

CALIFORNIA HIGHWAYS

A BULLETIN ISSUED BY THE CALIFORNIA HIGHWAY COMMISSION FOR THE
INFORMATION OF ITS EMPLOYEES AND THE PUBLIC

Vol. 3

APRIL, 1926

No. 4



NEW PAVEMENT THROUGH MONTECITO—A reconstruction project recently completed on the state highway in Santa Barbara County was the widening and thickening of the county-built pavement through beautiful Montecito. A description of this project will be found on page three. (Photo courtesy Santa Barbara Chamber of Commerce.)

In this issue: PROGRESS ON GRADE CROSSING ELIMINATION—SELECTION OF ROCK AND GRAVEL FOR HIGHWAY CONSTRUCTION.

CALIFORNIA HIGHWAYS

TABLE OF CONTENTS.

HARVEY M. TOY, Chairman;
 N. T. EDWARDS and LOUIS EVERDING, Commissioners.
 ROBERT M. MORTON, State Highway Engineer.
 W. F. MIXON, Secretary.

We are pleased to permit publication of any of the matter contained herein or to loan cuts, and this privilege is extended newspapers and periodicals without restrictions.

FRANK B. DURKEE Editor
 P. O. Box 1103, Sacramento, California.

Vol. 3 APRIL, 1926. No. 4

CALIFORNIA HIGHWAY DEPARTMENT

CALIFORNIA HIGHWAY COMMISSION

HARVEY M. TOY, Chairman, San Francisco
 N. T. EDWARDS, Commissioner, Orange
 LOUIS EVERDING, Commissioner, Arcata
 R. M. MORTON, State Highway Engineer, Sacramento

PAUL F. FRATESSA, Attorney, San Francisco
 W. F. MIXON, Secretary, Woodland

HEADQUARTERS STAFF, SACRAMENTO

T. E. STANTON, Assistant State Highway Engineer
 L. V. CAMPBELL, Office Engineer

FRED J. GRUMM, Engineer of Surveys and Plans	HARLAN D. MILLER, Bridge Engineer
C. S. POPE, Construction Engineer	R. H. STALNAKER Equipment Engineer
G. R. WINSLOW, Maintenance Engineer	C. L. MCKESSON, Materials and Research Engineer

BEN H. MILLIKEN, Superintendent of Prison Road Camps
 HERMAN B. WEAVER, Chief Accountant
 LOWELL R. SMITH, Purchasing Agent

DIVISION ENGINEERS

T. A. BEDFORD, Division I, Willits
 H. S. COMLY, Division II, Redding
 F. W. HASELWOOD, Division III, Sacramento
 J. H. SKEGGS, Division IV, San Francisco
 L. H. GIBSON, Division V, San Luis Obispo
 E. E. WALLACE (Acting), Division VI, Fresno
 S. V. CORTELYOU, Division VII, Los Angeles
 E. Q. SULLIVAN, Division VIII, San Bernardino
 F. G. SOMNER, Division IX, Bishop
 R. E. PIERCE (Acting), Division X, Sacramento

General Headquarters, Fifth Floor, Forum Bldg., Sacramento

Views of New Pavement Through Montecito.....*Front Cover*
 Progress Made on Grade Crossing Elimination....pages 3 and 4
 Dowell Bill Passes House.....page 5
 Selection of Rock and Gravel for Highway Construction
pages 6 to 10
 By C. L. McKesson, Materials and Research Engineer.
 What the Divisions Are Doing.....pages 12 and 13
 Wallace Succeeds Woodsonpage 14
 Commendation for Ventura Maintenance Man.....page 15
 Table of Contracts Pending, Awarded and Accepted...*Back Cover*

EASTERN EDITORS REPUBLISH RESEARCH ARTICLES

FOR several months past CALIFORNIA HIGHWAYS has been publishing a series of articles contributed by Construction Engineer C. S. Pope and Materials and Research Engineer C. L. McKesson, explaining in detail the construction practices now in force on California state highways and the result of research upon which these practices are founded.

In approving this series of articles State Highway Engineer R. M. Morton had several purposes in view. It was his desire that members of the engineering staff of the department, particularly resident engineers in the field, be given complete information concerning the underlying reasons for the specifications which they are required to carry into execution. It was his belief, also, that county and city engineers, and others engaged in public work, might find much of value in the information presented which would benefit them in the planning and execution of highway projects off the state system.

The widespread interest within the highway department and the many commendations received from those outside the organization give assurance that Mr. Morton's hopes have been more than realized.

Approval also has come from another source. Editors of eastern engineering publications have joined those of western states in giving generous space to republication of many of these articles. The work of the California Bridge Department also is attracting attention. Engineering societies have watched with interest the successful consummation of the Klamath River bridge project, thought impossible by some a few years ago.

Commenting on the interest of eastern publications, a western editor says:

"I note that many of the eastern magazines are reprinting these articles which I consider not only a compliment to the work of these men but a great thing for California, giving this state the lead in another line of development."

The California Highway Department has gathered much valuable information as a result of experience and research. Whatever it can contribute through the Bulletin or otherwise to the counties and the cities, and to others interested, will be gladly given for the benefit of the state.

Judge: So you tried to drive by the officer after he blew his whistle.

Motorist: Your honor, I'm deaf.

Judge: That may be, but you'll get your hearing in the morning. Next case.—Princeton Tiger.

COUNTY PAVEMENT THROUGH MONTECITO REBUILT BY STATE

COUNTS of traffic on the state highway between Los Angeles and Santa Barbara show a heavy travel, which is steadily increasing. A study of the situation clearly indicates the imperative need of reconstruction of existing pavements and the highway commission recently has authorized several important projects looking to the early completion of a highway of a minimum width of twenty feet between the two cities. Through thickly settled sections of Santa Barbara County, south of Santa Barbara city, it is probable a width of thirty feet will be adopted.

The first of these reconstruction projects to be completed was the widening and straightening of the highway through Montecito, the beautiful and widely known district immediately south of Santa Barbara. For years an oil macadam pavement placed by the county in 1909, and a gift to the state at the inception of state highway construction, has carried this mounting traffic. Maintenance costs were high and the condition of the pavement unsatisfactory. Sharp curves became hazards for the heavy traffic.

Through this congested area the commission has recently completed a thirty-foot pavement, extending from the Santa Barbara city limits southward for a distance of 1.9 miles. Cement concrete shoulders, each 7½ feet in width, were built on either side of the existing oil macadam. These shoulders have an eight-inch edge and a six-inch thickness of center. The fifteen feet of oil macadam was resurfaced and thickened with asphalt concrete. The roadbed was graded practically to the full width of the right of way and the alignment improved at several curves where new rights of way were secured with the cooperation of the county.

Gasoline Tax Pays Bill.

As a result, the Montecito section of the state highway is one of the finest on the Coast route. The work was done by the Cornwall Construction Company of Santa Barbara and was supervised by Division V. E. B. Brown was resident engineer. The gasoline tax paid the bill. A photographic view of the new pavement is reproduced on the front cover.

PROGRESS MADE ON GRADE CROSSING ELIMINATION

By L. D. PACKARD, Bridge Department.

THE RAPID increase in the number of motor vehicles operating on state highways has made elimination of railroad grade crossings one of the important problems confronting the California Highway Commission. This work has been going forward for several years and a number of the most dangerous crossings in the state have been eliminated. It will take many years, however, and a large amount of funds to complete the program.

The commission in 1922, in conjunction with the Bureau of Public Roads and the State Railroad Commission, made a study of existing grade crossings on state highways. A total of 573 crossings were investigated, 446 of which were outside the corporate limits of cities and the remaining 127 within the limits of cities but on state highway routes.

Crossings Classified.

Crossings were classified according to importance as follows:

Class I—Grade crossings possible of elimination by relocation. (This number is indefinite.)

Class II—Crossing of a primary highway and trunk line railway of two or more tracks, 24;

Class III—(a) Grade crossing of a single track line and

a primary or trunk highway or of any trunk line and secondary highway, 71;

(b) Grade crossings of a single track line carrying a moderate traffic (not a transcontinental road) and a primary trunk or secondary lateral. Includes important suburban electric railroads, 58;

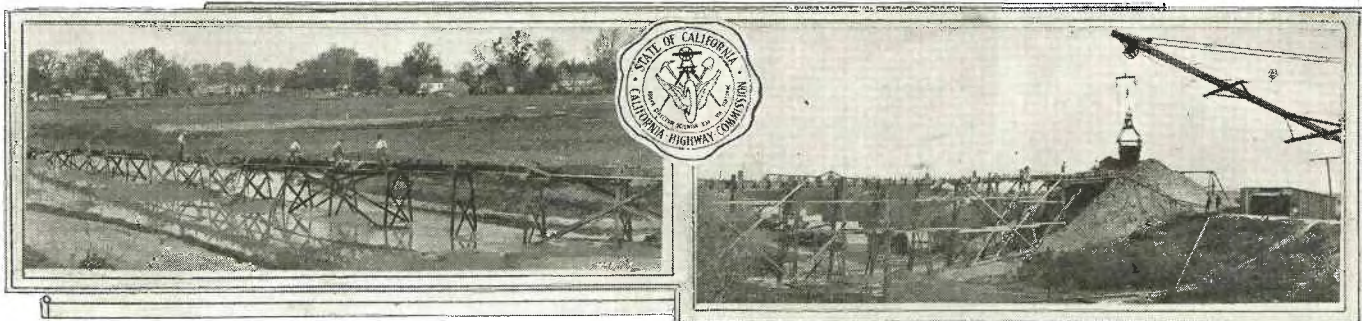
Class IV—(a) Grade crossings of unimportant single track steam or electric lines on which service is limited and primary trunk or secondary lateral highways, 124;

(b) Grade crossings of spur and switch lines with all highways, 114.

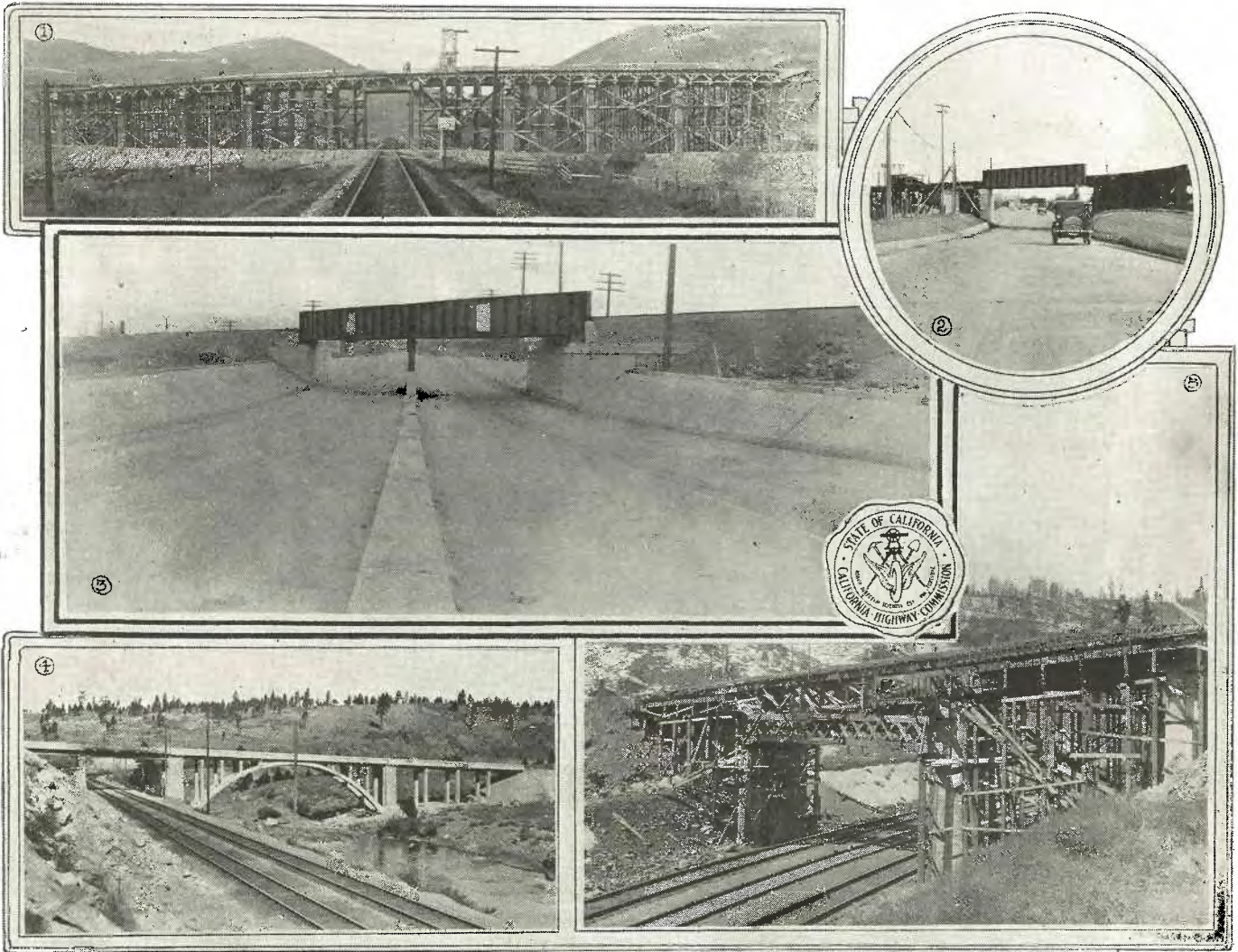
In addition to grade crossings, a number of existing subways or overhead crossings are of timber construction or otherwise unsatisfactory as to clearance and alignment and will have to be replaced with modern structures.

The type of elimination is controlled by topographic conditions which necessarily affect cost. In some cases it is possible to eliminate crossings entirely by relocation of the highway, while others will involve a combination of relocation and structures. In some instances eliminations may be made at the existing crossing by means of a subway or overhead structure.

(Continued on next page.)



UNIQUE GRADING PROJECT—Making a fill at West Sacramento. Sand lifted from bed of Sacramento River by bucket dredge is sluiced through flume for building new approach to M street bridge. (Photos by Division X.)



NEW GRADE SEPARATIONS—(1) Concrete structure over Southern Pacific tracks at Pismo, San Luis Obispo County; (2) new grade separations at North Sacramento, second under pass may be seen in distance; (3) Montebello subway on Whittier Boulevard, Los Angeles County; each opening has a clear roadway width of 28 feet for one-way traffic; (4) Polaris bridge over Truckee River and double track of Southern Pacific in Truckee canyon, Nevada County; (5) Hinton Crossing of Southern Pacific in Truckee canyon. (Photos by Bridge Department.)

PROGRESS MADE ON GRADE CROSSING ELIMINATION

(Continued from page 3.)

Projects are Cooperative.

Cost of grade separations is usually borne jointly by the railroad company and the state, but counties and other political subdivisions often are willing to participate. Division of cost among the various participating bodies is affected by features pertinent to particular crossings and frequently is agreed to in advance, but in some instances it is necessary to have the State Railroad Commission determine the matter. In all instances official authorization for the project must come from the Railroad Commission.

The design of structures for grade separations is a duty of the bridge department of the commission. The plans, of course, have to meet with the approval of railroad engineers and the Railroad Commission. Generally the work is done by the state, but sometimes the railroad company desires to construct a portion of a subway or superstructure.

Preliminary steps necessary are numerous and convenience of the public must be considered at all times. It is often difficult to satisfy all concerned, but an earnest effort is being made by

the commission to accomplish the greatest good for the traveling public with the least expense to the railroads and damage to adjacent property.

COMPLETED ELIMINATIONS.

Since 1924, fourteen grade crossing eliminations on state highways have either been completed or are now under construction as follows:

POLARIS, Nevada County—Crossing of two main line tracks of the Southern Pacific Company and Truckee River was effected with one structure, an arch spanning the river, the tracks passing under the girder approach span. Proctor and Cleghorn, contractors; cost \$53,000; completed October, 1925.

NORTH SACRAMENTO, Sacramento County—Subways under the tracks of the Western Pacific and Sacramento Northern railways made possible the removal of a dilapidated wooden trestle which crossed the railroad lines at grade. Lord and Bishop, contractors; cost \$59,000; completed January, 1926.

WEST SACRAMENTO, Yolo County—Subway constructed under Sacramento Northern tracks to replace inadequate timber structure on poor alignment. Lord and Bishop, contractors; cost \$22,000; completed March, 1926.

VENTURA, Ventura County—New underpass at same location to replace inadequate subway with center pier, which was removed and sight distance in either direction greatly

improved. Further improvement of alignment in highway is proposed. Construction by Southern Pacific forces; cost \$16,000.

MONTEBELLO, Los Angeles County—Largest subway on state highway system, located south of Montebello on Los Angeles-Whittier highway, one of the heaviest traveled state highways. Original narrow highway, crossing tracks of Los Angeles and Salt Lake Railway (Union Pacific system) at grade, has been widened to 56 feet and a modern structure built to eliminate the grade crossing. The subway has two one-way openings, each with 28 feet clear width, dividing traffic into three lines each way. Subway was built by the railroad company, the highway commission cooperating at a cost of \$200,000. Completed March, 1926.

ORO GRANDE, San Bernardino County—Subway constructed by Santa Fe railroad at cost of approximately \$40,000. This elimination was made in conjunction with the realignment of both the state highway and the railroad between San Bernardino and Barstow; a very decided improvement.

ENCINITAS-CARDIFF, San Diego County—Two dangerous crossings of the Santa Fe Railroad were eliminated at these points in cooperation with the railroad by the relocation of a mile of highway under the direction of Division VII.

GRADE SEPARATIONS UNDER CONSTRUCTION.

HINTON, Nevada County—Overhead structure on the Truckee River highway crossing three tracks of Southern Pacific Company. T. H. and M. C. Polk, contractors; estimated cost \$30,000.

PISMO, San Luis Obispo County—Overhead structure of reinforced concrete girder type over tracks of Southern Pacific; J. L. Webster, contractor; estimated cost \$60,000. Part of important realignment project.

OCEANSIDE, San Diego County—Subway on Coast route under construction by the forces of Santa Fe Railroad; to be completed during the summer; estimated cost \$50,000. Construction involves relocation of about a mile of highway which will materially improve alignment where traffic is heavy.

LAS FLORES, San Diego County—This project involves shifting of present subway and putting it on greater skew to provide wider opening and better alignment for highway. Grading of approaches now under way and construction of new subway will be started in near future by Santa Fe Railroad forces. Present narrow opening and sharp approach curves will be eliminated.

CARLSBAD, San Diego County—Reinforced concrete overhead structure to make possible realignment of Coast highway, and to relieve through traffic of the necessity of crossing the tracks of the Santa Fe and passing through business district of Town of Carlsbad. Most of through traffic will be taken away from present dangerous crossing; right angle turns will be eliminated from highway. Coon Brothers, contractors; estimated cost \$35,000.

DOWELL BILL PASSES HOUSE

THE ACTION of the House of Representatives in passing the Dowell Bill (H. R. 9504) on April 16th without a single dissenting vote is cheering news for supporters of federal aid throughout the country. It is evidence that congress has become convinced that the nation as a whole favors this legislation and a continuation of the present policy of state and national cooperation in the construction of interstate highways.

The bill authorizes appropriations of \$75,000,000 a year for the fiscal years 1928 and 1929 for aid to the states, and \$7,500,000 a year for each of the two years for construction of roads in the national forests. This latter provisions is of special importance to western public land states.

The measure now goes to the Senate where it will come before the committee on Post Offices and Post Roads. The membership of this committee is as follows:

George H. Moses, New Hampshire, Chairman; Lawrence C. Phipps, Colorado; Tasker L. Oddie, Nevada; Robert N. Stanfield, Oregon; Porter H. Dale, Vermont; Jesse H. Metcalf, Rhode

PROPOSED ELIMINATIONS.

The following eliminations have been proposed:

BEN ALI, Sacramento County—Subway to be built under double track main line of Southern Pacific north of city of Sacramento. A dangerous crossing where numerous fatal accidents have occurred will be eliminated. Application for order made to Railroad Commission.

SOUTH SAN FRANCISCO, San Mateo County—Proposed subway on Bay Shore highway at South San Francisco under five tracks of Southern Pacific Railroad and one track of South San Francisco Belt Railway. Construction will be difficult because subway will be 1200 feet long and partly below tide level. Waterproofing will be necessary. Order dividing cost already has been made by the Railroad Commission. Plans are being prepared.

BRANAGAN, Orange County—Permanent subway will replace existing timber trestle under tracks of Southern Pacific branch line near Newport Beach on the new Coast highway. Authorized for construction during 1926.

SERRA, Orange County—Two subways are necessary at this point to effect connection between new Coast highway and existing Los Angeles-San Diego highway, one leading to Los Angeles and other to San Diego. The Santa Fe Railroad will elevate several miles of track to facilitate building of subways and will have charge of construction under cooperative agreement with commission. Estimate cost \$115,000; work authorized for 1926.

DEL MAR, San Diego County—Application filed with Railroad Commission for order authorizing construction of reinforced concrete structure over Santa Fe Railroad, as part of plan for relocation of state highway through town of Del Mar. Present dangerous crossing at grade will be eliminated. Project authorized for 1926.

MOSSDALE, San Joaquin County—Subway under Southern Pacific Railroad on new alignment to replace present narrow and dangerous passage through pile trestle. This subway is necessary to complete approach to new Mossdale bridge over San Joaquin River. Proposed for construction during 1926.

Construction of grade separations by railroad forces does not mean that the work is being done solely at the expense of the railroads. It means, merely, that a cooperative agreement has been reached for the work to be done by construction forces of the lines. The Railroad Commission, as a general rule, assesses at least 50 per cent of the cost of all grade separations to the public.

The ultimate solution of all grade crossing problems is their elimination. The work necessarily will be going on for many years and will entail an expenditure of millions of dollars before all dangerous crossings have been removed from California state highways.

Island; Coleman Dupont, Delaware; Thomas D. Schall, Minnesota; W. H. McMaster, South Dakota; Lynn J. Frazier, North Dakota; Kenneth McKeller, Tennessee; J. Thomas Hefflin, Alabama; Park Trammell, Florida; Woodbridge N. Ferris, Michigan; Cole L. Blease, South Carolina; Sam G. Bratton, New Mexico. George H. Henry, 241 Senate Office Building, Washington, D. C., is secretary of the committee.

STATE GETS ON JOB PROMPTLY

(From the Marysville Appeal.)

The prompt action of the California Highway Commissioner in putting a crew of men with necessary machinery to work on the Browns Valley grade to keep up this section of road in the best possible condition will be highly appreciated by all travelers, but it will be especially gratifying to those who will have their fruit to market this summer.

Within twenty-four hours after accepting the cooperation offers of the supervisors the state had its employees on the job and the work will be rushed to early completion. The road will be graded, widened and covered with a heavy coat of crushed rock and then oil will be applied and should prove a mighty satisfactory improvement over the present deplorable condition of this important artery of travel to this city.

SELECTION OF ROCK AND GRAVEL FOR HIGHWAY CONSTRUCTION*

By C. L. McKesson, Materials and Research Engineer.

IN HIGHWAY construction work approximately half of the material, measured by volume, consists of rock and gravel. The safety and durability of structures, pavements, and of cheaper metalled surfacing is, in varying degrees, dependent upon the quality of the stone and gravel used in the work.



C. L. McKesson.

Most of the tests heretofore developed and in general use at the present time were devised in the days when macadam surfacing was the highest type of pavement and when structures were generally of masonry. Quarrying methods and equipment have greatly changed, and some of the tests which could easily be applied to material quarried by hand and produced in small quantities are not practicable for testing of material produced in modern quarries, where many thousands of tons are produced by a single blast. Hand quarrying permitted of elimination of waste, soft materials in seams and of the selection of materials of uniform quality.

In modern quarry practice such refinements are not usually feasible and the product must be accepted or rejected upon average samples and not upon small hand-picked samples. Some of the tests were considered of special value in anticipating wear of macadam under slow moving, iron-tired vehicles, but now, instead of such traffic, we have fast moving, heavily loaded, rubber-tired vehicles.

Impact Now Important.

Impact is now one of the most important considerations in the design of pavement or structures. Toughness in rock is the property which enables it to resist impact while hardness has to do more with resistance to abrasion, yet it is safe to venture that 90 per cent of the rock is tested for abrasion only and the material accepted or rejected on this property alone. It is well known and will be demonstrated hereinafter that rock, often extremely hard, is yet quite brittle and, therefore, unsuited for many uses in highway construction.

In the work of the California Highway Commission we have endeavored to develop tests which will indicate the important properties of rock and gravel, with the realization that such tests should be applicable to average samples of material as commercially produced. We have endeavored, as far as possible, to make the tests parallel the results of actual service conditions. In many cases samples were secured of rock products which have actually given unusually good service in highway work. These samples were tested and the results were used in arriving at tentative standard requirements. Unsatisfactory materials have been similarly tested and studied. In this work we have had valuable cooperation from the division engineers and their assistants.

New Testing Methods Developed.

Our tests are, in part, a modification of the older and well-known tests, and, in part, a development of our own laboratory. The standard test will, in each case, be described together with the modified test or new test used by us. The testing practices described are not given out with the idea that they are to be adopted as standard tests in their present form, but in order that

others interested in the improvement of testing practices may have the benefit of our work in this direction. The tests will be taken up for discussion in what we believe to be the order of importance.

1. Toughness.
2. Cementing value.
3. Hardness.
4. Wear when saturated.
5. Absorption.
6. Voids.

TOUGHNESS TESTS.

A. S. T. M. Standard Method and Jackson Test.

The toughness test which has been considered standard practice in the past, and described in U. S. D. A. Bulletin No. 1216, was made in the following manner:

Quarry samples were taken, measuring at least 6" on a side and 4" in thickness. It was specified that the plane of structural weakness should be marked on the specimen; that the sample should be freshly quarried material and free from incipient fractures or flaws. Preferably the samples were taken by splitting from large pieces by the use of plugs and feathers. The prepared specimens consisted of cores about 1" in diameter and 1" in length which were drilled from the larger samples perpendicular and parallel to the plane of structural weakness of the rock. These cores were drilled with a diamond drill and the ends sawed with a diamond saw.

The specimens were tested by placing them on an anvil in a Page impact machine and subjected to blows from a hammer weighing about 2½ pounds. The fall of the hammer was carefully measured and the height of the fall in centimeters at failure was taken as the toughness of the specimen.

Not Suitable for Commercial Output.

The foregoing test, while well adapted to scientific research work, did not lend itself to the testing of commercial quarry output. It will be noted that the specimen required was a large piece of carefully selected rock. In the larger quarries there is usually a lack of uniformity in the quarry face and this toughness test would be accurate only for the particular quality of rock selected for the test. In order to determine the average toughness of the commercial product, it would have been necessary in some quarries to have taken many samples representing the softer rock in the quarry face and the harder grades of rock. After determining the toughness of each, some average might have been worked out which would have been indicative of the toughness of the commercial product.

The fact that the samples had to be so carefully prepared and required a diamond drill and other expensive mechanism, has prevented the test from coming into general use in the smaller laboratories. The test, as originally outlined, was entirely inapplicable to gravels, and a similar test was worked out by Mr. F. H. Jackson and published in the Proceedings of the American Society of Testing Materials in 1922 in which fifty pieces of gravel were selected varying from ¾" to 2" in diameter and these specimens were subjected to the blow of a hammer. This test at least had the merit of being applicable to field samples, but it left some things to be desired.

It will be noted that the toughness tests are really impact tests in which the toughness of the stone is expressed in terms of its ability to resist destruction under the impact of a hammer blow.

L. A. Rattler Test.

During 1916 and 1917, the writer, with Mr. B. W. Matteson, was engaged in a revision of specifications for the City Engineer's Department of Los Angeles, and at that time the inadequacy or unsuitableness of the standard test for toughness was given consideration. The standard toughness test above described was not applicable to local conditions because of the extreme lack of uniformity of the rock in some of the larger quarries and because it could not be used for testing gravels.

*Presented at the State Convention of County Engineers at San Diego, California, March 12, 1926.

Research work at that time demonstrated that the Deval rattler test did not insure a uniformly good quality of rock for all construction purposes. In tests of specially prepared samples, it was found that adulterations of sound andesite rock with as much as 15 or 20 per cent of soft weathered stone did not greatly lower the percentage of loss in the Deval. Such a high percentage of soft material was believed to be objectionable and a large number of concrete tests were made in the study of the effect of quality of stone upon strength of concrete. In these tests it was found that appreciable quantities of the softer stone did affect the strength of concrete in the richer mixtures. Up to about 3000-pound concrete the quality of the rock apparently had little effect on concrete strength, but in concrete running from 3000 pounds to 6000 pounds per square inch, compressive strength, the quality of rock was of increasing importance.

New Impact Test Developed.

A new test was devised in an effort to secure an impact test which would give a relative measure of the toughness of rock and which could be applied to typical samples of commercial products. Mr. T. A. Fitch, Testing Engineer of the city of Los Angeles, cooperated with Mr. Matteson and the writer in the experimental work which led to the adoption of this rattler test which was adopted by the city of Los Angeles as the Los Angeles rattler test. It is believed that this test has not been described heretofore except in standard specifications in use in southern California. The Los Angeles rattler test is very closely related to the test now regularly used by the California Highway Commission. It will be described in some detail in order that the principles involved in impact tests of this sort may be clearly understood.

The rattler used in the Los Angeles rattler test consisted of a drum 28" in diameter and 20" in length, longitudinally mounted on a horizontal shaft and having a shelf 4" wide extending from end to end on the inside. The shell of the rattler drum consists of sheet steel 1/2" in thickness. The drum is revolved during the test at a rate of between 28 and 30 revolutions a minute. The sample for the rattler test consists of 11 pounds (5 kilograms) of crushed rock or gravel, all of which passes a 2" screen, 60 per cent of which is retained on 3/4" screen and all retained on 1/2" screen. The sample is placed in the drum with a charge consisting of fourteen cubical blocks of cast iron having rounded corners and edges, the blocks having a total weight of 11 pounds.

After charging with the sample and the iron cubes, the drum is revolved 500 revolutions. With each revolution, the rock sample and iron cubes are picked up on the shelf and carried upward until discharged across the drum by the inclination of the shelf. The shot and rock falling together produce impact quite similar to that produced by hammer blows. The loss is considered that portion of the sample which, after the test, will pass a 10-mesh screen.

There is doubtless some slight loss in this test due to abrasion or the wear of the rock particles upon themselves and upon the iron cubes. This proportionate part of the loss is, however, very low due to the fact that the total time of operation is only about 17 minutes, 1/20 of the time required for the Deval abrasion test. Rock and gravel, lacking in toughness, will show very high losses in the Los Angeles rattler test, although the hardness may be excellent. Experimental work shows clearly that this test measures the toughness rather than hardness or resistance to abrasion. Any appreciable percentage of soft stone mixed with a harder rock proportionately affects the loss in this test. Although the test is of short duration, it is very severe and the losses are much higher than in the Deval rattler, the toughest rock encountered showing a wear in this test of about 7 per cent and some of the brittle granites and granitic gravel showed losses as high as 50 to 60 per cent.

In a study of the comparative results of the Los Angeles rattler and the Deval abrasion tests, identical samples were prepared and run in both rattlers. The samples complied with the standard practices for the Deval except that they were graded samples, 60 per cent passing the 1 1/2" and retained on the 3/4" and 40 per cent passing the 3/4" and retained on the 1/2". In Figure No. 1 the results are shown of these special Deval tests and of tests with the Los Angeles rattler and from these comparative results it is quite clear that the impact rattler measures toughness and not resistance to abrasion.

Abrasion Test for Gravel.

This test, originally described in Bulletin No. 555 and later in a revised form in Bulletin No. 1216, U. S. Department of Agriculture, is, in reality, a modified impact test rather than an abrasion test as is indicated by the name. The charge in this case consists of 11 pounds of graded material passing 2" and 25 per cent retained respectively on the 1 1/2", 1", 3/4" and 1/2" screens. The wear test is made in the standard Deval rattler with a charge of shot consisting of six cast-iron spheres weighing approximately 1 pound each. As the Deval drum has an inclined axis, the charge of shot and sample is thrown alternately from end to end in the revolving cylinder and the heavy shot produces impact. The test is continued for 10,000 revolutions as in the Deval test and there is undoubtedly some loss due to abrasion.

That the greater percentage of the loss is due to impact rather than abrasion has been well demonstrated in our laboratory by comparison of Deval tests and shot rattler tests on identical samples. This test is used as a standard test for toughness and abrasion of gravels by the California Highway Commission. Occasionally when it is desired to determine toughness independently of abrasion, samples are also run in the Los Angeles rattler described above.

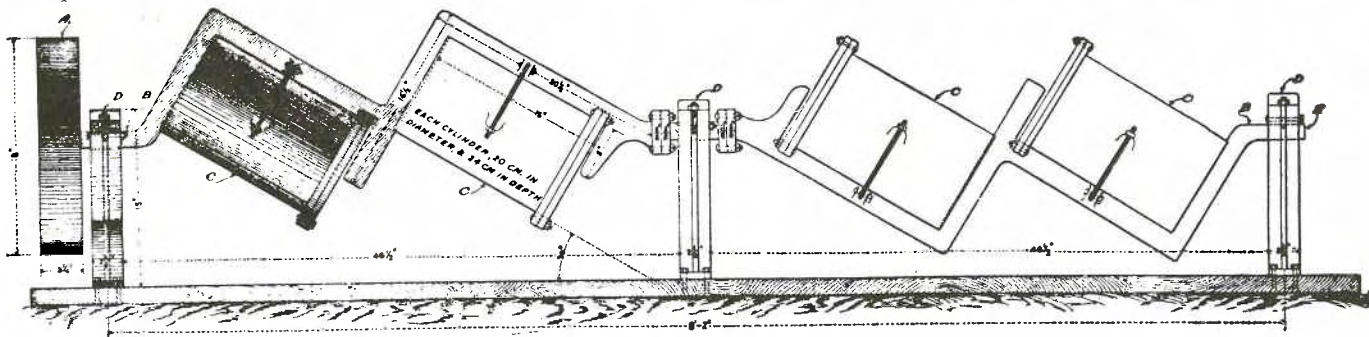
Impact Rattler Test for Rock.

This test, now being used as a standard in the laboratory of the California Highway Commission, is identical with the foregoing test for gravel, except that the charge consists of crushed rock. During the last two years, hundreds of tests have been made on samples from all sections of the state. Whenever possible, tests have been made on the same sample with the standard Deval as well as this impact test. Experience has demonstrated very conclusively that this shot rattler test is indicative of toughness. The losses in this test are much less than those in the Los Angeles rattler test, although the time of operation is 20 times greater.

There is no fixed relation between the losses in impact tests, either shot rattler or Los Angeles rattler, and the losses in the standard Deval. The hard brittle rocks show low losses in the Deval but high losses in the impact. Hard and tough rocks show low losses in all of these tests. Typical comparisons are shown in Table No. 1 in which the results of this test are compared with those obtained with the standard Deval. The test is readily applicable to field samples in that it may be made on graded material. It is usually the practice to secure 50 to 200 pounds of the material from the work. This is quartered down to the 11 pounds required for the test, and the test is, therefore, made on a sample which is typical of the commercial product. No special apparatus is required as is the case with the A. S. T. M. standard toughness test described above.

In many cases it is necessary to test material which contains crushed particles and rounded water-worn material. In such cases, after the sample is quartered down, the rounded particles are counted and this is taken into consideration in connection with the percentage of wear in determining the suitability of the material. The sharp angular particles in crushed rock show a some-

(Continued on next page.)



Abrasion machine—Deval type (front view).

SELECTION OF ROCK AND GRAVEL FOR HIGHWAY CONSTRUCTION

(Continued from page 7.)

what higher loss due to abrasive action in the test. The losses from impact are probably more or less the same in both tests.

Figure No. 2 shows a comparison of results of tests on identical samples made with the shot rattler and with the Los Angeles rattler. The material consisted of crushed rock in each case. This graph indicates that there is a relation between losses in both tests although the relation is not a constant one. With the crushed rock samples, the shot rattler test gives about 60 per cent of the loss obtained with the Los Angeles rattler. On rounded gravel, the losses are about one-half those obtained in the Los Angeles rattler.

CEMENTING VALUE TESTS.

Standard Test.

The standard test for determining the binding power or cement value of rock described in Bulletin No. 370, U. S. D. A., consisted of grinding 500 grams (1.1 pound) of the material in a ball mill until it reached a consistency of stiff dough. The sample was then moulded under pressure into cylindrical briquettes 1" in diameter and 1" in length. After thoroughly drying, these cylinders were broken by allowing a 2.2-pound hammer to strike them with a drop of 4". The number of blows required to produce failure was called the cementing value of the rock.

California Cement Value Test.

The standard test above described, being made on a flour produced by grinding the rock, did not take into consideration the shape of the finer rock particles in the crusher product and the tendency of such particles to bind in the roadway by interlocking. We have, therefore, developed a test which we believe to be somewhat more practical in that it measures the cementing value of the material which will be actually used. In our test, the material passing $\frac{1}{2}$ " circular opening is removed from the sample received from the field. Screen analysis is made of the material, and if it is found to contain less than 15 per cent passing the 100-mesh sieve, enough material is pulverized to supply the deficiency and to bring the fines up to this requirement.

It was found in earlier experiments that material containing less than 15 per cent of fines passing the 100-mesh did not show satisfactory binding properties and that it was necessary to maintain the fines at a constant figure to secure uniform results. The $\frac{1}{2}$ " material thus selected is ordinarily typical of the finer material which will be sent to the work from the quarry or gravel pit. It represents what might be considered the mortar or matrix in the crushed rock surfacing.

How Sample is Tested.

The sample, prepared as above, is moistened and mixed as in the preparation of a concrete sample. The amount of water used varies with the character of the material, but an effort is made to approach the condition known in soil tests as moisture equivalent saturation. The same consistency in concrete would be defined as "stiff." With ordinary crushed rock surfacing material, the amount of water usually runs from 10 to 12 per cent. The material, after wetting, is tamped into a $4\frac{1}{2}$ " cubical mould and is placed in a warm oven at a temperature of about 100° F. until it has dried sufficiently to permit of its removal from the mould. Drying is then continued until the specimen ceases to give off moisture, after which it is capped with plaster of paris and tested for compression in a Universal testing machine.

The cementing value is taken as the average compressive strength per square inch of three specimens. There is a wide variation in results obtained with different materials, but fairly uniform results can be obtained in repeated tests of the same material. The strength developed ranges from 0 to about 225 pounds per square inch. One hundred to 150 pound strengths are not unusual. Figure No. 3 shows cementing test specimens ready for testing machine.

HARDNESS TESTS.

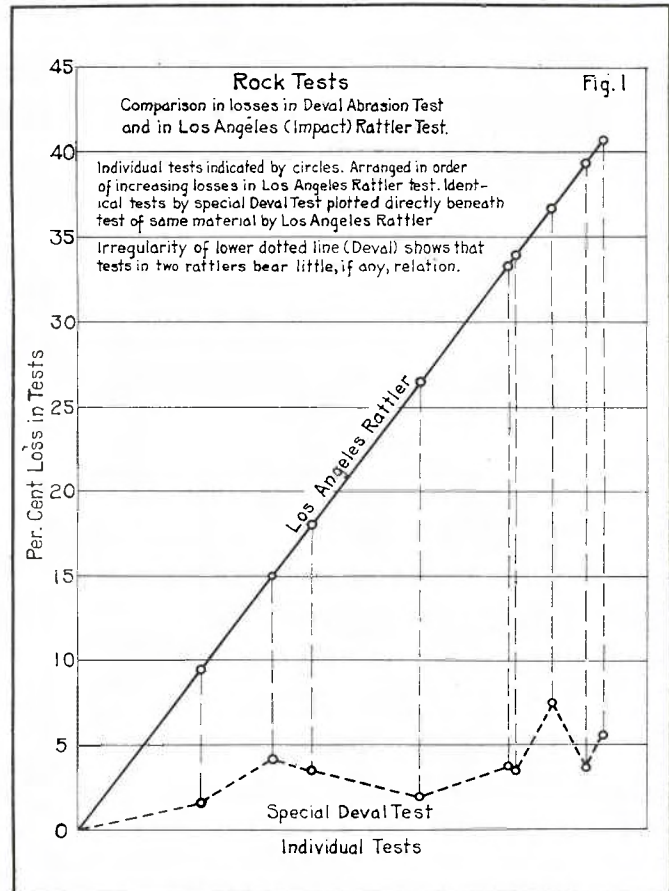
Dorry Hardness Test.

This test has been recognized as a standard for many years, but is seldom made outside of the very large laboratories due to the special equipment required. The test consists of drilling a 1" core with a diamond drill and of grinding it on a disc in a Dorry Hardness Machine, using sand as an abrasive agent. The test is,

from a practical standpoint, open to all of the objections pointed out in the standard toughness test.

Deval Abrasion Test.

This test, which has been standard practice for a number of years throughout the country, is essentially a hardness test in that the abrasive losses are produced by the particles rubbing together in the cylinder of the testing machine. In this test, fifty pieces are usually cut by hand with a stone hammer and are about 2" in size. The sample is placed in a cylinder which is inclined at an angle of 30° to the horizontal shaft by which it is rotated. The cylinder is closed with a cap and rotated 10,000 revolutions at the rate of about thirty revolutions per minute. The pieces of rock slide from end to end as the cylinder revolves. The portion of the sample which, after the test, passes a 16-mesh sieve is considered the loss.



With ordinary quarry rock of a reasonable degree of hardness, the losses vary within very narrow limits. It has been more or less standard practice to consider any material showing less than 4 per cent wear as satisfactory in this test. The usual variation is from 2 to 5 or 6 per cent, and in order to emphasize the small differences, the originators of this test devised the "French coefficient," which is the quotient obtained by dividing 40 by the loss in per cent. A sample showing 2 per cent loss has a French coefficient of 20, while a sample showing 4 per cent loss has a French coefficient of 10.

In discussing this test, engineers sometimes describe it as an impact and abrasion test and there are possibly some slight losses due to the impact of the particles sliding back and forth in the cylinder. The losses due to this cause are probably extremely low and the test can not be considered as any measure of the toughness of the rock.

In Table No. 1 it will be noted that many samples which show a low loss in the Deval, show very high losses in the shot rattler which is much more nearly an impact test. The Deval rattler test is still a useful test for determining hardness of rock, but we believe that it should be used in conjunction with the shot rattler or Los Angeles rattler which determine the relative toughness. The artificial term "French coefficient" has little value and has been dropped by many of the leading testing laboratories, the loss being expressed simply as the loss in per cent.

WET TESTS.

Sodium Sulphate Test.

This standard test is made by immersing ten small pieces weighing about 2 pounds in a saturated solution of sodium sulphate. The immersion is continued for twenty hours, the sample dried for four hours and then immersion repeated. This treatment is carried on for five successive periods, twenty-four hours each. Samples which exhibit marked checking, cracking or disintegrating are considered to have failed in this test. This test has value in determining the likelihood of the rock breaking up due to frost action or disintegration in continued wet weather.

Wet Wear Test.

In the laboratory of the California Highway Commission, we have experimented considerably with the wet wear test in which the sample is subjected to the standard Deval or shot rattler test as above described except that sufficient water to cover the sample is added when the specimen is placed in the cylinder. It has been found that materials which show excessive wear or tendency to slack will show much higher losses in this wet test than they show in the same test made dry. Some materials which are unaffected by water, show slightly less losses in the wet test due probably to the cushioning action of the water in the test cylinder.

MISCELLANEOUS TESTS.

Rock and gravel samples are tested for absorption and specific gravity by the standard methods. These characteristics are of more or less importance in identifying materials and in that they give some general index to the character of the rock. The specific gravity test is necessary in order to determine the voids in crushed stone or gravel as received on the work. Void determinations are made on concrete aggregate by measuring one cubic foot or a fraction thereof of loose material and then by weighing the material so measured. The voids are determined from the ratio of the material weighed to the weight of one cubic foot absolute volume of the same material.

INTERPRETATION AND APPLICATION OF TESTS.

In General.

There are no fixed and set standards by which any rock or rock product can be said to be good or bad. In every case the material must be studied with reference to the specific use for which it is intended and its suitability determined by comparing the tests which are more or less comparable to the service requirements. The interpretation of tests will be discussed in connection with some of the more important types of construction in which rock products are used.

Cement Concrete.

In cement concrete, the stone is surrounded by Portland cement mortar and there is no abrasive action between the rock particles. Extreme wearing conditions might in time expose the rock in the surface of the pavement to direct wear, but the wear tests which have been made do not indicate that the wear of the concrete would necessarily be in proportion to the abrasive losses of rock in the Deval test. Some of the softer rocks have made excellent showings in the wear tests of concrete. Concrete in pavement and in structures is subjected to tensile and compressive stresses and it has been found by laboratory experiments, that the better quality of aggregate is reflected by increased strength in concrete.

The effect on concrete strengths is quite appreciable when the mortar strength is high. Weak mortars do not develop the strength of the coarse aggregate. In concrete of 3000 pounds, or more, compressive strength, the quality of the coarse aggregate is an important consideration. The Deval rattler and shot rattler tests indicate relative hardness and toughness of the material and are, therefore, applicable in securing a good quality of rock for use as coarse aggregate. For aggregate used in high strength concrete, the loss by the Deval test should probably not exceed 5 per cent, and the loss by the shot rattler test should probably not exceed 25 per cent on crushed rock.

The shot rattler loss should not exceed 18 or 20 per cent on screened gravel. Coarse aggregate for concrete work should not show excessive gain in the absorption test, particularly where the concrete is to be water-tight for the protection of steel or resistance of alkalis. Rock which weathers rapidly and which shows excessively high losses in the wet test would not be desirable for use in unprotected concrete.

Asphaltic Concrete and Bituminous Macadam.

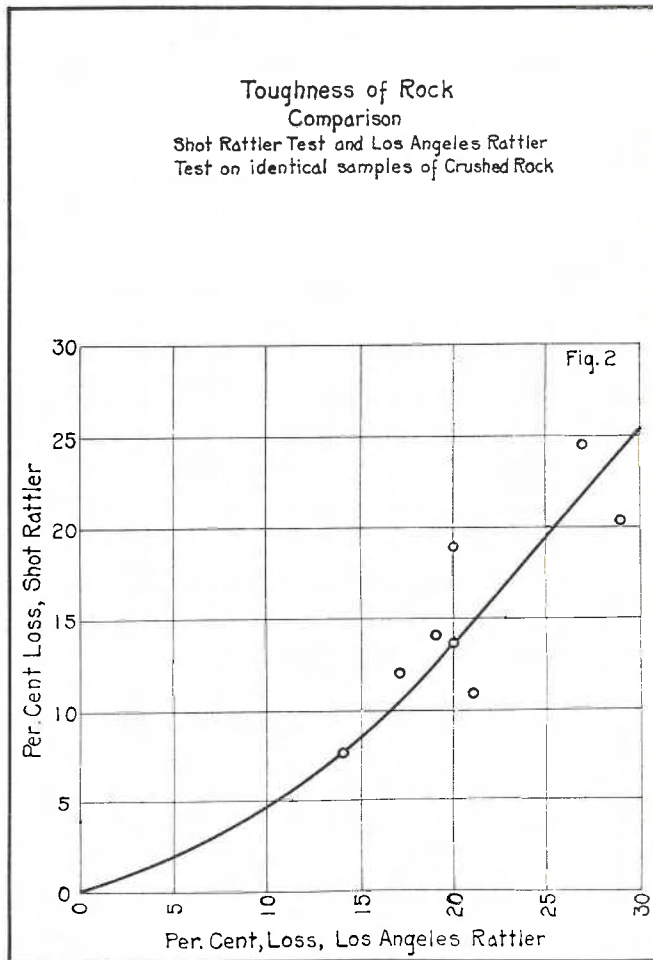
In this type of work, the coarse aggregate is embedded in a plastic mortar consisting of sand and asphalt. The rock is not

protected from impact, but is largely protected from abrasive losses. It is very obvious, in the light of the preceding discussion, that a material which will resist repeated blows from the wheels of traveling vehicles, will be one which will show similar resistance to destruction in any of the impact tests described. In other words, toughness is essential in rock which is to be used in bituminous work. The writer has had the occasion to investigate bituminous pavements in which brittle coarse aggregate had been used, and found a very large number of shattered pieces of stone and of fractured surfaces which had been produced in rolling and under traffic. This destruction of coarse aggregate and the production of uncoated fractured areas is to be avoided in bituminous work. The Deval rattler test gives little or no indication as to the suitability of rock for bituminous work.

In Table No. 1 attached, will be found samples showing a loss of less than 2 per cent in the Deval with a loss of more than 20 per cent in the shot rattler. Such material is hard and brittle and may be expected to break up under the roller and under traffic in bituminous pavement.

Should Consider Materials.

In this type of work, as in all others, the character of materials available should be considered in fixing the limits of loss in any rattler test. The writer states as his opinion based on experience and observation, that the limit of loss in shot rattler test for rock to be used in bituminous work should not exceed 15 per cent. With this limit on shot rattler, the loss in the Deval rattler test might reasonably be fixed at 4 per cent. These values, of course, apply to crushed rock or crushed gravel and not to screened gravel.



The desirability of using screened gravel in bituminous work is a matter which will not be gone into in this discussion. In much of the bituminous macadam construction, the bituminous wearing surface is placed on a water-bound macadam base. In such cases, the base rock should conform with requirements for macadam and crushed stone surfacing.

Macadam or Crushed Rock Surfacing.

In this type of construction the rock is exposed directly to weathering action. In countries where the macadam type of con-

SELECTION OF ROCK AND GRAVEL FOR HIGHWAY CONSTRUCTION

(Continued from page 9.)

struction prevails, much study has been given to the wearing qualities of surfacing rock. In some sections of Europe, the road authorities are able to forecast quite accurately the tonnage of road metal per year required for the maintenance for any given section of road. They are familiar, from long service tests, with the wearing properties of their road metal, which is usually taken from quarries which have been in operation for many years.

In this country we are continuously opening up new sections of highway and experience in the locality does not give data from which to judge the wearing properties of the local materials. In this state, we have a constantly increasing mileage of crushed stone surfacing, some of it under very heavy traffic. There can be no question but that the cost of maintenance of such a road will vary greatly with different surfacing materials. In such cases we are forced to rely on laboratory tests in an effort to pass on the relative suitability of materials which are locally available. Crushed rock is heavy and transportation charges high. It is usually desirable to develop local materials instead of shipping from remote commercial supplies.

It was the idea of securing practical, easily interpreted tests that has led to considerable research work in our laboratory, during the last two years. The tests which have been described above are believed to give a good index to the probable value as surfacing material of any type of crushed stone or gravel. Separate tests,

somewhat similar in nature, are being developed for disintegrated granite and the lower types of metal surfacing. These will be omitted from this discussion.

As availability of material and the character of local deposits are of paramount importance in crushed rock surfacing, no attempt will be made to set forth exact test limits. Desirable material should show a cementing value of more than 30 pounds. Material which shows 100 to 200 pounds cementing value may be expected to give a well cemented surface which will be easily maintained and not excessively dusty under normal conditions. The lower the loss in the shot rattler test, the better the material for surfacing as long as it shows reasonable cementing qualities, and usually good cementing quality is found associated with toughness, while low cementing value is frequently found in a rock which shows a low loss in the Deval and high loss in the shot rattler.

Local Samples Tested.

The comments in Table No. 1 under the column of remarks, will indicate, in a measure, the manner in which the test results are interpreted in the laboratory of the California Highway Commission. It is our usual practice to secure samples of the various materials locally available and to test each for Deval, wet and dry shot rattlers, and cementing value. The results from the various local materials are compared and the ones which show good cementing values, and the lowest loss in the shot rattler, are recommended for use.

In macadam work and in crushed stone surfacing, no material should be considered as first-class which shows a loss in the shot rattler in excess of 15 per cent. Materials up to 20 per cent are

TABLE 1—RECENT ROCK TESTS.

The Testing and Research Laboratory of the California Highway Commission.

Sample No.	Material	From	County	Deval		L. A. Rattler. per cent loss	Absorption	Per cent loss Shot Rattler		Per cent crushed in Shot Rattler	Sp. Gr.	Cementing test (Chl.)	Remarks
				Per cent loss	F. C.			Dry	Wet				
2001	Gravel	San Dimas	Los Angeles				0.8	24.9	36.0	13	2.61		Unsuitable for use in concrete.
2002-5	Cr. Rock	Veronica	Santa Barbara	4.9	8.2		1.8	22.4	35.0	100	2.52		Might be used in concrete or macadam base.
2006	Gravel	Yosemite	Merced				0.7	28.0	29.5	33	2.64		Not satisfactory for use in asphaltic concrete.
2007	Shldr. Rock	Orestimba Creek	Merced				0.9	13.1		64	2.65	84	Satisfactory for rock shoulders.
2008-11	Cr. Rock	Honda	Santa Barbara				0.5	15.9		100	2.44		
1686	Cr. Gravel	Livermore	Alameda	4.1	9.7	19	0.9	14.2		100	2.64		Satisfactory for any purpose.
1684	Cr. Rock	Logan	Santa Cruz	4.1	9.7	20	0.7	20.6		100	2.97		Satisfactory for concrete.
1681	Cr. Rock	Logan	Santa Cruz	3.6	9.2	21	0.6	11.0		100	2.93		Satisfactory for any purpose.
1674	Cr. Rock	Steger	Contra Costa	7.9	5.06	27	1.3	24.6		100	2.93		Unsatisfactory.
1678	Cr. Rock	Steger	Contra Costa	3.3	12.1	17	0.6	12.1					Satisfactory for any purpose.
2023	Gravel	Yosemite	Merced				0.8	24.9		19	2.67		Lacking in toughness.
2026	Crushed Rk.	Convict Camp	Del Norte	1.5	26.7		0.2	3.8		100	2.88	207	Very satisfactory for any purpose.
2027	Crushed Rk.	Convict Camp	Del Norte	1.6	25.0		0.3	8.4		100	2.89	194	Very satisfactory for any purpose.
2028	Crushed Rk.	Convict Camp	Del Norte	1.5	26.7			5.3		100		116	Very satisfactory for any purpose.
2031-42	Crushed Rk.	Tomasson	Solano				1.4	7.2		100	2.65	197	Very satisfactory for any purpose.
2045	Cr. Boulders	Cascade Plant	Yosemite	3.8	10.5		0.8	30.4		100	2.68		Lacking in toughness.
2051-84	Surf. Rock	State Hwy. Quarry	Mendocino				1.5	17.7	42.0	100	2.76	112	Satisfactory for maintenance of rock surfacing.
2052	Cr. Rock	Columbia	Tuolumne	3.2	12.5		0.3	25.9		100	2.82		Abrasion O.K. but toughness low.
2057	Cr. Rock	State Hwy. Quarry	Mendocino	7.2	5.6		2.3	14.8		100	2.75	108	Satisfactory for rock surface maintenance.
2060	Gravel	Near Blythe	Riverside				1.2	26.7		93	2.62	78	Satisfactory for rock surface maintenance.
2061	Gravel	SW. of Black Butte	Riverside				1.0	17.0		70	2.58	182	Very satisfactory for rock surface maintenance.
2067	Gravel	Oakdale	Stanislaus	1.4	28.6		0.3	20.0		100	2.70		Satisfactory for use in concrete.
2072	Cr. Rock	Novato	Mendocino	2.1	19.0		0.2	12.6	9.6	100	2.67	105	Satisfactory for all purposes.
2079	Cr. Rock	Clearinghouse	Mariposa	2.4	16.6		0.5	13.6	21.7	100	2.71	39	Satisfactory for all purposes.
2080	Cr. Rock	N. Crescent City	Del Norte	2.8	14.3		1.3	10.1		100	2.68	105	Satisfactory for all purposes.
2095	Cr. Rock	S. of Petaluma	Sonoma	2.9	13.8		1.5	11.5	20.6	100	2.78		Satisfactory as to wear. Had a chalky coating.
2098	Gravel	Green Valley	Sonoma				1.1	12.5	17.3	95	2.61		Satisfactory for concrete.
2103-5	Gravel	Butte Cr.	Butte	1.8	22.2		2.1	10.4	11.7	100	2.70	131	Satisfactory for all purposes.
2107	Cr. Rock	Wool Rock	Mendocino	4.6	8.7		1.2	15.8		100	2.58	97	Satisfactory for all purposes.
2108	Cr. Rock	Saratoga Springs	Lake	4.1	9.8		1.5	12.0		100	2.72	69	Satisfactory for all purposes.
2109	Cr. Rock	W. of Lakeport	Lake	6.6	6.1		1.5	13.0		100	2.84	104	Satisfactory for rock surfacing.
2111	Cr. Rock	Hopland Grade	Mendocino	7.1	5.6		0.8	15.6		100	2.62	119	Has given satisfactory service in rock surfacing.
2121	Cr. Rock	Rattle Snake Cr.	Mendocino	11.0	3.6		1.1	19.5		100	2.81	128	Has given satisfactory service in rock surfacing.
2124	Gravel	San Geronio	Riverside				0.7	18.5	23.6	55	2.73		May be used in concrete.
2125	Cr. Rock	Men-1-A	Mendocino	8.7	4.6		1.0	16.0		100	2.79	93	Has given satisfactory results in rock surfacing.
2126	Cr. Rock	Men-48-C	Mendocino	5.0	8.0		1.1	17.9		100	2.54	130	Satisfactory for rock surfacing.
2127	Cr. Rock	Men-48-C	Mendocino	14.7	2.7		3.2	36.0		100	2.43	73	Would wear rapidly in surfacing. No. 2126 should be used.
2128	Cr. Rock	Sutter Butte	Sutter	9.4	4.3		8.3	44.2	54.0	100	2.10	93	Little wearing value. Good binder for harder rock.
2130	Cr. Rock	Santa Cruz	Santa Cruz	2.5	16.0		0.8	7.4	12.1	100	2.82		Satisfactory for concrete or asph. conc.
2142	Cr. Rock	Yuma, Ariz.		3.4	12.0		0.7	22.9	21.1	100	2.65		Somewhat brittle—good abrasive test.
2144	Cr. Rock	Lemoine	Shasta	3.2	12.5		2.2	20.8	45.9	100	2.64	116	Good dry weather rock surfacing.
2165	Cr. Rock	Truckee	Nevada	2.1	19.0		1.8	20.9		100	2.66	33	Low cementing value. Probably very dusty in rock surfacing.
2166	Cr. Rock	Alta	Placer	5.9	6.8		2.7	23.3	27.0	100	2.30	90	Will make good summer surfacing. Will wear rapidly.
2167	Cr. Rock	Rte. 1 Sec. C	Del Norte	2.3	17.4		1.2	6.6	12.1	100	2.78	177	An ideal rock for highway construction.
2183	Cr. Rock	Ventura River	Ventura	2.2	18.2		1.2	18.7	22.6	100	2.60	74	Satisfactory for all purposes.

perhaps entirely satisfactory for water-bound base when protected by an oiled top. For lighter traffic on crushed rock roads, material map be used which shows much higher losses in rattler tests provided the cementing value is good.

In comparing the usefulness of such material, it must be borne in mind that the softer material will wear away much more rapidly and will, therefore, require frequent replacing. It is quite possible that the loss from wear, other conditions being equal, might be in direct proportion to the loss shown in the shot rattler test. In such cases, analysis of the situation from an economic standpoint would sometimes indicate the desirability of shipping material instead of using that locally available but of lower quality.

The wet tests are of importance in considering the material for this type of work. These tests give an indication as to the increased wear which may be expected in wet weather and sometimes suggest that the material might be slippery when wet.

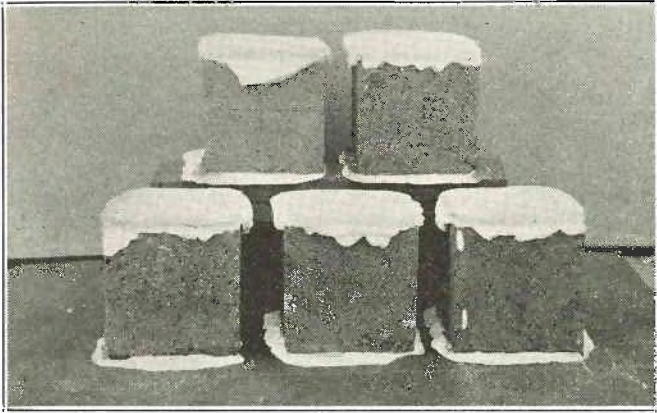


FIGURE 3—Cementing test specimens consist of 4½-inch cubes capped with plaster of paris. These specimens are ready for compression test.

CONCLUSION.

There are other tests which are of importance. In concrete, for example, it is very desirable, when the opportunity offers, to make up concrete with the same fine aggregate and cement, using the different coarse aggregate locally available. Compressive strength tests in these cases indicate in some measure the relative suitability of the coarse aggregates. Beam tests of concrete, similarly made, are also of value in indicating the effect of the different aggregates on flexural strength of the concrete.

Many millions of tons of crushed stone and screened gravel are used annually in road construction work. *If proper testing and inspection will result in any appreciable increase in service, the slight expense involved is certainly justifiable.* Fifty to a hundred dollars expended in rock tests may result in the selection of material which will give double the service of that which would otherwise have been used. Too frequently specifications use the general terms "hard, sound and durable" in a more or less meaningless way, and the selection of the stone to be used is left entirely to the contractor. He in turn chooses the source which is most economical from the production standpoint. The writer has seen cases in which the additional expenditure of 15 or 20 cents per cubic yard on material which was costing \$3 per cubic yard, in place, would have resulted in at least a 100 per cent increase in the quality of the rock. Such practice is not good engineering or sound from an economical standpoint.

Due credit is given to Mr. F. T. Maddocks, Testing Engineer, for his active part in the development of rock testing as now practiced in the laboratory of the California Highway Commission and to Mr. C. S. Pope, Construction Engineer, who has made many suggestions which have been of value and assistance.

WORKMEN FIND SKELETON.

A maintenance crew employed by Division VI on widening work on the Sequoia Park Lateral near Three Rivers, Tulare County, recently unearthed a human skeleton, which was found in a sitting position and in a splendid state of preservation.

It is of small frame and has been pronounced by Dr. D. D. Nice, Sequoia Park physician, to be that of a woman, probably an Indian. There were some small pointed bones, not human, believed to be Indian hair ornaments, according to Dr. Nice, and a string of shell beads hung about the neck.

"PLEASURE TO PAY GASOLINE TAX"

So thinks Los Angeles man after drive over reconstructed highway along San Diego coast.

TXPAYERS generally are not opposed to reasonable taxes when they have evidence that public funds are being expended economically and efficiently in the interest of the public good. This is true of taxes for state highways as well as other public enterprises. After a recent trip to San Diego over sections of reconstructed pavement, C. S. Phister, Los Angeles business man, wrote the Highway Commission declaring the work, when finished, will make the Coast highway the finest road in the land. When such results are obtained, it is a pleasure, Mr. Phister says, to pay the gasoline tax for highways.

His letter, which was wholly unsolicited, follows:

CHARLES S. PHISTER
WHOSALE COAL
LOS ANGELES, CALIFORNIA
1228 S. Berendo Street

March 25, 1926.

California Highway Commission,
P. O. Box 1103,
Sacramento, California.

Gentlemen:

I have just returned from a trip to San Diego, and I want to compliment the commission on the good work it has done and is doing on the state highway from Santa Ana to the San Diego city limits.

When that work is finished it is going to be the finest piece of road in the world. Not only the plain cement road, but the grades, curves, and everything pertaining to the work is good and pleasant to drive over.

I also noticed the wire guards at dangerous curves, and other places needing protection. They are much better than the ordinary fence. I noticed in two or three places, where some of the wild drivers had run into them, that they do not break down like the board fence; wire mesh bends but holds.

The contractor working on the piece of road between San Juan Capistrano and Oceanside keeps the detour in good shape, making it more pleasant for the driver than is usual on detours. Where the driver is forced to go off the concrete, this contractor keeps the holes filled up smooth and even so there is very little roughness to go over. He is to be congratulated on his work.

If the city of San Diego can now only be induced to build new approaches to Torrey Pines, both on the north and south ends, the highway from Los Angeles to San Diego is going to be the finest in the land, and one that will be a pleasure to drive over.

With such a road as the result of your work, it is a pleasure to pay the gasoline tax.

Very truly yours,

(Signed) C. S. PHISTER.

1926 ESSAY CONTEST.

May 8th has been fixed as the closing date for the 1926 essay contest conducted by the Highway Education Board for the H. S. Firestone University Scholarship. The subject this year is: "The Relation of Improved Highways to Education." It is open to all students of high school grade throughout the United States and its territories.

MOUNTAINEERS TO BE GIVEN BATH.

"Please issue a purchase order for water to be used during the sprinkling season on the following parties:

Mr. F. -----, M. -----, Ione, Cal.
Mr. J. -----, H. -----, Pine Grove, Cal."

—Excerpt from recent field requisition received by Division X.

WHAT THE DIVISIONS ARE DOING

DIVISION I.

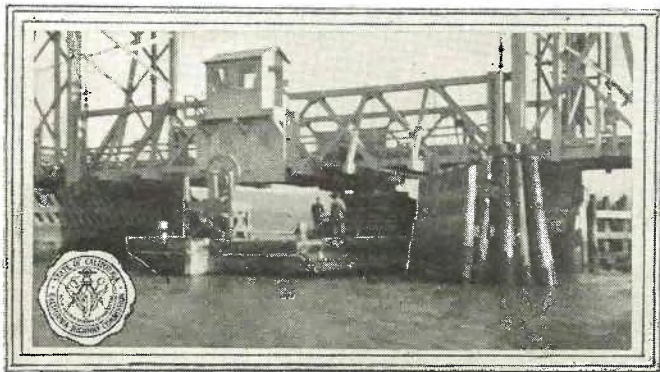
HEADQUARTERS, WILLITS.

T. A. BEDFORD, DIVISION ENGINEER.

Counties of Del Norte, Humboldt, Mendocino, and Lake.

THE 80-foot vertical lift span timber truss bridge over Eureka Slough, at the city limits of Eureka, became unsafe for traffic, when the lower chord of one truss parted, thrusting the end posts against the towers at each end. To permit light traffic, and be able to raise the span for boats to pass thereunder, it was necessary to make quick emergency repairs. The tides were harnessed to assist with the work.

A barge was floated under the truss on a rising tide, anchored in position and cribbing built up on the deck to the truss. A wedge



Scow floated in on tide supports Eureka Slough bridge, Division I, while repairs are being made.

was placed between the truss and the cribbing and as the tide raised the truss from its seat, the wedge was driven out to hold the truss at the correct elevation, while house jacks were used on the ends of the broken lower chord to force the ruptured member together at the break until splice plates were fitted in position.

The work was completed on the one tide and traffic up to five tons permitted to use the bridge immediately. Additional strengthening of the truss is being accomplished.

DIVISION III.

HEADQUARTERS, SACRAMENTO.

F. W. HASELWOOD, DIVISION ENGINEER.

Counties of Butte, Colusa, El Dorado, Glenn, Nevada, Placer, southern Plumas, Sierra, Sutter, Yuba, and northern Sacramento and Yolo.

COMPLETION of the grading through the famous Truckee canyon, one of the most spectacular projects ever attempted in Division III, is now nearing completion. Within two or three weeks after this Bulletin is off the press, the Nevada Contracting Company will have completed the work between Floriston and the Nevada line. Between Truckee and Floriston, the work already is finished.

Survey work on this major project was begun in March, 1923, on the 19 miles from Truckee to the state line. The first grading contract was awarded early in 1924 and work has been under way continuously ever since. Citizens of many sections of the state are planning to join with the commission in celebrating the opening of the highway.

Work on New Roads Taken Over.

Maintenance of the roads taken over on January 1st is now well organized. A high standard has been set and the men in charge are taking an active interest in furthering improvements. Wherever possible with the money available, narrow points are being

widened, and drainage and alignment improved, in addition to a well maintained surface.

Rock surfacing under specific authority is proposed for 5 miles east of Marysville, on the Tahoe-Ukiah route; for 5 miles west of Grass Valley on the same route; for 5½ miles, Auburn to Cool, on the Mother Lode highway.

The supervisors of Nevada County have agreed to donate \$5,000 per year for five years for use by the commission in improving the Tahoe-Ukiah route from Nevada City to Emigrant Gap. Negotiations also have been completed for the cooperation of Yuba County in rock surfacing a portion of the same route, east of Marysville.

Lake Tahoe Work.

Preparations have been completed for the work proposed at Lake Tahoe this season. Clearing has been under way most of the winter. Removing of stumps will start immediately to be followed by grading and surfacing. About \$60,000 of maintenance funds have been allotted for work by state forces.

Plans are in progress for placing a limited amount of rock surfacing on the Donner Lake-Truckee section.

An improvement will be undertaken at once to reduce the hazard at Rattlesnake Creek, south of Grass Valley. Due to sharp curvature and maximum grades at a point sheltered from the sun, and always wet in winter, many accidents have occurred. The sum of \$4,000 has been allotted for the work.

On the Mother Lode highway \$4,000 will be expended for improving a 1.3 mile section at the notorious Log Town grade.

Plans are in progress for spreading light oil as a dust preventive on about 100 miles of road in Division III during the summer.

The division has installed 41 Redflex signals at danger points this year. During the latter part of 1925, foreman Vance constructed and placed overhead caution signs at the approaches to the Ben Ali crossing of the Southern Pacific railroad near Sacramento.

Tree Planting and Care.

Division III this spring purchased 1400 trees of several varieties from the state nursery for replacement work. Eighty miles of the 92 miles of trees in Division III are on the east side of the Sacramento Valley. Care and maintenance of trees has been placed in charge of a single tree crew under Foreman F. A. Smith. This specialization has proved an economy over the old plan under which the various foremen cared for the trees on their several sections.

The division program for cutting grass and weeds on the right of way, while not as extensive as last year, provides for cutting grass and weeds and burning when justified.

Signs showing the name and address of maintenance foremen are being placed at section boundary points throughout the division.

To reduce inconvenience and danger to traffic due to moving of droves of cattle along the highway, "Stock trail signs" are being placed wherever possible.

DIVISION VII.

HEADQUARTERS, LOS ANGELES.

S. V. CORTELYOU, DIVISION ENGINEER.

Counties of Los Angeles, Ventura, Orange, San Diego, and eastern Kern, south of Mojave.

TWO ROCK slides, aggregating about 15,000 cubic yards, recently occurred on the Coast highway in Ventura County, southerly from Oxnard, adding to the already large quantity of slide material which has come down onto the highway during the past three months. The removal of this material is being carried on by a special maintenance crew equipped with a gasoline power shovel. This crew is also engaged in quarrying and placing heavy riprap rock to protect the highway embankment from ocean waves.

Work is in progress along the paved highway northwesterly from Santa Monica where a maintenance crew is replacing highway embankment washed out during recent storms. Heavy riprap rock is being placed to protect the highway from wave action. This crew is equipped with a power shovel and a fleet of trucks.

which are provided with hydraulic hoists for loading and unloading the heavy rock.

Coast Highway Paving Progresses.

Along the new Coast highway in Orange County, between Newport Beach and Laguna, the laying of concrete pavement was recently started at Corona Del Mar and will be extended to Newport Beach. From Corona Del Mar southerly to Laguna, the rock base for an asphalt macadam pavement has been completed and is awaiting a dry season for the application of asphaltic oil.

On the Jahn and Bressi reconstruction contract in San Diego County the "second story" concrete pavement has been completed from the Las Flores underpass crossing to the north end of the contract near San Onofre. The gasoline tax is providing funds for this work.

From Camarillo to Springville, Ventura County, the old fifteen-foot concrete pavement has been thickened and widened to twenty feet. The mixer has been moved to the Ventura city limits and concrete for the double decking is now being poured in an easterly direction. As a part of this contract a grade change is being made in the vicinity of Beetox, where the grade line will be raised from two to three and a half feet for a distance of several thousand feet, with drainage structures to prevent flood water crossing the highway. This is also a gasoline tax job.

Causeways are Being Removed.

North of Ventura, a maintenance crew under special allotment has commenced work on the removal of the "Long Causeway" from behind the recently completed Rincon concrete seawall. Traffic, which now uses the timber causeway, will be carried on the sand fill back of the seawall, which will be surfaced with quarry waste rock.

DIVISION VIII.

HEADQUARTERS, SAN BERNARDINO.

E. Q. SULLIVAN, DIVISION ENGINEER.

Counties of San Bernardino, Riverside, and Imperial.

THE RECONSTRUCTION contract for the widening of the state highway between Edom and Indio, Riverside County, has been completed. The existing highway has been widened to 20 feet by the addition of cement concrete shoulders on either side of the existing pavement. The improvement has greatly increased the safety of a section of the highway, where, in the past, many accidents have occurred as a result of soft sand shoulders.

Bids are now being asked for additional widening work between Edom and Whitewater, where the existing sixteen-foot highway will be widened to 20 feet by the addition of a single four-foot cement concrete shoulder.

Grading Nearing Completion.

Grading work between Victorville and Daggett on the National Old Trails is about completed and placing of surfacing, now ready to start, will complete a splendid highway.

Considerable maintenance work is under way on the Waterman Canyon road, where alignment is being improved at points and the highway widened at various places.

The equipment department has completed the painting of all the motor vehicles in use by Division VIII, using French gray, the official highway department color.

DIVISION IX.

HEADQUARTERS, BISHOP.

F. G. SOMNER, DIVISION ENGINEER.

Counties of Inyo, Mono, and eastern Kern County, north of Mojave.

A VISIT to the Division "East of the High Sierra" recently by Governor Friend Wm. Richardson was welcomed by citizens of Owens Valley. The Governor was accompanied by his son John, Commissioner N. T. Edwards, Secretary W. F. Mixon and State Highway Engineer R. M. Morton. The inspection trip covered all of the state roads in Division IX as far north as snow conditions would permit, together with the new highway in Kern County along the Kern River via Walker Pass.

At a public meeting in Bishop, at which the Governor was the guest of honor, local speakers commended the commission for recognition of the Mojave-Bridgeport highway as an important traffic artery of the state.

Maintenance forces are now covering all county roads taken over by the commission on January 1, 1926. Following up of the melting snow in Mono County on either side of the Deadman divide will soon be in progress.

The grading contract of Harry Wilson, covering 36.7 miles, Ricardo to Five-Mile Canyon, in Kern County, is completed. Funds have been authorized and preparations are being made for surfacing of this section at an early date.

DIVISION X.

HEADQUARTERS, SACRAMENTO.

R. E. PIERCE, ACTING DIVISION ENGINEER.

Counties of Amador, Calaveras, Alpine, Tuolumne, Stanislaus, San Joaquin, Solano, and southern Sacramento and Yolo counties.

BY THE time this Bulletin is off the press more than half the fill for the new approach to the M street bridge, at the western entrance to Sacramento, will be in place. The H. V. Tucker Company, contractors, are now making rapid progress. The method by which the work is being done is novel in highway grading operations. A floating dredge with a six-yard bucket deposits sand from the Sacramento River on the west levee from which it is sluiced into place by means of a wooden flume. C. W. Springer, assistant resident engineer, is in charge for the state.

Mother Lode Work Commended.

Local residents using the Mother Lode highway between Plymouth and Sonora are commending the commission for the results accomplished by maintenance forces of the division, under the new plan of state maintenance of traversable county roads on state highway routes.

Lumber has been ordered for the reconstruction of the Big Bar bridge on the Mother Lode highway between Jackson and San Andreas. Foreman H. S. Clark will have charge of the work.

A field party has been assigned to the Mother Lode highway for a survey of that section between Drytown and the northerly boundary of Amador County.

The Reason.

What makes us hate the guys who speed,
And cuss 'em and sass 'em?
It's this, I think: We loathe the breed
Because we can not pass 'em.

Time for All Things.

"Hi, gimme a handful of waste!" I howled.
(I was under the auto to grease it.)
But Jim had an armful of waist in the car,
And wasn't disposed to release it.

On!

Are you tired—work on!
Are you slipping—hang on!
Are you standing—move on!
Are you discouraged—hope on!
And, above all—live on!

—Maine Motorist.

"KILLED IN THE PERFORMANCE OF HIS DUTY."

IT IS probable the general public does not consider keeping the highways open to traffic a particularly dangerous undertaking. Maintenance men, nevertheless, are constantly risking danger to serve the traveling public.

During a recent storm Frank E. Rais, 30, employed by Division II on the Trinity lateral, was killed by a falling tree, uprooted by a terrific wind. Rais and Foreman Charles Cuff were engaged in an inspection and repair of storm damage in the vicinity of Lewiston, when the accident occurred. The tree crashed through the top of their car without warning.

The deceased workman leaves a widow and a little daughter, also a father and mother who live at Douglas City, Trinity County.

Foreman Cuff's injuries did not prove serious but he suffered considerably from shock. The storm is reported by Division Engineer H. S. Comly to have been the worst in years.

WALLACE SUCCEEDS WOODSON AS ACTING HEAD OF DIVISION VI

ON APRIL 1st, E. E. Wallace, of Division V, became acting division engineer of Division VI, headquarters Fresno, succeeding J. B. Woodson, resigned. The appointment was announced by State Highway Engineer R. M. Morton too late for publication in last month's bulletin.



E. E. WALLACE.

Mr. Wallace, who has been assistant division engineer under L. H. Gibson, is another of the "old timers" on the engineering staff of the commission. His first service was in 1913, when he joined the forces of Division V as draftsman. Later he became chief draftsman of the division, and six and a half years ago was promoted to the position of assistant division engineer which he has held ever since.

During his long service in the latter position he has had extensive experience with both construction and maintenance work on the Coast highway.

Tilton Succeeds Wallace.

George A. Tilton, Jr., who has been with Division V for the last eight years as chief of party and resident engineer, will succeed Mr. Wallace as assistant division engineer. He will have charge, Mr. Gibson announces, particularly of the maintenance work of the division.

SOUTHERN DETOURS LAUDED

THE TIME was when motorists were left to themselves to find a way around construction work as best they could, but highway construction has long since passed that stage. Today, the commission recognizes its duty toward the traveling public demands that detours be provided and kept in travelable condition. The department must operate as well as construct highways.

The following letter comments favorably upon traffic conditions maintained by Division VII in connection with widening and thickening of the Coast highway in San Diego County:

AUTOMOBILE CLUB OF SOUTHERN CALIFORNIA.

137 Broadway.

San Diego, California.

April 8, 1926.

Mr. Spencer V. Cortelyou,
1111 Sun Finance Building,
Los Angeles, California.

Dear Mr. Cortelyou:

Very sorry that I missed you, having found your card in the door this morning when we opened.

It was quite evident to me, however, that you were on the job for the reason that the construction work in northern San Diego County, which practically everybody felt would hinder automobile travel, was so nicely handled that we have heard nothing but compliments and automobile travel has not been hampered nor checked in any way.

Assuring you that we of San Diego County appreciate this very much, and trusting I will have the pleasure of seeing you the next time you are here or when I happen to be in Los Angeles, I am with kindest personal regards,

Very sincerely yours,

(Signed) HAL H. HOBSON,
Representative.

HHH:GC

HIGHWAY NEWS NOTES

THE CLUBHOUSE in William Land Park was the scene recently of a farewell party at which employees of Division X were hosts to Mr. and Mrs. J. C. McLeod, the affair being given in honor of Mr. McLeod, who has resigned as division engineer. During an intermission in the evening's program, Mr. McLeod was presented with a gold watch as a token of the esteem in which he is held by his former associates of the division. Mrs. McLeod was presented with a candelabra.

Nearly forty employees of Division X with their families and friends were present to bid their former chief goodbye. Mr. McLeod is now a member of the firm of Force, Currihan and McLeod, engineers and contractors. Among those present were employees of the division from Sacramento, Stockton, Modesto, Pine Grove, Fairfield and Ione.

W. D. Cook to Take Bride.

Miss Clareene Kimball, stenographer in the offices of Division VIII, has announced her engagement to Mr. Willis D. Cook, superintendent of shop VIII of the equipment department, located in San Bernardino. The wedding will take place in the near future.

The marriage of Miss Edan Meyer, stenographer of Division VIII, to Mr. James Palmer, San Bernardino business man, has been announced.

Highway Clerk Becomes Postmaster.

C. C. Darrow, chief clerk in Division I, headquarters, Willits, has resigned to accept appointment as postmaster at Willits. He has been succeeded by F. L. Meyer.

New Foremen Named.

Division III announces the appointment of the following new maintenance foremen:

Wesley Cooper, at Meyers; W. F. Pomeroy, at Tahoe City; Harry Ingraham, at Grass Valley and Ray McCauley at Nevada City, to work under Superintendent Dan Breuning; John Walters, at Coloma under Superintendent H. L. Montfort; Ray Crocker, at Lotus under Superintendent W. H. Miller.

R. K. Forrest, in charge of maintenance work from Auburn to the Nevada line, has resigned.

Miss Ida D. Dawson, for a long period an employee of the Equipment Department at the Sacramento office, was married recently to Rev. S. M. Reiste. They will make their home in Iowa.

"Another Nash."

A. M. Nash, chief draftsman with Division X, proudly announces Ann Elizabeth Nash, who weighed 9 pounds 2 ounces upon her arrival, April 5th.

T. M. Joyce, formerly foreman at Sonora, Division X, under S. E. Harris, has been placed in charge of maintenance work on the Mother Lode highway between Angeles Camp and Sonora and on the Sonora Pass route from the westerly boundary of Tuolumne County to a point eight miles east of Sonora.

H. S. Clark, formerly subforman at Stockton, has been promoted to the position of foreman to succeed J. W. Bertram, who has been transferred to Division III with headquarters at Auburn.

HAVE YOU ANY BACK COPIES OF THE BULLETIN?

BECAUSE of the limited editions printed and the heavy demand for early copies of CALIFORNIA HIGHWAYS, headquarters is in need of copies of the January, February, March, April, May and June issues of 1924 to complete files.

If any of our readers have copies of these issues which they do not want, we would be glad to have them and will repay postage necessary to send them to Sacramento. Address, California Highway Commission, P. O. Box 1103, Sacramento, Cal.

COMMENDATION FOR WORK OF VENTURA MAINTENANCE FOREMAN

THE PERIOD of recent storm was a trying time for maintenance crews, particularly the men caring for highways in the southern counties. How well the responsibility for keeping traffic moving was met by a maintenance foreman of Division VII, the following letter will evidence:

THE SAMUEL EDWARDS ASSOCIATES.

(A Corporation.)
Santa Paula, California.

April 15, 1926.

Mr. W. F. Mixon, Secretary,
California Highway Commission,
Sacramento, California.

Dear Sir:

No doubt you frequently have letters commenting on the work under your commission.

In this case I want particularly to send you one of commendation of the activities of your maintenance foreman for Ventura County, Mr. L. B. Prosper. It was my fortune or misfortune to have to travel the Rincon road during the day of the storm last week, and I know from long experience in travelling that particular stretch of the highway, that those on the road that day experienced one of the most trying times that I recall. Traffic was kept going through the good judgment of Mr. Prosper in directing the work.

I send this along purely because I think it is only proper that instances of this kind should be called to your attention when they are a little out of the ordinary.

Very truly yours,

(Signed) ROGER W. EDWARDS.

ACTING ENGINEERS PROMOTED

IN ADDITION to changes in Divisions V and VI, other promotions in the state highway organization announced recently by State Highway Engineer R. M. Morton are as follows:

F. W. HASELWOOD, Division III, headquarters, Sacramento, from acting division engineer to be Division Engineer.

E. Q. SULLIVAN, Division VIII, headquarters, San Bernardino, from acting division engineer to be Division Engineer.

Long Service for State.

Division Engineer Haselwood first entered the service of the state highway department on January 1, 1912 as chief of party in Division I, the Redwood Highway division. Later he was with the bridge department, and in 1924 was named acting division engineer in Division III.

Mr. Sullivan began his career with the department in 1914 as assistant resident engineer in Division II, where he worked on the Pacific Highway and lateral roads. He has been in charge of state highway work in the counties of San Bernardino, Riverside and Imperial since the creation of Division VIII in 1923.

DOUGLAS MEMORIAL BRIDGE TO BE DEDICATED MAY 17th

AS DIRECTED by the terms of the legislative act making an appropriation for its construction, the California Highway Commission is preparing appropriate exercises for the dedication of the great Klamath River bridge, in Del Norte County to the memory of Dr. G. H. Douglas, former Assemblyman from the first district. The date has been definitely set for Monday, May 17th.

Governor Walter M. Pierce of Oregon has accepted the

FLOWERS THAT BLOOM IN THE SPRING

Uncontrollable longings to be on the move

The warm April breezes now bring;
The downtrodden draftsman does longingly think
Of the flowers that bloom in the Spring.

He envies the fieldmen, who blithely and gay
Punch their stakes as they happily sing,
And he pines to pick bouquets and ramble around
Midst the flowers that bloom in the Spring.

The maintenance man gets out graders and rakes
Tractors, shovels, all tools—everything!
And he scrapes from the shoulder and clears from the ditch
The flowers that bloom in the Spring.

The surface he smooths and the ruts he fills up
For he knows that warm weather will bring
The Stars and the Fords and their owners to pick
All the flowers that bloom in the Spring.

And when they've departed he comes with a truck
Behind which a trailer does swing
And gathers the litter they've left in exchange
For the flowers that bloom in the Spring.

At headquarters, too, the fever is felt
From the itch they are all suffering,
On the slimmest excuse they depart to enjoy
The flowers that bloom in the Spring.

The departmental chairs are vacant for weeks
The desks piled with letters that bring
From divisions requests, that have nothing to do
With the flowers that bloom in the Spring.

The "D. E." keeps wond'ring why he doesn't hear;
Why the mail doesn't bring anything
To settle the matter and let him commune,
With the flowers that bloom in the Spring.

C. S. P., G. R. W., and T. E. S., too,
Never pass up a chance for a fling
Or a chance for a look—it's a strenuous trip!—
At the flowers that bloom in the Spring.

But they're not alone, all the others, as well,
At their desk, wait the telephone's ring
With the hope they'll be called on a far distant trip
Through the flowers that bloom in the Spring.

R. M. M., of them all, seems immune to the spell,
Undisturbed by the Spring's whispering;
But he takes it all out on his garden at home,
Raising flowers that bloom in the Spring.

You impatiently ask, what this all has to do
With State Highways? I say—"Everything!"
We need to be roused from our long winter nap
By the flowers that bloom in the Spring.

We need inspiration and pep in our work,
To our minds new ideas it will bring
To better our roads, so the folks can enjoy
The flowers that bloom in the Spring.

But lest we disturb by this blather and blurb
The scribe will cease further to sing
As the words outward surge, there's relief from the urge
Caused by flowers that bloom in the Spring.

F. J. GRUMM.

invitation of Governor Richardson to join him in taking part in the dedication. Other officials and organizations which will join with the California Commission in the dedicatory ceremonies are:

Oregon Highway Commission, Boards of Supervisors of Del Norte and Humboldt counties; Chambers of Commerce of Crescent City and Eureka; Redwood Highway Association; Save the Redwoods League; The Cave Men of Grants Pass; and the California Press Association.

The Bulletin, in the May issue, will publish details of the program and will reproduce the latest photographs of the bridge, which is the largest and most beautiful on the state highway system.

STATE HIGHWAY FUND CONTRACTS (Bond Funds, Including Federal Aid)

Cont. No.	Di- vision	County	Route	Sec.	Location	Miles	Type	Contractor	Estimated cost	Date contract awarded	Con- tract time, days
480	X	Yolo	6	C	COMPLETED AND ACCEPTED SINCE MARCH 17, 1926. At Washington.....		Underpass S. N. R. R. crossing.....	Lord and Bishop.....	\$25,064 55	Sept. 3, 1925	
496	V	San Luis Obispo	2	F	AWARDED SINCE MARCH 17, 1926. Across the Santa Maria River 2 miles N. of Santa Maria. Sub-total.....		Reinforced Concrete Girder Bridge.....	Roecca and Caletti.....	\$126,832 05	April 5, 1926	200
					PENDING AWARD—None. Total State Highway Fund Contracts Awarded and Pending Award.....				\$126,832 05		

NOTE.—Primary construction covered by the above contracts does not include funds obligated on cooperative forest highway projects, prison camp road activities, or day labor jobs not being done under contract.

STATE HIGHWAY MAINTENANCE FUND CONTRACTS (Including Gasoline Tax Fund)

Cont. No.	Di- vision	County	Route	Sec.	Location	Miles	Type	Contractor	Estimated cost	Date contract awarded	Con- tract time, days
M-57	II	Shasta	3	C	COMPLETED AND ACCEPTED SINCE MARCH 17, 1926. Halfway Creek to Dog Creek.....	10.84	Grading and Rock Surfacing.....	Nevada Contracting Co.....	\$454,628 25	Jan. 3, 1925	
M-96	VIII	Riverside	26	E	Edom to Indio.....	11.43	P. C. C. Pavement widening.....	Basch Bros. Co.....	117,943 54	July 29, 1925	
M-115	VII	Los Angeles	2	B	At Chalk Hill.....	0.70	Grading and Bit. Mac. Pavement.....	H. A. McCray.....	\$50,603 02	April 5, 1926	100
M-116	VII	Los Angeles	2	D	Across the Rio Hondo near Los Angeles.....		Widen existing steel bridges.....	Groffman Bros.....	\$6,543 81	April 5, 1926	125
M-117	IV	Contra Costa	14	A	Across San Pablo Creek at San Pablo.....		Reinf. Concrete Girder Bridge.....	R. B. McDaniel.....	\$23,231 00	April 23, 1926	100
M-118	II	Shasta	3	C	Between Dog Creek and Lamone.....	4.5	Grading and Rock Surfacing.....	George Pollock Co.....	\$66,073 00	April 23, 1926	200
M-119	X	Stanislaus	4	B	Between Modesto and the Stanislaus River.....	7.8	P. C. C. Widening and A. C. Surfacing.....	Valley Paving & Const. Co.....	\$83,916 00	April 23, 1926	150
M-120	VI	Madera	4	A	Between Bordien and Madera.....	2.19	P. C. C. Pavement Widening.....	Hansen Co.....	20,185 00	April 23, 1926	90
M-121	IV	Sonoma	8	B	Between Vineburg Junction and East County line.....	1.0	Grading and Bit. Macadam Surface.....	W. H. Hauser.....	11,742 00	April 23, 1926	50
					Sub-total.....	16.19			\$692,896 73		
					PENDING AWARD—None. Total State Highway Maintenance Fund Contracts Awarded and Pending Award.....	16.19			\$692,896 73		

NOTE.—The above obligations charged against the State Highway Maintenance Funds do not include funds from these sources obligated for general maintenance and for specific betterments being done under day labor authorization.

CALIFORNIA STATE PRINTING OFFICE:
JOHN E. KING, State Printer
SACRAMENTO, 1926