness (Design)	2"	
Core Thickness (1968)	2.1"	2.3"
R Value of Design Mix	93	
Seal Coat Thickness	.1	.3
% Asphalt (1953)	5.2	5.2
% Asphalt (1968)	4.4	4.0
Density During Const.	143.5	143.3
Density (1968)	137.1	139.6
Penetration (1953)	190	190
Penetration (1968)	27	39

BASE

	69+00	75+00
Additive	None	
Thickness (Design)	4.0	4.0
Thickness (1968)	4.0	3.0
Hveem "R" Value (1953)	84	84
Hveem "R" Value (1968)	85	84
Permeability (ft/day)	.04'	.01'
Sand Equivalent (1953)	61	61
Sand Equivalent (1968)	35	33
Liquid Limit (1953)	NV	NV
Liquid Limit (1968)	21	23
Plasticity Index (1953)	NP	NP
Plasticity Index (1968)	2	5
% Moisture (1968)	5.9	5.8
Shoulder Width	4'	4'

SUBBASE

	Stations 69+00	75+00
Thickness(Design)	0	4"
Thickness (1968)	None	6"
Hveem "R" Value(1953)		80
Hveem "R" Value(1968)		86
Permeability(ft/day)		.17
Sand Equivalent(1953)		62
Sand Equivalent(1968)		26
Soil Classification('68)	A-1-a	
Liquid Limit(1953)	NV	
Liquid Limit(1968)	NV	
Plasticity Index(1953)	NP	
Plasticity Index(1968)	NP	
Specific Gravity		2.54
%Moisture		4.3

SUBGRADE

	69+00	75+00
Calif Bearing Ratio '53	?	?
Field CBR in 1968	33	33
Wet Density (1968)	126	125
Dry Density (1968)	120	120
% Moisture Top (1968)	5.7	5
% Moisture Avg (1968)	5.4	5
Soil Classification '53	A-2-4(0)	A-2-4(0)
Soil Classification '68	A-2-4(0)	A-2-4(0)
% Rock in 1968	51	42
Opt Moist.without Rock	11	10
Max Density w/o Rock	126	126
Liquid Limit (1953)	?	?
Liquid Limit (1968)	25	24
Plasticity Index (1953)	?	?
Plasticity Index (1968)	9	8
"R" Value at 400 psi	78	78
"R" Value at 300 psi	70	70
Soil Support Value	8.8	8.8
% Relative Compaction	96%	96

STRENGTH

	69+00	75+00
Thickness Index	1.06	1.48
Structural Number	1.29	1.29
Weighted Str.Number	1.14	1.14
Performance Index	5.19	5.19
Period of Most Failure	Gradual	
Years of Maint-Free Serv	14	
PSI from Sufficiency Rpt	2.9	
Cut or Fill Section	Fill	Fill

Remarks: Looks very good. Seal coat or Reclamite would hold this project for many more years.

May 1970

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0007(1) LOCATION N of Yuma PSI=2.3 SITE NO. 9

		Station 273	Station 269
PERFORMANCE	Pres.Service.Index	3.0	3.0
	Avg Pavement Deflection	.030	.021
	Radius of Curvature	180	257
	Avg Rut Depth	.2"	.2"
	Cracking(Cl II & III)	173	173
	Patching($ft^2/1000ft^2$)	64	
	Bleeding	None	
	Accum.18^k EWL($X10^3$)	90719	
	Years of Service	16	
	Design Avg Daily Traffic	400	
	Present ADT	320	
	Avg Yearly Precipitation	16.77	
	Avg Annual Temperature	50.4	
	Freezing Index	195	
	Elevation	4070	
	Drainage	Fair	Good
	Regional Factor	1	0.5
SURFACING	Asphalt Type	MC-3	
	Thickness (Design)	2"	2"
	Core Thickness (1968)	1.4	1.9
	R Value of Design Mix	84	84
	Seal Coat Thickness	0.1	0.1
	% Asphalt (1953)	3.9	3.9
	% Asphalt (1968)	4.4	4.3
	Density During Const.	139.5	
	Density (1968)	136.7	140.4
	Penetration (1953)	190	
	Penetration (1968)	3	11
BASE	Additive	None	
	Thickness (Design)	4.0	4.0
	Thickness (1968)	4.0	4.0
	Hveem "R" Value (1953)	60	60
	Hveem "R" Value (1968)	79	78
	Permeability (ft/day)	.45'	0.05'
	Sand Equivalent (1953)	38	38
	Sand Equivalent (1968)	31	31
	Liquid Limit (1953)	NV	NV
	Liquid Limit (1968)	NV	NP
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	NP	NP
	% Moisture (1968)	3.5	3.8
	Shoulder Width	3'	3'

		Station 273	Station 269
SUBBASE	Thickness(Design)	6"	6"
	Thickness (1968)	8"	6"
	Hveem "R" Value(1953)	60	60
	Hveem "R" Value(1968)	78	75
	Permeability(ft/day)	.2'	.5'
	Sand Equivalent(1953)	29	29
	Sand Equivalent(1968)	21	33
	Soil Classification('68)	A-1-6	A-1-6
	Liquid Limit(1953)	NV	NV
	Liquid Limit(1968)	NV	NV
	Plasticity Index(1953)	NP	NP
	Plasticity Index(1968)	NP	NP
	Specific Gravity	2.57	2.57
	%Moisture	5.6	3.2
SUBGRADE	Calif Bearing Ratio '53	4	5
	Field CBR in 1968	16	14
	Wet Density (1968)	133	137
	Dry Density (1968)	116	121
	% Moisture Top (1968)	15	14
	% Moisture Avg (1968)	8	11
	Soil Classification '53	A-4(7)	A-4(7)
	Soil Classification '68	A-4(4)	A-6(2)
	% Rock in 1968	1	4
	Opt Moist.without Rock	13.4	13.1
	Max Density w/o Rock	116	118
	Liquid Limit (1953)	33	25
	Liquid Limit (1968)	25	29
	Plasticity Index (1953)	9	NP
	Plasticity Index (1968)	10	14
	"R" Value at 400 psi	43	50
	"R" Value at 300 psi	25	39
	Soil Support Value	4.7	6.0
	% Relative Compaction	100	101
STRENGTH	Thickness Index	1.44	1.32
	Structural Number	2.18	1.77
	Weighted Str.Number	2.18	1.57
	Performance Index	5.17	5.17
	Period of Most Failure	Gradual	
	Years of Maint-Free Serv	15	
	PSI from Sufficiency Rpt	2.0	2.0
	Cut or Fill Section	Grade	fill

Remarks: Alligator cracking badly. Mat too thin.

May 1970

PROJECT NO. S 0021(1) LOCATION South of Brush PSI=3.2 SITE NO. 10

Group	Item	Station 505	Station 515
PERFORMANCE	Pres. Service. Index	3.4	3.6
	Avg Pavement Deflection	.049	.055
	Radius of Curvature	225	164
	Avg Rut Depth	.1	.1
	Cracking (Cl II & III)	2	2
	Patching ($ft^2/1000ft^2$)	1	1
	Bleeding	2	2
	Accum. 18^k EWL ($X10^3$)	425187	
	Years of Service	15	
	Design Avg Daily Traffic	750	
	Present ADT	970	
	Avg Yearly Precipitation	13.1	
	Avg Annual Temperature	49°	
	Freezing Index	384	
	Elevation	4340	
	Drainage	Good	Good
	Regional Factor	0.5	0.5
SURFACING	Asphalt Type	RC-2	
	Thickness (Design)	1.5"	1.5"
	Core Thickness (1968)	3.5"	3.5"
	R Value of Design Mix	63	63
	Seal Coat Thickness	2"	2"
	% Asphalt (1953)	6	6
	% Asphalt (1968)	7	7.5
	Density During Const.	134	136
	Density (1968)	135	137
	Penetration (1953)	115	115
	Penetration (1968)	26	28
BASE	Additive	5% Cement	
	Thickness (Design)	6"	
	Thickness (1968)	4"	4"
	Hveem "R" Value (1953)	67	
	Hveem "R" Value (1968)	67	
	Permeability (ft/day)	.03'	.06'
	Sand Equivalent (1953)	30	30
	Sand Equivalent (1968)	13	15
	Liquid Limit (1953)	NV	NV
	Liquid Limit (1968)	23	22
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	5	2
	% Moisture (1968)	11.6	12.5
	Shoulder Width	4'	4'

Group	Item	Station 505	Station 515
SUBBASE	Thickness (Design)	6"	6"
	Thickness (1968)	6.5"	7"
	Hveem "R" Value (1953)	59	59
	Hveem "R" Value (1968)	69	71
	Permeability (ft/day)	0.6'	.4'
	Sand Equivalent (1953)	17	17
	Sand Equivalent (1968)	19	16
	Soil Classification ('68)	A-2-4(0)	A-2-4(0
	Liquid Limit (1953)	NV	NV
	Liquid Limit (1968)	NV	NV
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	NP	NP
	Specific Gravity	2.6	2.6
	%Moisture	4.5	7.2
SUBGRADE	Calif Bearing Ratio '53	3	
	Field CBR in 1968	6.8	4.7
	Wet Density (1968)	128	135
	Dry Density (1968)	103	110
	% Moisture Top (1968)	24%	23%
	% Moisture Avg (1968)	22%	22%
	Soil Classification '53	A-7-6(17)	A-6(10)
	Soil Classification '68	A-6(12)	A-7-6(17)
	% Rock in 1968	0	0
	Opt Moist. without Rock	18	18
	Max Density w/o Rock	109	109
	Liquid Limit (1953)	48	38
	Liquid Limit (1968)	38	44
	Plasticity Index (1953)	28	19
	Plasticity Index (1968)	21	29
	"R" Value at 400 psi	32	25
	"R" Value at 300 psi	29	19
	Soil Support Value	5.1	4.2
	% Relative Compaction	95	99
STRENGTH	Thickness Index	3.06	3.11
	Structural Number	2.76	3.12
	Weighted Str. Number	2.50	2.84
	Performance Index	6.09	6.28
	Period of Most Failure	Early on thin mat	
	Years of Maint-Free Serv	5	
	PSI from Sufficiency Rpt	3.2	
	Cut or Fill Section	Cut	Fill

Remarks: Original mat was only 1½" thick and showed early failure by way of sliding on the base. After several thin overlays the surface looks good. No base failures.

May 1970

PROJECT NO. S 0029(2) LOCATION N of Fort Morgan PSI = 2.4 SITE NO. 11

		Station 925	Station 835
PERFORMANCE	Pres.Service.Index	3.0	2.6
	Avg Pavement Deflection	.037	.049
	Radius of Curvature	138	106
	Avg Rut Depth	.1	.1
	Cracking(Cl II & III)	272	
	Patching(ft^2/1000ft^2)	12	
	Bleeding	None	
	Accum.18^k EWL(X10^3)	193,558	
	Years of Service	15	
	Design Avg Daily Traffic	225	
	Present ADT	630	
	Avg Yearly Precipitation	13.1	
	Avg Annual Temperature	49° F	
	Freezing Index	384	
	Elevation	4480	
	Drainage	Good	Good
	Regional Factor	0.5	
SURFACING	Asphalt Type	MC-3	
	Thickness (Design)	1.5"	
	Core Thickness (1968)	1.5"	1.5"
	R Value of Design Mix	76	
	Seal Coat Thickness	0.1	0.1
	% Asphalt (1953)	4.6	5.1
	% Asphalt (1968)	4.6	4.5
	Density During Const.	142	142
	Density (1968)	142	142
	Penetration (1953)	190	190
	Penetration (1968)	27	8
BASE	Additive	None	
	Thickness (Design)	3.5"	3.5"
	Thickness (1968)	3.5"	3.5"
	Hveem "R" Value (1953)	76	76
	Hveem "R" Value (1968)	75	77
	Permeability (ft/day)	3.8'	.08'
	Sand Equivalent (1953)	22	22
	Sand Equivalent (1968)	33	24
	Liquid Limit (1953)	22	22
	Liquid Limit (1968)	21	22
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	1	2
	% Moisture (1968)	3.5	3.8
	Shoulder Width	3'	

		Station 925	Station 835
SUBBASE	Thickness(Design)	8"	8"
	Thickness (1968)	9"	9"
	Hveem "R" Value(1953)	72	72
	Hveem "R" Value(1968)	75	77
	Permeability(ft/day)	3.8'	.39
	Sand Equivalent(1953)	31	29
	Sand Equivalent(1968)	33	23
	Soil Classification('68)	A-1-a	A-1-6
	Liquid Limit(1953)	NV	NV
	Liquid Limit(1968)	21	20
	Plasticity Index(1953)	NP	NP
	Plasticity Index(1968)	1	1
	Specific Gravity	2.61	2.61
	%Moisture	3.3	5.2
SUBGRADE	Calif Bearing Ratio '53	5	5
	Field CBR in 1968	13.7	9
	Wet Density (1968)	131	134.2
	Dry Density (1968)	115	112
	% Moisture Top (1968)	14	20
	% Moisture Avg (1968)	14	14
	Soil Classification '53	A-4(8)	A-6(3)
	Soil Classification '68	A-4(8)	A-6(8)
	% Rock in 1968	1	1
	Opt Moist.without Rock	14.4	14.8
	Max Density w/o Rock	113	114
	Liquid Limit (1953)	30	30
	Liquid Limit (1968)	27	32
	Plasticity Index (1953)	5	12
	Plasticity Index (1968)	8	17
	"R" Value at 400 psi	43	39
	"R" Value at 300 psi	29	29
	Soil Support Value	5.1	5.1
	% Relative Compaction	100	98
STRENGTH	Thickness Index	1.54	1.54
	Structural Number	2.40	2.40
	Weighted Str.Number	2.16	2.16
	Performance Index	5.5	5.5
	Period of Most Failure	Gradual	
	Years of Maint-Free Serv	10	
	PSI from Sufficiency Rpt	2.9	
	Cut or Fill Section	Cut	Fill

Remarks: Much crack filling has been necessary in the last 5 years.

May 1970

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0024(8) LOCATION W of Buckingham PSI=2.8 SITE NO. 12

Section	Item	Station 950	Station 893
PERFORMANCE	Pres. Service. Index	2.7	2.7
	Avg Pavement Deflection	.043	.045
	Radius of Curvature	150	150
	Avg Rut Depth	.1	.1
	Cracking (Cl II & III)	29	29
	Patching ($ft^2/1000ft^2$)	24	
	Bleeding	None	
	Accum. 18^k EWL ($X10^3$)	374,309	
	Years of Service	15	
	Design Avg Daily Traffic	640	
	Present ADT	700	
	Avg Yearly Precipitation	13.2	
	Avg Annual Temperature	46.9	
	Freezing Index	297	
	Elevation	4920	
	Drainage	Good	
	Regional Factor	.25	
SURFACING	Asphalt Type	MC-3	
	Thickness (Design)	2"	
	Core Thickness (1968)	2"	2.5"
	R Value of Design Mix	75	
	Seal Coat Thickness	0.1	0.1
	% Asphalt (1953)	4.6	
	% Asphalt (1968)	4.9	4.3
	Density During Const.	140	
	Density (1968)	140	141
	Penetration (1953)	190	
	Penetration (1968)	30	38
BASE	Additive	None	
	Thickness (Design)	0-No Base	
	Thickness (1968)		
	Hveem "R" Value (1953)		
	Hveem "R" Value (1968)		
	Permeability (ft/day)		
	Sand Equivalent (1953)		
	Sand Equivalent (1968)		
	Liquid Limit (1953)		
	Liquid Limit (1968)		
	Plasticity Index (1953)		
	Plasticity Index (1968)		
	% Moisture (1968)		
	Shoulder Width	2' Sod	

Section	Item	Station 950	Station 893
SUBBASE	Thickness (Design)	8"	10"
	Thickness (1968)	6"	8.5"
	Hveem "R" Value (1953)	75	75
	Hveem "R" Value (1968)	80	78
	Permeability (ft/day)	12'	3.3'
	Sand Equivalent (1953)	40	56
	Sand Equivalent (1968)	24	43
	Soil Classification ('68)	A-1-6	A-1-6
	Liquid Limit (1953)	NV	NV
	Liquid Limit (1968)	22	NV
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	3	NP
	Specific Gravity	2.52	2.52
	%Moisture	5.9	5.3
SUBGRADE	Calif Bearing Ratio '53	5.5	5.5
	Field CBR in 1968	11.6	17.9
	Wet Density (1968)	126	132
	Dry Density (1968)	115	117
	% Moisture Top (1968)	9	11
	% Moisture Avg (1968)	10	12
	Soil Classification '53	A-6(3)	A-6(3)
	Soil Classification '68	A-2-4	A-2-4
	% Rock in 1968	0	1
	Opt Moist. without Rock	12	14
	Max Density w/o Rock	117	115
	Liquid Limit (1953)	31	29
	Liquid Limit (1968)	23	27
	Plasticity Index (1953)	11	11
	Plasticity Index (1968)	5	10
	"R" Value at 400 psi	43	43
	"R" Value at 300 psi	32	36
	Soil Support Value	5.4	5.7
	% Relative Compaction	98	101
STRENGTH	Thickness Index	1.06	1.44
	Structural Number	2.59	2.47
	Weighted Str. Number	2.32	2.21
	Performance Index	5.65	5.65
	Period of Most Failure	Gradual	
	Years of Maint-Free Serv	8 Years	
	PSI from Sufficiency Rpt	2.8	
	Cut or Fill Section	Fill	Cut

Remarks: Sealed when 7 years old. Looks good in 1969.

May 1970

PROJECT NO. S 0001(9) LOCATION S of Burlington PSI=2.9 SITE NO. 13

PERFORMANCE

	Station 171	Station 175
Pres.Service.Index	overlayed 3.6	3.7
Avg Pavement Deflection	.064	.050
Radius of Curvature	150	180
Avg Rut Depth	0.1	0.1
Cracking(Cl II & III)	None in overlay	
Patching($ft^2/1000ft^2$)	51	51
Bleeding	None	
Accum. 18^k EWL($X10^3$)	137,592	
Years of Service	16	
Design Avg Daily Traffic	350	
Present ADT	940	
Avg Yearly Precipitation	16.4	
Avg Annual Temperature	51	
Freezing Index	56	
Elevation	4170	
Drainage	Good	Fair
Regional Factor	0.5	

SURFACING

	Station 171	Station 175
Asphalt Type	MC-3 originally	
Thickness (Design)	3"	
Core Thickness (1968)	4.5"	4.0"
R Value of Design Mix	73	
Seal Coat Thickness	1.6"	0.9"
% Asphalt (1953)	3.7	3.7
% Asphalt (1968)	2.9	3.0
Density During Const.	139	
Density (1968)	136	134
Penetration (1953)	190	
Penetration (1968)	37	34

BASE

	Station 171	Station 175
Additive	None	
Thickness (Design)	3"	
Thickness (1968)	2"	2"
Hveem "R" Value (1953)	73	
Hveem "R" Value (1968)	80	80
Permeability (ft/day)	1.5'	1'
Sand Equivalent (1953)	49	
Sand Equivalent (1968)	32	30
Liquid Limit (1953)	18	18
Liquid Limit (1968)	19	19
Plasticity Index (1953)	NP	NP
Plasticity Index (1968)	2	2
% Moisture (1968)	3.5	3.0
Shoulder Width	2'	

SUBBASE

	Station 171	Station 175
Thickness(Design)	6"	
Thickness (1968)	6"	6"
Hveem "R" Value(1953)	68	68
Hveem "R" Value(1968)	68	68
Permeability(ft/day)	1.2'	1.2'
Sand Equivalent(1953)	28	28
Sand Equivalent(1968)	18	18
Soil Classification('68)	A-2-4	A-2-4
Liquid Limit(1953)	NV	NV
Liquid Limit(1968)	25	26
Plasticity Index(1953)	NP	NP
Plasticity Index(1968)	9	9
Specific Gravity	2.57	2.57
%Moisture	9.6	7.5

SUBGRADE

	Station 171	Station 175
Calif Bearing Ratio '53	4.3	4.3
Field CBR in 1968	10.5	24.8
Wet Density (1968)	129	133
Dry Density (1968)	118	120
% Moisture Top (1968)	8.5	10.8
% Moisture Avg (1968)	8.6	10.4
Soil Classification '53	A-6(10)	A-6(10)
Soil Classification '68	A-2-6	A-4(2)
% Rock in 1968	4	1
Opt Moist.without Rock	11	11.4
Max Density w/o Rock	122	122
Liquid Limit (1953)	38	38
Liquid Limit (1968)	25	22
Plasticity Index (1953)	16	16
Plasticity Index (1968)	11	5
"R" Value at 400 psi	55	63
"R" Value at 300 psi	40	51
Soil Support Value	6.1	7.1
% Relative Compaction	97	98

STRENGTH

	Station 171	Station 175
Thickness Index	1.7	1.6
Structural Number	1.83	1.57
Weighted Str.Number	1.66	1.57
Performance Index	5.7	5.9
Period of Most Failure	Early	
Years of Maint-Free Serv	4	
PSI from Sufficiency Rpt	3.2	
Cut or Fill Section	Fill	Cut

Remarks: Original mat failed after 5 years. The 2" overlay looks good. Possible mixing of Subgrade with subbase on this project.

May 1970

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. F 1005-5(1) LOCATION E of Arriba PSI=2.6 SITE NO. 14

	Stations 819	Stations 833
PERFORMANCE		
Pres.Service.Index	2.5	2.8
Avg Pavement Deflection	0.027	.027
Radius of Curvature	300	450
Avg Rut Depth	0.2	0.2
Cracking(Cl II & III)	50	50
Patching($ft^2/1000ft^2$)	None	
Bleeding	None	
Accum.18^k EWL($X10^3$)	738,805	
Years of Service	16	
Design Avg Daily Traffic	1900	
Present ADT	2350	
Avg Yearly Precipitation	14.3	
Avg Annual Temperature	47.4	
Freezing Index	46.5	
Elevation	5130'	
Drainage	Fair	
Regional Factor	1.0	
SURFACING		
Asphalt Type	AC	
Thickness (Design)	4"	
Core Thickness (1968)	4.5"	4"
R Value of Design Mix	70	
Seal Coat Thickness	.4"	.1"
% Asphalt (1953)	5	5
% Asphalt (1968)	5.6	6.2
Density During Const.	137	
Density (1968)	133	132
Penetration (1953)	130	
Penetration (1968)	31	28
BASE		
Additive	None	
Thickness (Design)	No Base Course	
Thickness (1968)		
Hveem "R" Value (1953)		
Hveem "R" Value (1968)		
Permeability (ft/day)		
Sand Equivalent (1953)		
Sand Equivalent (1968)		
Liquid Limit (1953)		
Liquid Limit (1968)		
Plasticity Index (1953)		
Plasticity Index (1968)		
% Moisture (1968)		
Shoulder Width	10'	

	Stations 819	Stations 833
SUBBASE		
Thickness(Design)	13"	13"
Thickness (1968)	9.5	10"
Hveem "R" Value(1953)	69	68
Hveem "R" Value(1968)	75	72
Permeability(ft/day)	1'	1'
Sand Equivalent(1953)	62	55
Sand Equivalent(1968)	36	41
Soil Classification('68)	A-1-6	A-1-6
Liquid Limit(1953)	NV	20
Liquid Limit(1968)	19	20
Plasticity Index(1953)	NP	1
Plasticity Index(1968)	3	4
Specific Gravity	2.5	2.5
%Moisture	4.5	2.3
SUBGRADE		
Calif Bearing Ratio '53	4.9	4.6
Field CBR in 1968	10.2	8.8
Wet Density (1968)	115	136
Dry Density (1968)	101	118
% Moisture Top (1968)	14.5	15.3
% Moisture Avg (1968)	16	12.7
Soil Classification '53	A-4	A-6(2)
Soil Classification '68	A-2-7	A-6(5)
% Rock in 1968	12	2
Opt Moist.without Rock	20.0	12.5
Max Density w/o Rock	101	119
Liquid Limit (1953)	29	31
Liquid Limit (1968)	74	36
Plasticity Index (1953)	10	13
Plasticity Index (1968)	48	19
"R" Value at 400 psi	25	29
"R" Value at 300 psi	21	21
Soil Support Value	4.4	4.4
% Relative Compaction	95	100
STRENGTH		
Thickness Index	3.0	2.9
Structural Number	3.1	3.1
Weighted Str.Number	3.1	3.1
Performance Index	5.8	5.9
Period of Most Failure	Early	
Years of Maint-Free Serv	1	
PSI from Sufficiency Rpt	2.8	
Cut or Fill Section	Fill	Cut

Remarks: Surface cracked badly, soon after construction, but the seal coat has held up well considering the heavy traffic.

May 1970

PROJECT NO. C 33-0008-15 LOCATION E of Hugo PSI=2.1 SITE NO. 15

PERFORMANCE	Station 900	Station 918
Pres.Service.Index	2.3	2.3
Avg Pavement Deflection	.035	.026
Radius of Curvature	300	600
Avg Rut Depth	.2	.2
Cracking(Cl II & III)	220	
Patching($ft^2/1000ft^2$)	184	
Bleeding	None	
Accum.18^k EWL($X10^3$)	1,057,595	
Years of Service	15	
Design Avg Daily Traffic	3240	
Present ADT	2150	
Avg Yearly Precipitation	12.6	
Avg Annual Temperature	47.4	
Freezing Index	294	
Elevation	5000	
Drainage	Good	
Regional Factor	0.25	

SURFACING	Station 900	Station 918
Asphalt Type	AC	
Thickness (Design)	3"	
Core Thickness (1968)	4.5	3.5
R Value of Design Mix	79	
Seal Coat Thickness	.4	.2
% Asphalt (1953)	7.2	
% Asphalt (1968)	7.0	7.3
Density During Const.	137	
Density (1968)	133	133
Penetration (1953)	112	
Penetration (1968)	28	17

BASE	Station 900	Station 918
Additive	None	
Thickness (Design)	No base course	
Thickness (1968)		
Hveem "R" Value (1953)		
Hveem "R" Value (1968)		
Permeability (ft/day)		
Sand Equivalent (1953)		
Sand Equivalent (1968)		
Liquid Limit (1953)		
Liquid Limit (1968)		
Plasticity Index (1953)		
Plasticity Index (1968)		
% Moisture (1968)		
Shoulder Width		

SUBBASE	Station 906	Station 918
Thickness(Design)	15"	15"
Thickness (1968)	14"	15"
Hveem "R" Value(1953)	69	69
Hveem "R" Value(1968)	73	73
Permeability(ft/day)	1'	1'
Sand Equivalent(1953)	42	45
Sand Equivalent(1968)	37	53
Soil Classification('68)	A-1-6	A-1-6
Liquid Limit(1953)	NV	NV
Liquid Limit(1968)	NV	NP
Plasticity Index(1953)	NP	NV
Plasticity Index(1968)	NP	NP
Specific Gravity	2.6	2.6
%Moisture	5.7	3.2

SUBGRADE	Station 906	Station 918
Calif Bearing Ratio '53	3	5.8
Field CBR in 1968	19.0	24
Wet Density (1968)	126	117
Dry Density (1968)	119	113
% Moisture Top (1968)	6.6	4
% Moisture Avg (1968)	6	7
Soil Classification '53	A-6(4)	A-2-6(1)
Soil Classification '68	A-1-6	A-2-6(0)
% Rock in 1968	3	10
Opt Moist.without Rock	10.1	11.4
Max Density w/o Rock	121	119
Liquid Limit (1953)	45	33
Liquid Limit (1968)	27	26
Plasticity Index (1953)	NV	18
Plasticity Index (1968)	NP	11
"R" Value at 400 psi	76	70
"R" Value at 300 psi	73	70
Soil Support Value	9	8.8
% Relative Compaction	98	93

STRENGTH	Station 906	Station 918
Thickness Index	3.52	3.2
Structural Number	1.72	1.75
Weighted Str.Number	1.40	1.43
Performance Index	5.9	5.9
Period of Most Failure	Early	Early
Years of Maint-Free Serv	4	4
PSI from Sufficiency Rpt	2.7	2.7
Cut or Fill Section	Fill	Cut

Remarks: Heavy seal has held mat together, but roadway is distorted.

May 1970

PROJECT NO C 33-0008-20 LOCATION E of Hugo PSI-3.0 SITE NO. 16

PERFORMANCE

	Stations 1620	1643
Pres.Service.Index	3.0	
Avg Pavement Deflection	.054	.032
Radius of Curvature	257	164
Avg Rut Depth	.1	.1
Cracking(Cl II & III)	None	
Patching($ft^2/1000ft^2$)	2	
Bleeding	None	
Accum.18^k EWL($X10^3$)	948,872	
Years of Service	13	
Design Avg Daily Traffic	3600	
Present ADT	2150	
Avg Yearly Precipitation	12.6	
Avg Annual Temperature	47.4	
Freezing Index	294	
Elevation	4840	
Drainage	Good	
Regional Factor	0.25	

SURFACING

	1620	1643
Asphalt Type	AC + 5% Lime	
Thickness (Design)	3"	
Core Thickness (1968)	3.7"	3.4"
R Value of Design Mix	80	
Seal Coat Thickness	.2"	.2"
% Asphalt (1953)	5.6	5.6
% Asphalt (1968)	5.8	5.8
Density During Const.	140	140
Density (1968)	139	141
Penetration (1953)	110	110
Penetration (1968)	41	50

BASE

	1620	1643
Additive	3% Cottrell Dust	
Thickness (Design)	4"	4"
Thickness (1968)	4"	4"
Hveem "R" Value (1953)	81	81
Hveem "R" Value (1968)	76	76
Permeability (ft/day)	1'	1'
Sand Equivalent (1953)	40	31
Sand Equivalent (1968)	40	31
Liquid Limit (1953)	NV	NV
Liquid Limit (1968)	NP	NP
Plasticity Index (1953)	NV	25
Plasticity Index (1968)	NP	7
% Moisture (1968)	6.5	8.3
Shoulder Width	4'	4'

SUBBASE

	Stations 1620	1643
Thickness(Design)	15"	15"
Thickness (1968)	15"	15"
Hveem "R" Value(1953)	65	65
Hveem "R" Value(1968)	70	73
Permeability(ft/day)	1'	1'
Sand Equivalent(1953)	36	36
Sand Equivalent(1968)	32	31
Soil Classification('68)	A-1-6	A-1-6
Liquid Limit(1953)	18	18
Liquid Limit(1968)	NP	NP
Plasticity Index(1953)	20	NV
Plasticity Index(1968)	5	NP
Specific Gravity	2.6	2.6
%Moisture	3.6	4.6

SUBGRADE

	1620	1643
Calif Bearing Ratio '53	2	2
Field CBR in 1968	3	3
Wet Density (1968)	126	121
Dry Density (1968)	97	90
% Moisture Top (1968)	30	35
% Moisture Avg (1968)	28	27
Soil Classification '53	A-7-6(20)	A-7-6(2
Soil Classification '68	A-7-6(19)	A-7-6(20
% Rock in 1968	0	0
Opt Moist.without Rock	21	23
Max Density w/o Rock	104	98
Liquid Limit (1953)	67	67
Liquid Limit (1968)	39	39
Plasticity Index (1953)	65	69
Plasticity Index (1968)	45	48
"R" Value at 400 psi	12	12
"R" Value at 300 psi	10	10
Soil Support Value	3.4	3.4
% Relative Compaction	94	91

STRENGTH

	1620	1643
Thickness Index	3.56	3.43
Structural Number	3.92	3.92
Weighted Str.Number	3.59	3.59
Performance Index	6.2	6.1
Period of Most Failure	Gradual	
Years of Maint-Free Serv	16	
PSI from Sufficiency Rpt	3.0	
Cut or Fill Section	Fill	Cut

Remarks: Mat and Base in good condition considering the distortion of the swelling subgrade.

May 1970

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0175(1) LOCATION N of Lamar PSI=3.0 SITE NO. 17

PERFORMANCE	Station 190	Station 290
Pres.Service.Index	3.7	3.5
Avg Pavement Deflection	.034	.038
Radius of Curvature	150	200
Avg Rut Depth	.1	.1
Cracking(Cl II & III)	62	62
Patching($ft^2/1000ft^2$)	4	4
Bleeding	None	
Accum.18^k EWL($X10^3$)	115,678	
Years of Service	15	
Design Avg Daily Traffic	640	
Present ADT	580	
Avg Yearly Precipitation	13.7	
Avg Annual Temperature	53.4	
Freezing Index	43.4	
Elevation	3740	
Drainage	Good	
Regional Factor	0.25	

SURFACING	Station 190	Station 290
Asphalt Type	MC-3	
Thickness (Design)	3	
Core Thickness (1968)	3"	2"
R Value of Design Mix	72	
Seal Coat Thickness	.1	.1
% Asphalt (1953)	4.6	
% Asphalt (1968)	4.8	4.8
Density During Const.	142	
Density (1968)	141	141
Penetration (1953)	190	190
Penetration (1968)	17	17

BASE	Station 190	Station 290
Additive	None	
Thickness (Design)	3"	3"
Thickness (1968)	3"	3"
Hveem "R" Value (1953)	72	78
Hveem "R" Value (1968)	81	77
Permeability (ft/day)	1'	1'
Sand Equivalent (1953)	29	39
Sand Equivalent (1968)	23	31
Liquid Limit (1953)	NV	19
Liquid Limit (1968)	23	21
Plasticity Index (1953)	NP	NP
Plasticity Index (1968)	9	6
% Moisture (1968)	5.5	4.6
Shoulder Width	1'	1'

SUBBASE	Station 190	Station 290
Thickness(Design)	12"	15"
Thickness (1968)	12"	15"
Hveem "R" Value(1953)	64	75
Hveem "R" Value(1968)	81	77
Permeability(ft/day)	1'	1'
Sand Equivalent(1953)	29	48
Sand Equivalent(1968)	23	31
Soil Classification('68)	A-2-4	A-1-6
Liquid Limit(1953)	NV	21
Liquid Limit(1968)	23	21
Plasticity Index(1953)	NP	NP
Plasticity Index(1968)	9	6
Specific Gravity	2.55	2.55
%Moisture	5.4	3.5

SUBGRADE	Station 190	Station 290
Calif Bearing Ratio '53	2.4	2.4
Field CBR in 1968	10.2	11.6
Wet Density (1968)	136	131
Dry Density (1968)	125	116
% Moisture Top (1968)	9	13
% Moisture Avg (1968)	14	16
Soil Classification '53	A-6(11)	A-6(10)
Soil Classification '68	A-2-4(0)	A-2-4 (0)
% Rock in 1968	43	40
Opt Moist.without Rock	8	9
Max Density w/o Rock	131	129
Liquid Limit (1953)	39	40
Liquid Limit (1968)	22	23
Plasticity Index (1953)	17	19
Plasticity Index (1968)	10	10
"R" Value at 400 psi	61	81
"R" Value at 300 psi	48	77
Soil Support Value	6.8	9.4
% Relative Compaction	91%	91%

STRENGTH	Station 190	Station 290
Thickness Index	2.13	2.25
Structural Number	1.72	1.10
Weighted Str.Number	1.51	0.90
Performance Index	5.84	5.61
Period of Most Failure	Gradual	
Years of Maint-Free Serv	14	
PSI from Sufficiency Rpt	3.0	
Cut or Fill Section	Cut	Fill

Remarks: Mat and roadway appear in good condition. Low 18K loading may be the reason, although the subgrade is better than that for which the road was designed.

May 1970

PROJECT NO. S 0002(12) LOCATION E of Walsh PSI=2.4 SITE NO. 19

	Stations 1065	Stations 1112
PERFORMANCE		
Pres.Service.Index	2.5	2.6
Avg Pavement Deflection	.043	.037
Radius of Curvature	113	90
Avg Rut Depth	.1	.1
Cracking(Cl II & III)	4	4
Patching($ft^2/1000ft^2$)	8	8
Bleeding	None	
Accum.18^k EWL($X10^3$)	207,918	
Years of Service	15	
Design Avg Daily Traffic	420	
Present ADT	700	
Avg Yearly Precipitation	13.3	
Avg Annual Temperature	53.5	
Freezing Index	0	
Elevation	4020	
Drainage	Poor	
Regional Factor	0.75	
SURFACING		
Asphalt Type	MC-3	
Thickness (Design)	2"	
Core Thickness (1968)	3.0"	2.5"
R Value of Design Mix	61	61
Seal Coat Thickness	0.3	0.3
% Asphalt (1953)	4.2	4.2
% Asphalt (1968)	3.8	3.8
Density During Const.	140	140
Density (1968)	132	131
Penetration (1953)	190	190
Penetration (1968)	21	16
BASE		
Additive	None	
Thickness (Design)	0-No Base	
Thickness (1968)		
Hveem "R" Value (1953)		
Hveem "R" Value (1968)		
Permeability (ft/day)		
Sand Equivalent (1953)		
Sand Equivalent (1968)		
Liquid Limit (1953)		
Liquid Limit (1968)		
Plasticity Index (1953)		
Plasticity Index (1968)		
% Moisture (1968)		
Shoulder Width	2'	2'

	Stations 1065	Stations 1112
SUBBASE		
Thickness(Design)	12"	12"
Thickness (1968)	13"	12.5"
Hveem "R" Value(1953)	68	68
Hveem "R" Value(1968)	74	75
Permeability(ft/day)	1'	1'
Sand Equivalent(1953)	31	31
Sand Equivalent(1968)	25	24
Soil Classification('68)	A-1-6	A-2-4
Liquid Limit(1953)	21	21
Liquid Limit(1968)	21	22
Plasticity Index(1953)	6	NP
Plasticity Index(1968)	6	8
Specific Gravity	2.5	2.5
%Moisture	5.1	5.1
SUBGRADE		
Calif Bearing Ratio '53	4.8	4.7
Field CBR in 1968	25	14
Wet Density (1968)	135	127
Dry Density (1968)	121	106
% Moisture Top (1968)	11.6	20
% Moisture Avg (1968)	10.6	17.4
Soil Classification '53	A-4(1)	A-6(9)
Soil Classification '68	A-4(1)	A-6(12)
% Rock in 1968	0	1
Opt Moist.without Rock	12.5	17.1
Max Density w/o Rock	120	109
Liquid Limit (1953)	24	33
Liquid Limit (1968)	23	35
Plasticity Index (1953)	6	12
Plasticity Index (1968)	9	19
"R" Value at 400 psi	43	35
"R" Value at 300 psi	28	28
Soil Support Value	5	5
% Relative Compaction	101	97
STRENGTH		
Thickness Index	1.9	1.8
Structural Number	2.48	2.48
Weighted Str.Number	2.32	2.32
Performance Index	5.3	5.3
Period of Most Failure	Early	
Years of Maint-Free Serv	1	
PSI from Sufficiency Rpt	2.7	
Cut or Fill Section	Fill	Grade

Remarks: Early, heavy seal appears to be responsible for the continued service of this roadway.

May 1970

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0024(3) LOCATION E of Fort Collins PSI = 2.7 SITE NO. 20

		Station 76	Station 233
PERFORMANCE	Pres.Service.Index	2.9	2.4
	Avg Pavement Deflection	.029	.044
	Radius of Curvature	180	113
	Avg Rut Depth	.2"	.2"
	Cracking(Cl II & III)	111	
	Patching($ft^2/1000ft^2$)	49	
	Bleeding	None	
	Accum.18^k EWL($X10^3$)	344,508	
	Years of Service	16	
	Design Avg Daily Traffic	1360	
	Present ADT	1450	
	Avg Yearly Precipitation	14.17	
	Avg Annual Temperature	48.3	
	Freezing Index	186	
	Elevation	5030	
	Drainage	Good	
	Regional Factor	0.5	
SURFACING	Asphalt Type	MC-3	
	Thickness (Design)	2"	
	Core Thickness (1968)	2"	2"
	R Value of Design Mix	85	
	Seal Coat Thickness	0.2"	0.2"
	% Asphalt (1953)	4.7	4.1
	% Asphalt (1968)	4.1	3.9
	Density During Const.	147	147
	Density (1968)	148	145
	Penetration (1953)	190	190
	Penetration (1968)	83	43
BASE	Additive	None	
	Thickness (Design)	4"	4"
	Thickness (1968)	4"	6"
	Hveem "R" Value (1953)	79	79
	Hveem "R" Value (1968)	83	85
	Permeability (ft/day)	.07'	1.2'
	Sand Equivalent (1953)	54	54
	Sand Equivalent (1968)	23	22
	Liquid Limit (1953)	25	25
	Liquid Limit (1968)	23	23
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	3	3
	% Moisture (1968)	1.9	4.5
	Shoulder Width	6'	6'

		Station 76	Station 233
SUBBASE	Thickness(Design)	18"	12"
	Thickness (1968)	18"	11"
	Hveem "R" Value(1953)	79	79
	Hveem "R" Value(1968)	84	64
	Permeability(ft/day)	.2'	0
	Sand Equivalent(1953)	50	35
	Sand Equivalent(1968)	22	16
	Soil Classification('68)	A-1-a	A-1-b
	Liquid Limit(1953)	22	23
	Liquid Limit(1968)	24	28
	Plasticity Index(1953)	3	NP
	Plasticity Index(1968)	5	9
	Specific Gravity	2.6	2.6
	%Moisture	4.7	5.8
SUBGRADE	Calif Bearing Ratio '53	5.5	3.5
	Field CBR in 1968	17.5	16.8
	Wet Density (1968)	140	136
	Dry Density (1968)	123	118
	% Moisture Top (1968)	14	16
	% Moisture Avg (1968)	14	14
	Soil Classification '53	A-4(3)	A-4(4)
	Soil Classification '68	A-6(1)	A-6(5)
	% Rock in 1968	10	2
	Opt Moist.without Rock	11	16
	Max Density w/o Rock	121	111
	Liquid Limit (1953)	26	29
	Liquid Limit (1968)	27	32
	Plasticity Index (1953)	NP	8
	Plasticity Index (1968)	11	14
	"R" Value at 400 psi	50	40
	"R" Value at 300 psi	32	29
	Soil Support Value	5.4	5.1
	% Relative Compaction	99	100+
STRENGTH	Thickness Index	2.94	2.45
	Structural Number	2.51	2.61
	Weighted Str.Number	2.26	2.37
	Performance Index	5.7	5.5
	Period of Most Failure	Gradual	
	Years of Maint-Free Serv	9	
	PSI from Sufficiency Rpt	3.1	
	Cut or Fill Section	Fill	Cut

Remarks: Increasing truck traffic gradually cracking this mat.

May 1970

PROJECT NO. S 0014(1) LOCATION Eldorado Spgs. PSI=2.9 SITE NO. 21

		Stations 22	Stations 34
PERFORMANCE	Pres.Service.Index	3.0	3.0
	Avg Pavement Deflection	.024	.037
	Radius of Curvature	163	131
	Avg Rut Depth	.1	
	Cracking(Cl II & III)	7	
	Patching($ft^2/1000ft^2$)	13	
	Bleeding	None	
	Accum.18^k EWL($X10^3$)	51,033	
	Years of Service	16	
	Design Avg Daily Traffic	560	
	Present ADT	510	
	Avg Yearly Precipitation	18.6	
	Avg Annual Temperature	53.1	
	Freezing Index	0	
	Elevation	5600	
	Drainage	Fair	
	Regional Factor	1.5	
SURFACING	Asphalt Type	MC-3	
	Thickness (Design)	2"	
	Core Thickness (1968)	2.2	2.2
	R Value of Design Mix	78	
	Seal Coat Thickness	.2	.2
	% Asphalt (1953)	4.1	4.1
	% Asphalt (1968)	4.1	3.8
	Density During Const.	140	139
	Density (1968)	139	137
	Penetration (1953)	190	190
	Penetration (1968)	28	35
BASE	Additive	None	
	Thickness (Design)	4"	4"
	Thickness (1968)	2"	3"
	Hveem "R" Value (1953)	73	73
	Hveem "R" Value (1968)	83	83
	Permeability (ft/day)	.3'	.2'
	Sand Equivalent (1953)	39	39
	Sand Equivalent (1968)	21	32
	Liquid Limit (1953)	NV	NV
	Liquid Limit (1968)	NV	NV
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	NP	NP
	% Moisture (1968)	5.6	4.2
	Shoulder Width	2'	2'

		Stations 22	Stations 34
SUBBASE	Thickness(Design)	6"	6"
	Thickness (1968)	7.3"	9.8"
	Hveem "R" Value(1953)	72	72
	Hveem "R" Value(1968)	83	81
	Permeability(ft/day)	.3'	.04'
	Sand Equivalent(1953)	23	23
	Sand Equivalent(1968)	21	20
	Soil Classification('68)	A-1-a	A-1-a
	Liquid Limit(1953)	27	27
	Liquid Limit(1968)	NV	23
	Plasticity Index(1953)	3	3
	Plasticity Index(1968)	NP	3
	Specific Gravity	2.61	2.61
	%Moisture	2.8	4.0
SUBGRADE	Calif Bearing Ratio '53	3.4	3.0
	Field CBR in 1968	16.7	11.1
	Wet Density (1968)	139	136
	Dry Density (1968)	122	116
	% Moisture Top (1968)	14	18
	% Moisture Avg (1968)	13	19
	Soil Classification '53	A-6(3)	A-7-6(4)
	Soil Classification '68	A-6(4)	A-7-6(10)
	% Rock in 1968	26	5
	Opt Moist.without Rock	14	16
	Max Density w/o Rock	119	113
	Liquid Limit (1953)	40	43
	Liquid Limit (1968)	36	45
	Plasticity Index (1953)	16	19
	Plasticity Index (1968)	20	28
	"R" Value at 400 psi	53	32
	"R" Value at 300 psi	41	28
	Soil Support Value	6.1	5.1
	% Relative Compaction	100	99
STRENGTH	Thickness Index	1.52	1.94
	Structural Number	1.60	1.89
	Weighted Str.Number	1.69	1.89
	Performance Index	4.9	4.9
	Period of Most Failure	Gradual	
	Years of Maint-Free Serv	15	
	PSI from Sufficiency Rpt	3.1	
	Cut or Fill Section	Cut	Fill

Remarks: Very light traffic. Failure areas are short and associated with poor drainage and lack of lateral support on narrow shoulders on fills.

May 1970

PROJECT NO. S 0030(2) LOCATION E of Hudson PSI=3.2 SITE NO. 23

PERFORMANCE	Station 54	Station 144
Pres. Service. Index	2.1	2.2
Avg Pavement Deflection	.019	.024
Radius of Curvature	600	360
Avg Rut Depth	.1	
Cracking (Cl II & III)	None	
Patching ($ft^2/1000ft^2$)	None	
Bleeding	None	
Accum. 18^k EWL ($X10^3$)	183,244	
Years of Service	16	
Design Avg Daily Traffic	700	
Present ADT	680	
Avg Yearly Precipitation	15.6	
Avg Annual Temperature	50.7	
Freezing Index	15.5	
Elevation	5000	
Drainage	Fair	
Regional Factor	1	

SURFACING	Station 54	Station 144
Asphalt Type	MC-4	
Thickness (Design)	3.0	3.0
Core Thickness (1968)	3.5	4.0
R Value of Design Mix	85	85
Seal Coat Thickness	0.5"	1"
% Asphalt (1953)	4.6	6.6
% Asphalt (1968)	4.2	4.3
Density During Const.	122	122
Density (1968)	125	127
Penetration (1953)	160	160
Penetration (1968)	46	67

BASE	Station 54	Station 144
Additive	5% asphalt in 1953, 3.7% @ 25 pen now	
Thickness (Design)	3"	3"
Thickness (1968)	3"	3"
Hveem "R" Value (1953)	67	67
Hveem "R" Value (1968)	67	67
Permeability (ft/day)	--	--
Sand Equivalent (1953)	29	29
Sand Equivalent (1968)	29	29
Liquid Limit (1953)	NV	NV
Liquid Limit (1968)	NV	NV
Plasticity Index (1953)	NP	NP
Plasticity Index (1968)	NP	NP
% Moisture (1968)	3.4	5.6
Shoulder Width	2'	2'

SUBBASE	Station 54	Station 144
Thickness (Design)	13	11
Thickness (1968)	12.5	10
Hveem "R" Value (1953)	66	66
Hveem "R" Value (1968)	76	65
Permeability (ft/day)	.1'	.1'
Sand Equivalent (1953)	28	29
Sand Equivalent (1968)	23	29
Soil Classification ('68)	A-2-4	A-3
Liquid Limit (1953)	NV	NV
Liquid Limit (1968)	NV	NV
Plasticity Index (1953)	NP	NP
Plasticity Index (1968)	NP	NP
Specific Gravity	2.6	2.6
%Moisture	7.9	6.9

SUBGRADE	Station 54	Station 144
Calif Bearing Ratio '53	6.7	4.9
Field CBR in 1968	15.8	15.8
Wet Density (1968)	137	137
Dry Density (1968)	119	119
% Moisture Top (1968)	15	12
% Moisture Avg (1968)	14	12
Soil Classification '53	A-4(2)	A-4(1)
Soil Classification '68	A-6(7)	A-6(8)
% Rock in 1968	0	0
Opt Moist. without Rock	14	13
Max Density w/o Rock	118	117
Liquid Limit (1953)	21	25
Liquid Limit (1968)	29	29
Plasticity Index (1953)	NP	9
Plasticity Index (1968)	14	13
"R" Value at 400 psi	42	38
"R" Value at 300 psi	31	26
Soil Support Value	5.3	4.8
% Relative Compaction	101	101

STRENGTH	Station 54	Station 144
Thickness Index	2.98	2.80
Structural Number	2.3	2.48
Weighted Str. Number	2.3	2.22
Performance Index	5.13	5.16
Period of Most Failure	No Failure	
Years of Maint-Free Serv	14	
PSI from Sufficiency Rpt	3.1	
Cut or Fill Section	Cut	Fill

Remarks: Sealed recently. Excellent condition.

May 1970

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0080(1) LOCATION E of Loveland PSI=3.0 SITE NO. 24

PERFORMANCE

	Station 13	Station 60
Pres.Service.Index	2.5	2.4
Avg Pavement Deflection	.042	.049
Radius of Curvature	164	257
Avg Rut Depth	.1	
Cracking(Cl II & III)	None	
Patching($ft^2/1000ft^2$)	12	
Bleeding	None	
Accum.18^k EWL($X10^3$)	332,950	
Years of Service	15	
Design Avg Daily Traffic	500	
Present ADT	2700	
Avg Yearly Precipitation	15.4	
Avg Annual Temperature	48.4	
Freezing Index	79.7	
Elevation	4910	
Drainage	Fair	
Regional Factor	1.0	

SURFACING

	Station 13	Station 60
Asphalt Type	MC-3	
Thickness (Design)	2"	2"
Core Thickness (1968)	2.4"	1.9"
R Value of Design Mix	80	
Seal Coat Thickness	0.1	.1
% Asphalt (1953)	4.7	4.1
% Asphalt (1968)	4.4	4.1
Density During Const.	143	143
Density (1968)	144	141
Penetration (1953)	190	190
Penetration (1968)	33	28

BASE

	Station 13	Station 60
Additive	None	
Thickness (Design)	4"	4"
Thickness (1968)	4"	4"
Hveem "R" Value (1953)	80	80
Hveem "R" Value (1968)	82	82
Permeability (ft/day)	.1'	.1'
Sand Equivalent (1953)	52	52
Sand Equivalent (1968)	31	42
Liquid Limit (1953)	NV	NV
Liquid Limit (1968)	NV	NV
Plasticity Index (1953)	NP	NP
Plasticity Index (1968)	NP	NP
% Moisture (1968)	3.3	2.3
Shoulder Width	2'	2'

SUBBASE

	Station 13	Station 60
Thickness(Design)	4"	4"
Thickness (1968)	4"	4"
Hveem "R" Value(1953)	80	80
Hveem "R" Value(1968)	82	82
Permeability(ft/day)	.1'	.1'
Sand Equivalent(1953)	40	40
Sand Equivalent(1968)	31	42
Soil Classification('68)	A-1-a	A-1-a
Liquid Limit(1953)	NV	NV
Liquid Limit(1968)	NV	NV
Plasticity Index(1953)	NP	NP
Plasticity Index(1968)	NP	NP
Specific Gravity	2.65	2.65
%Moisture	2.5	2.5

SUBGRADE

	Station 13	Station 60
Calif Bearing Ratio '53	4.8	3.6
Field CBR in 1968	30	20.5
Wet Density (1968)	118	135
Dry Density (1968)	115	118
% Moisture Top (1968)	3	16
% Moisture Avg (1968)	3	14
Soil Classification '53	A-4(5)	A-6(10)
Soil Classification '68	A-2-4	A-6(5)
% Rock in 1968	24	3
Opt Moist.without Rock	11	13
Max Density w/o Rock	120	117
Liquid Limit (1953)	26.8	33.2
Liquid Limit (1968)	NV	29
Plasticity Index (1953)	NP	15.7
Plasticity Index (1968)	NP	13
"R" Value at 400 psi	75	47
"R" Value at 300 psi	75	36
Soil Support Value	9.2	5.8
% Relative Compaction	95	100

STRENGTH

	Station 13	Station 60
Thickness Index	1.32	1.22
Structural Number	1.45	2.37
Weighted Str.Number	1.45	2.13
Performance Index	5.5	5.5
Period of Most Failure	Gradual	
Years of Maint-Free Serv	12	
PSI from Sufficiency Rpt	3.0	
Cut or Fill Section	Grade	Fill

Remarks: Looks Good. 1 seal coat applied 3 years ago. Constructed by County Forces.

May 1970

PROJECT NO. S 0034(2) LOCATION E of Windsor PSI=2.9 SITE NO. 25

Section	Item	Station 141	Station 145
PERFORMANCE	Pres.Service.Index	2.8	
	Avg Pavement Deflection	.026	
	Radius of Curvature	225	
	Avg Rut Depth	.1	
	Cracking(Cl II & III)	10	
	Patching($ft^2/1000ft^2$)	31	
	Bleeding	None	
	Accum.18^k EWL($X10^3$)	401,840	
	Years of Service	15	
	Design Avg Daily Traffic	850	
	Present ADT	1950	
	Avg Yearly Precipitation	12.2	
	Avg Annual Temperature	48.1	
	Freezing Index	441	
	Elevation	4790	
	Drainage	Fair	
	Regional Factor	.75	
SURFACING	Asphalt Type	MC-3	
	Thickness (Design)	2"	2"
	Core Thickness (1968)	1.6	1.3
	R Value of Design Mix	92	
	Seal Coat Thickness	0.3	0.3
	% Asphalt (1953)	5.1	5.1
	% Asphalt (1968)	4.8	4.8
	Density During Const.	142	142
	Density (1968)	146	149
	Penetration (1953)	190	190
	Penetration (1968)	58	133
BASE	Additive	None	
	Thickness (Design)	4"	4"
	Thickness (1968)	4"	4"
	Hveem "R" Value (1953)	78	78
	Hveem "R" Value (1968)	80	79
	Permeability (ft/day)	.1'	.1'
	Sand Equivalent (1953)	29	29
	Sand Equivalent (1968)	25	19
	Liquid Limit (1953)	NV	NV
	Liquid Limit (1968)	NV	26
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	NP	7
	% Moisture (1968)	3.8	3.0
	Shoulder Width	3'	3'

Section	Item	Station 141	Station 145
SUBBASE	Thickness(Design)	12"	4"
	Thickness (1968)	12"	4"
	Hveem "R" Value(1953)	82	74
	Hveem "R" Value(1968)	82	76
	Permeability(ft/day)	.1	.01'
	Sand Equivalent(1953)	30	17
	Sand Equivalent(1968)	20	16
	Soil Classification('68)	A-2-4	A-2-4
	Liquid Limit(1953)	25	27
	Liquid Limit(1968)	26	30
	Plasticity Index(1953)	NP	NP
	Plasticity Index(1968)	7	8
	Specific Gravity	2.6	2.6
	%Moisture	5.4	3.2
SUBGRADE	Calif Bearing Ratio '53	7.1	14
	Field CBR in 1968	36.3	32
	Wet Density (1968)	146	121
	Dry Density (1968)	130	104
	% Moisture Top (1968)	12	16
	% Moisture Avg (1968)	11	9
	Soil Classification '53	A-4(2)	A-1-a
	Soil Classification '68	A-2-4	A-2-4
	% Rock in 1968	31	27
	Opt Moist.without Rock	11	14
	Max Density w/o Rock	119	112
	Liquid Limit (1953)	23.2	31
	Liquid Limit (1968)	29	29
	Plasticity Index (1953)	3.1	NP
	Plasticity Index (1968)	10	5
	"R" Value at 400 psi	53	64
	"R" Value at 300 psi	42	64
	Soil Support Value	6.3	8.2
	% Relative Compaction	99	94
STRENGTH	Thickness Index	2.2	1.26
	Structural Number	2.3	1.75
	Weighted Str.Number	2.17	1.55
	Performance Index	5.7	5.7
	Period of Most Failure	Gradual	
	Years of Maint-Free Serv	12	
	PSI from Sufficiency Rpt	2.8	
	Cut or Fill Section	Cut	Fill

Remarks: Apparently sealed at the proper time. Mat looks alive and good even though it is thin.

May 1970

EVALUATION OF COLORADO'S FLEXIBLE PAVEMENT DESIGN

PROJECT NO. S 0028(3) LOCATION E of Elizabeth PSI=2.5 SITE NO. 26

PERFORMANCE

	Station 235	Station 240
Pres.Service.Index	2.5	
Avg Pavement Deflection	.039	.053
Radius of Curvature	129	106
Avg Rut Depth	.1	
Cracking(Cl II & III)	1	
Patching(ft^2/1000ft^2)	126	
Bleeding	None	
Accum.18^k EWL($X10^3$)	139,936	
Years of Service	16 years	
Design Avg Daily Traffic	330	
Present ADT	760	
Avg Yearly Precipitation	17.4	
Avg Annual Temperature	48.0	
Freezing Index	180	
Elevation	6560	
Drainage	Fair	Good
Regional Factor	1.75	1.25

SURFACING

	Station 235	Station 240
Asphalt Type	MC-3	
Thickness (Design)	3"	3"
Core Thickness (1968)	3.5	4.1
R Value of Design Mix	68	68
Seal Coat Thickness	0.2	0.2
% Asphalt (1953)	5.1	5.1
% Asphalt (1968)	4.2	4.3
Density During Const.	133	132
Density (1968)	132	130
Penetration (1953)	190	190
Penetration (1968)	55	53

BASE

	Station 235	Station 240
Additive	None	
Thickness (Design)	No base used	
Thickness (1968)	--	
Hveem "R" Value (1953)	--	
Hveem "R" Value (1968)	--	
Permeability (ft/day)	--	
Sand Equivalent (1953)	--	
Sand Equivalent (1968)	--	
Liquid Limit (1953)	--	
Liquid Limit (1968)	--	
Plasticity Index (1953)	--	
Plasticity Index (1968)	--	
% Moisture (1968)	--	
Shoulder Width	2'	

SUBBASE

	Station 235	Station 240
Thickness(Design)	3"	3"
Thickness (1968)	3"	3"
Hveem "R" Value(1953)	64	64
Hveem "R" Value(1968)	70	71
Permeability(ft/day)	1.1'	0.7'
Sand Equivalent(1953)	36	36
Sand Equivalent(1968)	27	36
Soil Classification('68)	A-2-4	A-1-b
Liquid Limit(1953)	27	27
Liquid Limit(1968)	32	NV
Plasticity Index(1953)	NP	NP
Plasticity Index(1968)	10	NP
Specific Gravity	2.6	2.6
%Moisture	6.3	6.2

SUBGRADE

	Station 235	Station 240
Calif Bearing Ratio '53	23	23
Field CBR in 1968	25	30
Wet Density (1968)	112	127.9
Dry Density (1968)	105	117
% Moisture Top (1968)	6	9
% Moisture Avg (1968)	6	9
Soil Classification '53	A-2-4	A-2-4
Soil Classification '68	A-2-4	A-2-6(1
% Rock in 1968	3	0
Opt Moist.without Rock	12	12
Max Density w/o Rock	117	117
Liquid Limit (1953)	25	25
Liquid Limit (1968)	32	34
Plasticity Index (1953)	NP	NP
Plasticity Index (1968)	10	18
"R" Value at 400 psi	78	39
"R" Value at 300 psi	78	32
Soil Support Value	9.4	5.4
% Relative Compaction	91	100

STRENGTH

	Station 235	Station 240
Thickness Index	1.03	1.04
Structural Number	1.13	2.15
Weighted Str.Number	1.26	2.21
Performance Index	5.15	5.15
Period of Most Failure	Gradual	
Years of Maint-Free Serv	11	
PSI from Sufficiency Rpt	2.7	
Cut or Fill Section	Cut	Fill

Remarks: East end of project was overlaid just in time to prevent complete disintegration of the mat.

May 1970

PROJECT NO. S 0020(3) LOCATION E of Colorado Springs PSI=2.3 SITE NO. 27

PERFORMANCE

	Station 114	Station 106
Pres.Service.Index	2.3	2.3
Avg Pavement Deflection	.036	.043
Radius of Curvature	180	150
Avg Rut Depth	.1	
Cracking(Cl II & III)	11	
Patching($ft^2/1000ft^2$)	194	
Bleeding	None	
Accum.18^k EWL($X10^3$)	151,951	
Years of Service	16	
Design Avg Daily Traffic	600	
Present ADT	810	
Avg Yearly Precipitation	14.9	
Avg Annual Temperature	48.9	
Freezing Index	77.5	
Elevation	6250	
Drainage	Fair to Poor	
Regional Factor	.5	

SURFACING

	Station 114	Station 106
Asphalt Type	MC-4	
Thickness (Design)	3"	3"
Core Thickness (1968)	4"	4.5"
R Value of Design Mix	70	70
Seal Coat Thickness	1"	1.5
% Asphalt (1953)	4.1	4.1
% Asphalt (1968)	6.0	4.3
Density During Const.	135	135
Density (1968)	135	132
Penetration (1953)	190	190
Penetration (1968)	38	50

BASE

	Station 114	Station 106
Additive	None	
Thickness (Design)	No Base	
Thickness (1968)	--	
Hveem "R" Value (1953)	--	
Hveem "R" Value (1968)	--	
Permeability (ft/day)	--	
Sand Equivalent (1953)	--	
Sand Equivalent (1968)	--	
Liquid Limit (1953)	--	
Liquid Limit (1968)	--	
Plasticity Index (1953)	--	
Plasticity Index (1968)	--	
% Moisture (1968)	--	
Shoulder Width	4'	

SUBBASE

	Station 114	Station 106
Thickness(Design)	4"	4"
Thickness (1968)	36"	13.5"
Hveem "R" Value(1953)	70	70
Hveem "R" Value(1968)	77	78
Permeability(ft/day)	.6	1'
Sand Equivalent(1953)	27	27
Sand Equivalent(1968)	23	21
Soil Classification('68)	A-2-4	A-2-4
Liquid Limit(1953)	NV	NV
Liquid Limit(1968)	NV	NV
Plasticity Index(1953)	NP	NP
Plasticity Index(1968)	NP	NP
Specific Gravity	2.54	2.54
%Moisture	4.8	4.5

SUBGRADE

	Station 114	Station 106
Calif Bearing Ratio '53	3.1	3.1
Field CBR in 1968	8.5	9.0
Wet Density (1968)	117	123
Dry Density (1968)	90	102
% Moisture Top (1968)	31	20
% Moisture Avg (1968)	30	30
Soil Classification '53	A-7-6(6)	A-7-6(6)
Soil Classification '68	A-7-6(16)	A-7-6(12)
% Rock in 1968	0	1
Opt Moist.without Rock	25	18
Max Density w/o Rock	96	101
Liquid Limit (1953)	42	42
Liquid Limit (1968)	53	51
Plasticity Index (1953)	17	17
Plasticity Index (1968)	31	31
"R" Value at 400 psi	24	20
"R" Value at 300 psi	24	20
Soil Support Value	4.7	3.9
% Relative Compaction	94	100

STRENGTH

	Station 114	Station 106
Thickness Index	4.4	2.2
Structural Number	2.4	2.7
Weighted Str.Number	2.17	2.4
Performance Index	5.11	5.11
Period of Most Failure	Early-poor drainage	
Years of Maint-Free Serv	5	
PSI from Sufficiency Rpt	2.6	
Cut or Fill Section	Cut	Fill

Remarks: Good sections of this roadway correspond to well drained areas.

May 1970

PROJECT NO. S 0081(1) LOCATION N of Wetmore PSI=2.6 SITE NO. 28

PERFORMANCE

	Stations 294	Stations 424
Pres.Service.Index	2.4	2.4
Avg Pavement Deflection	.038	.068
Radius of Curvature	120	69
Avg Rut Depth	.1	.1
Cracking(Cl II & III)	5	5
Patching($ft^2/1000ft^2$)	32	
Bleeding	None	
Accum.18^k EWL($X10^3$)	84,665	
Years of Service	16	
Design Avg Daily Traffic	270	
Present ADT	490	
Avg Yearly Precipitation	19.51	
Avg Annual Temperature	50.2	
Freezing Index	0	
Elevation	5610	
Drainage	Fair	
Regional Factor	1	

SURFACING

	294	424
Asphalt Type	MC-3	
Thickness (Design)	2"	2"
Core Thickness (1968)	2.3"	2.75"
R Value of Design Mix	76	76
Seal Coat Thickness	0.1	0.1
% Asphalt (1953)	4.1	4.1
% Asphalt (1968)	4.0	4.0
Density During Const.	139	139
Density (1968)	143	144
Penetration (1953)	190	190
Penetration (1968)	28	36

BASE

	294	424
Additive	None	
Thickness (Design)	4"	4"
Thickness (1968)	4"	4"
Hveem "R" Value (1953)	82	82
Hveem "R" Value (1968)	83	83
Permeability (ft/day)	1.5'	0.3'
Sand Equivalent (1953)	28	28
Sand Equivalent (1968)	22	23
Liquid Limit (1953)	28	22
Liquid Limit (1968)	22	NV
Plasticity Index (1953)	NP	NP
Plasticity Index (1968)	1	NP
% Moisture (1968)	5.2	3.6
Shoulder Width	3'	3'

SUBBASE

	Stations 294	Stations 424
Thickness(Design)	7"	7"
Thickness (1968)	6"	6.25"
Hveem "R" Value(1953)	80	80
Hveem "R" Value(1968)	84	84
Permeability(ft/day)	.2'	.9'
Sand Equivalent(1953)	31	28
Sand Equivalent(1968)	23	23
Soil Classification('68)	A-1-a	A-1-a
Liquid Limit(1953)	22	23
Liquid Limit(1968)	NV	NV
Plasticity Index(1953)	NP	NP
Plasticity Index(1968)	NP	NP
Specific Gravity	2.62	2.62
%Moisture	4.6	3.1

SUBGRADE

	294	424
Calif Bearing Ratio '53	3	3
Field CBR in 1968	13.7	4.2
Wet Density (1968)	141	127
Dry Density (1968)	124	105
% Moisture Top (1968)	14	21
% Moisture Avg (1968)	14	24
Soil Classification '53	A-6(9)	A-6(9)
Soil Classification '68	A-6(10)	A-6(12)
% Rock in 1968	4	5
Opt Moist.without Rock	14	18
Max Density w/o Rock	117	109
Liquid Limit (1953)	32	32
Liquid Limit (1968)	34	40
Plasticity Index (1953)	12	12
Plasticity Index (1968)	18	24
"R" Value at 400 psi	24	32
"R" Value at 300 psi	20	28
Soil Support Value	4.3	5.0
% Relative Compaction	94	96

STRENGTH

	294	424
Thickness Index	1.68	1.80
Structural Number	2.30	2.06
Weighted Str.Number	2.30	2.06
Performance Index	4.89	4.89
Period of Most Failure	Late	
Years of Maint-Free Serv	14	
PSI from Sufficiency Rpt	2.8	
Cut or Fill Section	Cut	Fill

Remarks: Failure due mostly to hardening of the asphalt and poor drainage of the subbase and subgrade.

May 1970

PROJECT NO. S 0081(2) LOCATION S of Florence PSI=2.4 SITE NO. 29

Section	Item	Station 36	Station 200
PERFORMANCE	Pres.Service.Index	2.3	2.3
	Avg Pavement Deflection	.050	.037
	Radius of Curvature	120	138
	Avg Rut Depth	.1	
	Cracking(Cl II & III)	13	
	Patching($ft^2/1000ft^2$)	65	
	Bleeding	None	
	Accum.18^k EWL($X10^3$)	210,493	
	Years of Service	15	
	Design Avg Daily Traffic	800	
	Present ADT	740	
	Avg Yearly Precipitation	19.5	
	Avg Annual Temperature	50.2	
	Freezing Index	0	
	Elevation	5270	
	Drainage	Fair	
	Regional Factor	1.5	
SURFACING	Asphalt Type	MC-3	
	Thickness (Design)	2.0"	2"
	Core Thickness (1968)	3.0"	2.5"
	R Value of Design Mix	81	81
	Seal Coat Thickness	0.2	.02
	% Asphalt (1953)	3.8	3.6
	% Asphalt (1968)	3.8	4.1
	Density During Const.	141	141
	Density (1968)	140	144
	Penetration (1953)	190	190
	Penetration (1968)	32	25
BASE	Additive	None	
	Thickness (Design)	2	2
	Thickness (1968)	2	2
	Hveem "R" Value (1953)	82	82
	Hveem "R" Value (1968)	83	81
	Permeability (ft/day)	.02	1.5
	Sand Equivalent (1953)	31	28
	Sand Equivalent (1968)	18	28
	Liquid Limit (1953)	NV	NV
	Liquid Limit (1968)	NV	NV
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	NP	NP
	% Moisture (1968)	7.2	3.9
	Shoulder Width	2'	2'

Section	Item	Station 36	Station 200
SUBBASE	Thickness(Design)	10"	13"
	Thickness (1968)	10"	11.5"
	Hveem "R" Value(1953)	75	80
	Hveem "R" Value(1968)	83	81
	Permeability(ft/day)	.02	1.5
	Sand Equivalent(1953)	30	28
	Sand Equivalent(1968)	28	28
	Soil Classification('68)	A-1-a	A-1-a
	Liquid Limit(1953)	NV	NV
	Liquid Limit(1968)	NV	NV
	Plasticity Index(1953)	NP	NP
	Plasticity Index(1968)	NP	NP
	Specific Gravity	2.65	2.65
	%Moisture	4.7	4.8
SUBGRADE	Calif Bearing Ratio '53	4.6	3.2
	Field CBR in 1968	11.6	11.6
	Wet Density (1968)	136	135
	Dry Density (1968)	120	119
	% Moisture Top (1968)	13	14
	% Moisture Avg (1968)	13	14
	Soil Classification '53	A-4(8)	A-6(12)
	Soil Classification '68	A-6(9)	A-6(10)
	% Rock in 1968	0	5
	Opt Moist.without Rock	15	16
	Max Density w/o Rock	116	114
	Liquid Limit (1953)	28	38.5
	Liquid Limit (1968)	30	33
	Plasticity Index (1953)	5.3	19.4
	Plasticity Index (1968)	13	16
	"R" Value at 400 psi	32	32
	"R" Value at 300 psi	26	28
	Soil Support Value	5.3	5.0
	% Relative Compaction	103	103
STRENGTH	Thickness Index	1.98	2.05
	Structural Number	2.36	2.48
	Weighted Str.Number	2.50	2.61
	Performance Index	5.25	5.25
	Period of Most Failure	Gradual	
	Years of Maint-Free Serv	8	
	PSI from Sufficiency Rpt	2.7	
	Cut or Fill Section	Fill	Cut

Remarks: Roadway suffered heavy northbound truck traffic early in its life and that lane has considerable patching.

May 1970

PROJECT NO. F005-2(6) LOCATION S of Steamboat Springs PSI=2.9 SITE NO. 30

Group	Item	Station 61	Station 180
PERFORMANCE	Pres.Service.Index	2.3	2.5
	Avg Pavement Deflection	.017	.019
	Radius of Curvature	300	360
	Avg Rut Depth	.1	
	Cracking(Cl II & III)	8	
	Patching($ft^2/1000ft^2$)	21	
	Bleeding	None	
	Accum.18^k EWL($X10^3$)	792,144	
	Years of Service	16	
	Design Avg Daily Traffic	2500	
	Present ADT	2100	
	Avg Yearly Precipitation	24.59	
	Avg Annual Temperature	39	
	Freezing Index	1596	
	Elevation	6790	
	Drainage	Good in fills	
	Regional Factor	1.75	
SURFACING	Asphalt Type	A. C.	
	Thickness (Design)	2"	2"
	Core Thickness (1968)	2.1"	2.1"
	R Value of Design Mix	81	81
	Seal Coat Thickness	0.1	.1
	% Asphalt (1953)	4.8	4.8
	% Asphalt (1968)	5.2	5.4
	Density During Const.	149	147
	Density (1968)	149	147
	Penetration (1953)	200	200
	Penetration (1968)	47	48
BASE	Additive	None	
	Thickness (Design)	4"	6"
	Thickness (1968)	4"	6"
	Hveem "R" Value (1953)	78	81
	Hveem "R" Value (1968)	85	84
	Permeability (ft/day)	.02	.1
	Sand Equivalent (1953)	32	37
	Sand Equivalent (1968)	25	20
	Liquid Limit (1953)	NV	NV
	Liquid Limit (1968)	NV	NV
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	NP	NP
	% Moisture (1968)	4.3	3.5
	Shoulder Width	6'	6'

Group	Item	Station 61	Station 180
SUBBASE	Thickness(Design)	6"	28"
	Thickness (1968)	6"	28"
	Hveem "R" Value(1953)	81	73
	Hveem "R" Value(1968)	83	81
	Permeability(ft/day)	.7'	.5'
	Sand Equivalent(1953)	28	26
	Sand Equivalent(1968)	29	25
	Soil Classification('68)	A-1-a	A-1-a
	Liquid Limit(1953)	21	20
	Liquid Limit(1968)	NV	NV
	Plasticity Index(1953)	NP	NP
	Plasticity Index(1968)	NP	NP
	Specific Gravity	2.7	2.7
	%Moisture	4.6	5.7
SUBGRADE	Calif Bearing Ratio '53	4.3	4.3
	Field CBR in 1968	30+	25+Rock
	Wet Density (1968)	125	128
	Dry Density (1968)	119	121
	% Moisture Top (1968)	8	7
	% Moisture Avg (1968)	8	7
	Soil Classification '53	A-1-a	A-1-6
	Soil Classification '68	A-1-6	A-1-a
	% Rock in 1968	30%+	43%+
	Opt Moist.without Rock	10	10
	Max Density w/o Rock	126	127
	Liquid Limit (1953)	24	22
	Liquid Limit (1968)	NV	NV
	Plasticity Index (1953)	NP	NP
	Plasticity Index (1968)	NP	NP
	"R" Value at 400 psi	82	79
	"R" Value at 300 psi	82	70
	Soil Support Value	9.8	8.8
	% Relative Compaction	Unreliable	
STRENGTH	Thickness Index	2.1	4.8
	Structural Number	1.5	1.78
	Weighted Str.Number	1.6	1.93
	Performance Index	5.83	5.90
	Period of Most Failure	late	
	Years of Maint-Free Serv	10	
	PSI from Sufficiency Rpt	3.2	
	Cut or Fill Section	Fill	Fill

Remarks: Cuts have poor drainage. Lots of thin transverse cracks which do not affect anything but the appearance.

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APPENDIX B

APPENDIX B

Comparison of AASHO Design Coefficients With Coefficients Selected for the Design of Colorado Roadways

REGIONAL FACTOR

Precipitation	Colorado	BPR	Elevation	Colorado	BPR	Drainage	Colorado	BPR
+24"	1.5	1.5	+9500	1.5	1.5	Severe	2.0	2.0
18" to 24"	1.0	1.0	8500 to 95	1.0	1.0	Poor	1.0	1.0
14" to 17"	0.5	0.5	7500 to 85	0.5	0.5	Fair	0.5	0.5
10" to 13"	0.25	.25	6500 to 75	0.5	.25	Good	0.25	0
-10	0.25	0	-6500	0.25	0			

STRENGTH COEFFICIENTS

Component	Limiting Test Criteria	AASHO Coefficient	Colorado Coefficient
Plant Mix Seal		-	0.25
Hot Bituminous Pavement	R_t = 95	0.44	0.44
Hot Bituminous Pavement	R_t = 90-94	0.40	0.40
Hot Bituminous Pavement	R_t = 87-89	-	0.35
Hot Bituminous Pavement	R_t = 84-86	-	0.30
Hot Bituminous Pavement	R_t = 83	-	0.25
Road Mix Bituminous Pavement		0.20	0.20
Existing Bituminous Pavement		-	0.20 to 0.44
Plant Mix Bituminous Base	R_t = 90	.34	0.34
Plant Mix Bituminous Base	R_t = 85-89	.30	0.30
Plant Mix Bituminous Base	R_t = 80-84	-	0.25
Plant Mix Bituminous Base	R_t = 79	-	0.22
Aggregate Base Course (A.B.C.)	"R" = 84	-	0.14
Aggregate Base Course (A.B.C.)	"R" = 78-83	0.14	0.12
Aggregate Base Course (A.B.C.)	"R" = 70-77	0.10	0.11
Aggregate Base Course (A.B.C.)	"R" = 69	0.05	0.10
Emulsified Asphalt Treated A.B.C.	R_t = 95	0.34	0.23
Emulsified Asphalt Treated A.B.C.	R_t = 90-94	0.30	0.20
Emulsified Asphalt Treated A.B.C.	R_t = 84-89	-	0.15
Emulsified Asphalt Treated A.B.C.	R_t = 83	-	0.12
Cement Treated A.B.C.	7-day test = 650 psi	0.23	0.23
Cement Treated A.B.C.	7-day test = 400-649 psi	0.20	0.20
Cement Treated A.B.C.	7-day test = 399 psi	0.15	0.15
Hydrated Lime Treated A.B.C.	"R" = 84	0.30	0.14
Hydrated Lime Treated A.B.C.	"R" = 78-83	0.15	0.12

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