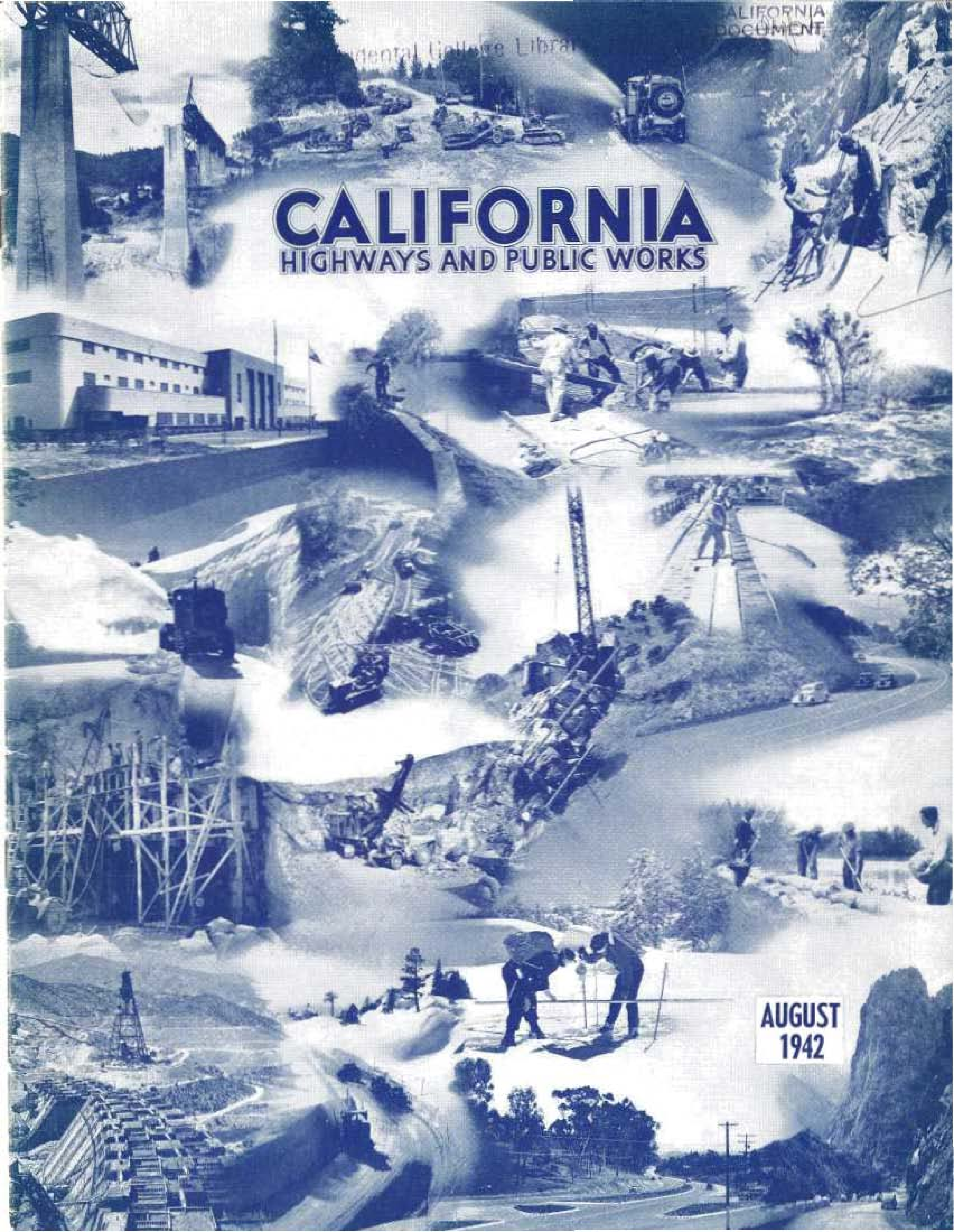
CALIFORNIA
HIGHWAYS AND PUBLIC WORKS



AUGUST
1942

CALIFORNIA HIGHWAYS AND PUBLIC WORKS

Official Journal of the Division of Highways, Department of Public Works, State of California

FRANK W. CLARK, Director | C. H. PURCELL, State Highway Engineer | J. W. HOWE, Editor | K. C. ADAMS, Associate Editor

Published for information of department members and citizens of California. Editors of newspapers and others are privileged to use matter contained herein. Cuts will be gladly loaned upon request. Address communications to California Highways and Public Works, P. O. Box 1499, Sacramento, California

Vol. 20 AUGUST, 1942 No. 8

Table of Contents

Defense Highway Program in California Reached Total of $52,880,000 August 1, 1942

By C. H. PURCELL, State Highway Engineer

ACTIVE preparation by the Division of Highways for defense highway construction in California began in the Summer of 1940. On the basis of the strategic network of highways designated by the War Department as of military importance and of roads requested by the Army, Navy and Marine Corps for access to military and naval cantonments, fields, bases and stations, work on preliminary surveys and plans was started nearly two years ago.

Acting under authority of amended Federal aid regulations, the State financed the preliminary engineering on access road projects and certain proposed improvements to the strategic network with Federal aid secondary and Federal aid funds. Under this procedure the Division of Highways was enabled to prepare programs for defense highway construction.

$45,000,000 PROGRAM

By the time the United States entered the war, the designated access road program included projects to the total value of nearly $45,000,000. Funds for the construction of access road projects were authorized under the National Defense Highway Act of 1941, approved on November 19, 1941. The total sum of $150,000,000 was provided by this act for access road construction throughout the Nation.

On February 1st of this year, plans and specifications had been completed on nearly $25,000,000 in access road projects in California and the Division of Highways was prepared to begin calling for bids on the program as soon as Federal certification for construction of individual projects was received.

The first certification for construction of an access road project was received late in January and bids were opened for this first certified project on February 18th. Since that time, work in getting construction under way has steadily progressed. During the same period, needed improvements to the Strategic Network have been advancing.

Report on Defense Highway Program Under Gov. Olson

Governor Culbert L. Olson has received a report from Director of Public Works, Frank W. Clark, covering defense construction by the Division of Highways, of the Department of Public Works, under Governor Olson's administration.

The report, made by State Highway Engineer, Charles H. Purcell, states that the defense highway program throughout California reached a total of $52,880,000 on August 1, 1942.

This figure, the report states represents work placed under construction, projects advertised for bids, pending advertisement and wholly or partially prepared. This amount includes work in connection with access road construction in the sum of $43,146,600; strategic highway network improvements to the value of $7,576,400 and $2,157,000 for the building of emergency flight strips adjacent to highways.

The complete report giving many interesting details is printed herewith.

ACHIEVEMENT TOTALS $52,880,000

On August 1st, the total accomplishments by the Division of Highways in the defense program are represented by the amount of $52,880,000 in work placed under construction, projects advertised for bids, pending advertisement and wholly or partially prepared. This amount includes work in connection with access road construction in the sum of $43,146,600; strategic highway network improvements to the value of $7,576,400; and $2,157,000 for the building of emergency flight strips adjacent to highways.

While the surveys, plans and specifications for these projects were prepared in advance of the receipt of certification by the War Production Board and approval by the Public Roads Administration, getting the work under way has not been simply a matter of advertising for and opening bids.

Many of the projects, particularly structures, were originally planned under standard designs before scarcity in certain materials became too critical and the status of highway construction in the priority set-up was definitely determined. As the situation clarified and it became apparent that such construction materials as bar reinforcing steel, structural steel, and metal pipe were unobtainable even with relative high priority ratings, changes in the design of structures included in some projects became necessary.

Timber has replaced reinforced concrete and steel girders for bridge construction; mass concrete piers and abutments are used in lieu of reinforced concrete; metal pipe culverts are out entirely, with unreinforced concrete arch culvert sections, wooden boxes and unreinforced concrete pipe taking their place. These required changes have necessitated the best efforts of the Division of Highways engineering staff in pushing the work along so that the revision in design would not result in delaying construction.

With the limitations placed upon normal highway construction activities through Federal control of materials by priority preference requirements, construction operations on the

(Continued on page 11)

New surfaced road through Warthan Canyon swings high above creek bed avoiding a dangerous crossing of ravaging stream

"Sea Going Bridges" No Longer Needed On Realigned Warthan Canyon Highway

By R. S. BADGER, District Construction Engineer

Realignment by-passes this washout of culvert and bridge

STATE Sign Route 198 starts at San Lucas on U. S. Route 101 and winds through the Coast Range to Coalinga and its oilfields, en route across the San Joaquin Valley through Hanford, Visalia, Lemon Cove and Three Rivers to Sequoia National Park. The portion of this route lying between the Fresno-Monterey County Line and Coalinga, includes a sinuous road following Warthan Canyon.

There have been discussions as to the correct name of this creek. Many call it "Wartham" and the U. S. Geological map incorrectly used "Waltham." However, historians have proved beyond doubt that the name should be "Warthan."

The greater portion of the road through this canyon was taken over by the State from Fresno County and has not been built to modern standards. Here Nature has evidenced almost a contemptuous attitude toward man's puny efforts to protect his holdings through the canyon. An outstanding example of this is her treatment of highway bridges and other stream crossings. Through the years man's carefully placed pipe culverts or wooden bridges have been blocked, washed out or floated away. In fact this "floating away" was so frequent that the State's maintenance forces had attached cables to the bridges, anchoring them to trees in order that the decks might be saved when the bridges washed off of their abutments. Mr. T. H. Dennis, State Maintenance Engineer, aptly termed them "The Sea Going Bridges."

It has long been the dream of the people, who depend on this road for frequent passage through the canyon, that some solution would be found for this distressful condition, which was an annual, if not more frequent occurrence in periods of heavy storms. One might say the solution is still well out of sight, as extensive construction is necessary before the whole road can be relocated along lines which conform to comfortable modern standards.

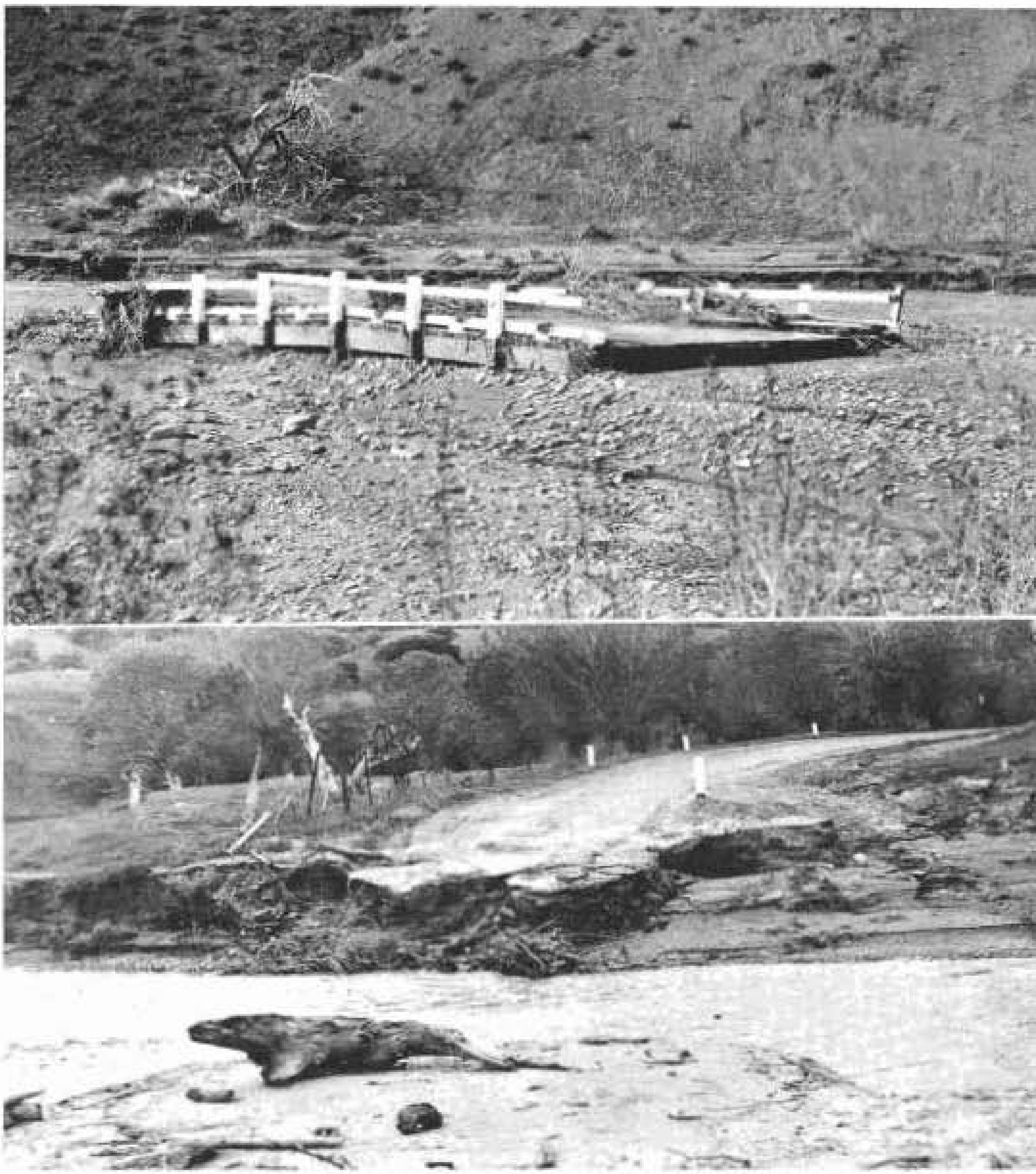
However, one short section has now been relocated and snatched from the threatening grasp of the stream. This section, beginning at a point some quarter mile west of Parkfield Junction, extends easterly about 1¾ miles. In this short distance it eliminates six former crossings of Warthan Creek and incidentally has greatly improved the alignment.

Culvert headwalls and drop inlets were constructed of a moderately hard sandstone, found on the job and which was the most suitable material within many miles.

Practically all of the grading was done with bulldozers, scrapers and scarifiers.

A "stage construction," necessitated by lack of sufficient funds to construct a higher type surfacing, still provides a roadbed width of 26 feet and a 5 inch surfacing of local gravels, oil-mixed with SC-3 to a depth of 2 inches.

The pictures accompanying this article indicate some of the past difficulties in maintaining stream crossings and show the new road, well removed and protected from damage by Warthan Creek.



Above—"Sea-going" bridge anchored by cable. Below—Typical road washout

The improvement is highly appreciated by the local residents and others who use this route frequently.

Harms Brothers were the contractors and Richard Windele was resident engineer.

Necessity Auto Use Totals 274 Billion Passenger Miles

A recent survey revealed that, in an average year, the Nation's automobiles run up a total of 498,000,000,000 passenger miles. Of this, more than 50 per cent is for purposes classified as "necessity" driving. This means that there is a total of about 274,000,000,000 passenger miles of necessity automobile use that can not be eliminated without seriously disrupting the entire transportation picture.

For example, workers in many defense plants throughout the Nation are largely dependent on passenger cars for getting back and forth to work. Approximately 2,320 cities with a total population of more than 12,500,000 are without local mass transportation systems and are, therefore, completely dependent on automobile transportation.

There are more than 45,000 communities with no railroad transportation and six States with no street cars. There are 18,000,000 people who work in the city but live in rural areas and most of them must travel by automobile to get to their work.

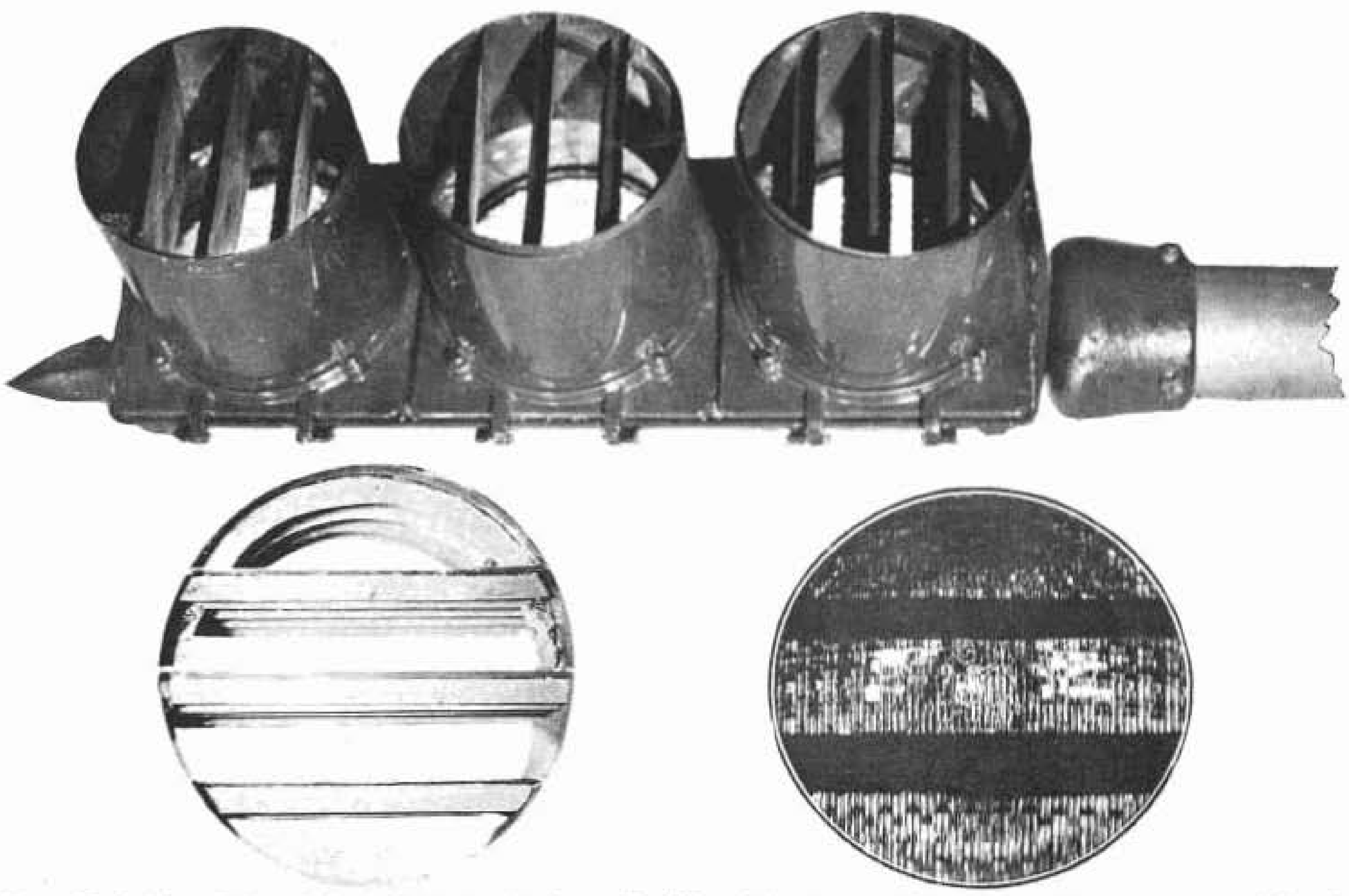
Highways Division Designs New Traffic Signal Blackout Unit

By A. E. SIMMONS, Assistant Highway Engineer

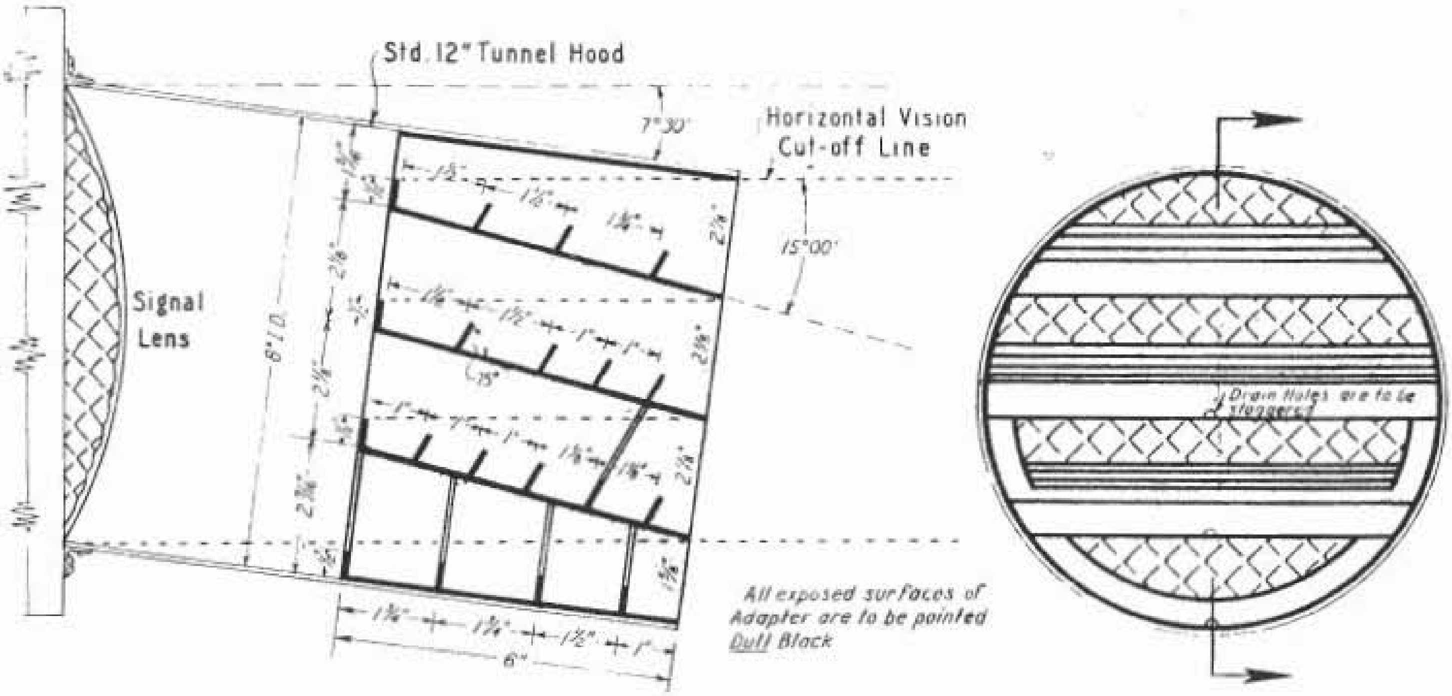
SINCE the first blackout was ordered there has been an urgent demand for a satisfactory method of controlling traffic signal lights so that the light from the signals could not assist enemy airmen to find their targets. Such a device has now been developed by the Division of Highways of the Department of Public Works and ordered installed on all State Highway signals.

A number of methods had been tried, but none had proved completely satisfactory. In London, for instance, the signal lenses were painted black with the exception of a small cross $\frac{1}{8}$ inch x $1\frac{1}{2}$ inches. At night this cross gave sufficient indication to traffic and satisfied blackout regulation, but during the daytime the small cross of light was not visible to the motorist, and consequently was a definite traffic hazard. Los Angeles, in trying to overcome the daytime faults of the London Cross, enlarged the cross dimensions to $\frac{7}{16}$ inch x 5 inches. While this enabled the cross to be seen in the daytime, at night there was so much light coming from the signals that blackout requirements were not satisfied.

At the warning for a blackout, some communities detailed a man to each signalized intersection to turn off the signals. While this method was effective from the standpoint of blackout control, it required the use of men who would be needed for other duties in case of an actual air raid. Then, too, it was desirable to retain some form of traffic control for the emergency vehicles that would be traveling without headlights during the blackout. With the traffic lights turned out there was no traffic regulation at all during the blackout, and in certain instances a great deal of



Upper—Typical installation of signal blackout unit. Lower left—View of blackout unit. Lower right—Closeup view of installed unit.



LONGITUDINAL SECTION   NORMAL FRONT VIEW

SIGNAL BLACKOUT UNIT

confusion and some accidents occurred at congested intersections.

MEETS HIGH SPEED TRAFFIC

What was really needed for the traffic signals was a device that could be easily and permanently installed and would completely shield the signal light from enemy airmen, and at the same time give an adequate signal indication to traffic during night and day. Therefore, a study was undertaken by the Division of Highways to develop a satisfactory signal blackout unit that would meet the requirements of military authorities and modern high speed traffic.

The inspection of a signal installation readily showed that the signal light visible to an enemy airman came from the lens itself, from signal light reflected off the visor or hood surrounding the lens, and from signal light reflected from the street.

A conference with military officials indicated that satisfactory blackout control would exist if all direct signal light from the lens and all reflected light from the hood or visor surrounding the lens were cut off above a plane level with the signals, and if reflected light from the street pavement was reduced to an amount visible not more than one-quarter mile.

The problem was to satisfy the above conditions and at the same time maintain an adequate signal indication for highway traffic at all times.

EFFICIENT DESIGN

A type of louver seemed to fit the requirements providing the light reflected from the top of the vanes could be eliminated. By inserting fins on the top of each vane and adjusting the fin height and spacing so that a series of shadows were developed on the top of the vanes, the problem was solved.

The design developed is so efficient that all the light from the signal (using a standard 60 watt traffic lamp at full brilliancy) was cut off within a vertical distance of five feet when viewed 500 feet from the signal.

The unit is cylindrical, being eight inches in diameter and six inches long and having three central vanes, and is intended for use in the end of the 12-inch tunnel hoods which are standard equipment on west coast signal installations.

The vanes occupy approximately 40 per cent of the lens area, leaving a maximum exposed lens area of 60 per cent. The actual amount of lens area visible to traffic will vary from this maximum amount, depending upon the signal mounting height and the distance from the observer.

DIFFUSION OF LIGHT

The unit shown is designed for use in signal hoods having the standard downward tip of 7½ degrees. For use in other hoods it would be necessary to alter the design in order to secure the horizontal cut off plane.

When viewed from a distance there is very little restriction of the signal indication. Most observers can not distinguish any reduction in signal intensity. This, of course, is due to the diffusion of the signal light around the vanes.

At a short distance the signal indication appears as three or four bands of light and due to the fact that these light bands are at full signal brilliancy they are entirely adequate under day and night conditions. A traffic signal installation consisting of signals on the far right hand corners and a four-way center suspended signal has been equipped with these blackout units and has been in operation for several months. Night observations have been made by officers of the Army and Navy for the purpose of checking the effectiveness of the blackout unit and their reports are indeed very satisfactory.

(Continued on page 20)

Establishing The Oil Content For Dense Graded Bituminous Mixtures

By F. N. HVEEM

This is the second and concluding installment of an article by F. N. Hveem, Senior Physical Testing Engineer, Materials and Research Department, Division of Highways, on "Establishing the Oil Content for Dense Graded Bituminous Mixtures."

ANY design or type of centrifuge can be used which will handle samples weighing 100 grams (with centrifuge cups approximately two inches inside diameter) and which can be operated at a speed subjecting the sample to a force of 400 times gravity. In view of the relatively low speed required, the operation is entirely practicable for a hand-operated centrifuge which can be readily carried into the field for control testing. The equipment used here was secured from the Emil Greiner Company, 161 6th Avenue, New York, catalog No. CE-8535. A safety dome cover is required in order to develop the necessary speed and prevent spattering of the kerosene. With this particular centrifuge the necessary force can be developed by turning the handle approximately 45 revolutions per minute. If other equipment is used, the radius of the centrifuge arm to the center of the sample can be calculated as follows:

$r \times (RPM)^2 = 14{,}000{,}000$

Where r = radius in inches to center of gravity of soil sample

RPM = revolutions per minute of centrifuge head.

See photograph, **Figure IX**, which shows the complete centrifuge and special head and cup assembly.

CENTRIFUGE KEROSENE EQUIVALENT

The procedure is as follows:

1. Secure a representative dry sample of aggregate and by sieving determine the percentage by weight of the material passing the U. S. Standard No. 4 sieve.
2. Place exactly 100 grams of the dry aggregate passing the No. 4 sieve in a tared centrifuge cup fitted with a screen on which is placed a disk of filter paper.
3. Place the bottom of the centrifuge cup in kerosene until the aggregate becomes saturated.
4. Centrifuge the saturated sample for two minutes at a force of 400 times gravity.
5. Weigh the sample after centrifuging and determine the amount of kerosene retained as per cent of dry aggregate. This value is called the Centrifuge Kerosene Equivalent abbreviated to C.K.E.).
6. If the specific gravity of the aggregate is appreciably different from 2.65, apply a correction to this C.K.E. according to the scale at the bottom of the chart, Figure III, Scale "E."
7. Using this corrected C.K.E. and per cent aggregate passing No. 4 sieve, the indicated oil ratio may be obtained from the alignment chart, Figure III, Scales "A," "B," and "C."
8. The oil ratio determined under 7 is the required oil ratio for the combined fine and coarse aggregate, applying to liquid asphalts having a viscosity range of 100 to 1,000 seconds Saybolt Furol at 140° F.

This method is simple and the operation can be carried through in 15 minutes or less and has been given a thorough trial for the past year by field engineers in California. Correlation between the Centrifuge Kerosene Equivalent and the oil content (found to be satisfactory on the road) is excellent, being accurate in at least 95 per cent of the cases.

If this procedure is used by the resident engineer or superintendent to control the oil content of the work during construction, the foregoing procedure appears to be adequate; however, when the C.K.E. values are determined in a central laboratory as a basis for oil content recommendations to the field engineer, it is then desirable to classify the aggregate in terms of appropriate surface factors in order that the field engineer may apply the necessary corrections due to changes in grading as indicated by surface area calculations. For this purpose chart, **Figure V**, is furnished which permits the assignment of a surface constant K_f from the C.K.E. As indicated by the development of equations (f) and (g), the value of K_f may be taken as equivalent to K_m and thus represent the entire aggregate in a large majority of cases; however, certain instances may arise wherein the coarse aggregate is of markedly different character than are the fines used in the C.K.E. determination, and some correction may be necessary to arrive at a composite surface factor representing the combined coarse and fine aggregates. For this determination the coarse aggregate must also be classified and given a surface constant designation (K_c).

AGGREGATE ABSORPTION TEST

A representative sample of dry coarse aggregate weighing 100 grams passing the $\frac{3}{8}$ inch and retained on the No. 4 sieve is placed in a glass funnel of approximately 4 inches diameter. Sample and funnel are submerged in a beaker containing light lubricating oil, grade S.A.E. No. 10, for five minutes at room temperature. The funnel is then lifted and the oil permitted to drain for 15 minutes while the sample is maintained at a temperature of 140° F. The sample is then weighed and the percentage increase in weight due to oil absorbed or retained on the surface is noted. This value is referred to the chart, **Figure VI,** and converted to the surface constant K_c.

After having determined the surface constant K_f for the fine aggregate and K_c for the coarse aggregate, it is then necessary to compute the value of K_m for the given combination of fine and coarse. When the coarse and fine materials are all of the same type, the values of K_c and K_f should be identical when determined by the methods described above. When the two values are markedly different, by reference to chart, **Figure VIII**, it is possible to arrive at the value of K for the composite mix by using the surface area calculated from sieve analysis of the combined aggregates and the percentage of material retained on the No. 4, together with the values (K_c-K_f). As noted on the chart, K_m is calculated by applying the indicated correction to K_f. If the value of K_c-K_f is negative, the correction will be negative; if the value of K_c-K_f is positive, the correction will be positive.

THE FORMULA

In other words, if, for example, the coarse aggregate were appreciably more absorbent than the fine materials, it is obviously necessary to increase the value of K for the combined mix over the value indicated for the fines alone. When the value of K_m is thus determined, reference may be made to the chart, **Figure III**, on which the corrected oil ratio may be reached by using the calculated surface area, the average specific gravity of the aggregate, and the value of K_m (Scale D to Scale B).

All of the foregoing methods have been designed to give the oil ratio requirement for use with the more fluid grades of the liquid asphalt; for example, grades SC-2 and 3, MC-2 and 3, or others of similar viscosity. If heavier grades are used, for example SC-5 or 6 or paving asphalts of varying consistency measured by penetration, it is usually necessary to increase the estimated quantity in line with the increasing absolute viscosity.

Thus far we have been unable to develop a universally successful method for applying this correction to all grades of asphalt for all construction conditions and types of aggregate, and it is evident that further work is required on this phase of the problem. However, a tentative method has been established to indicate

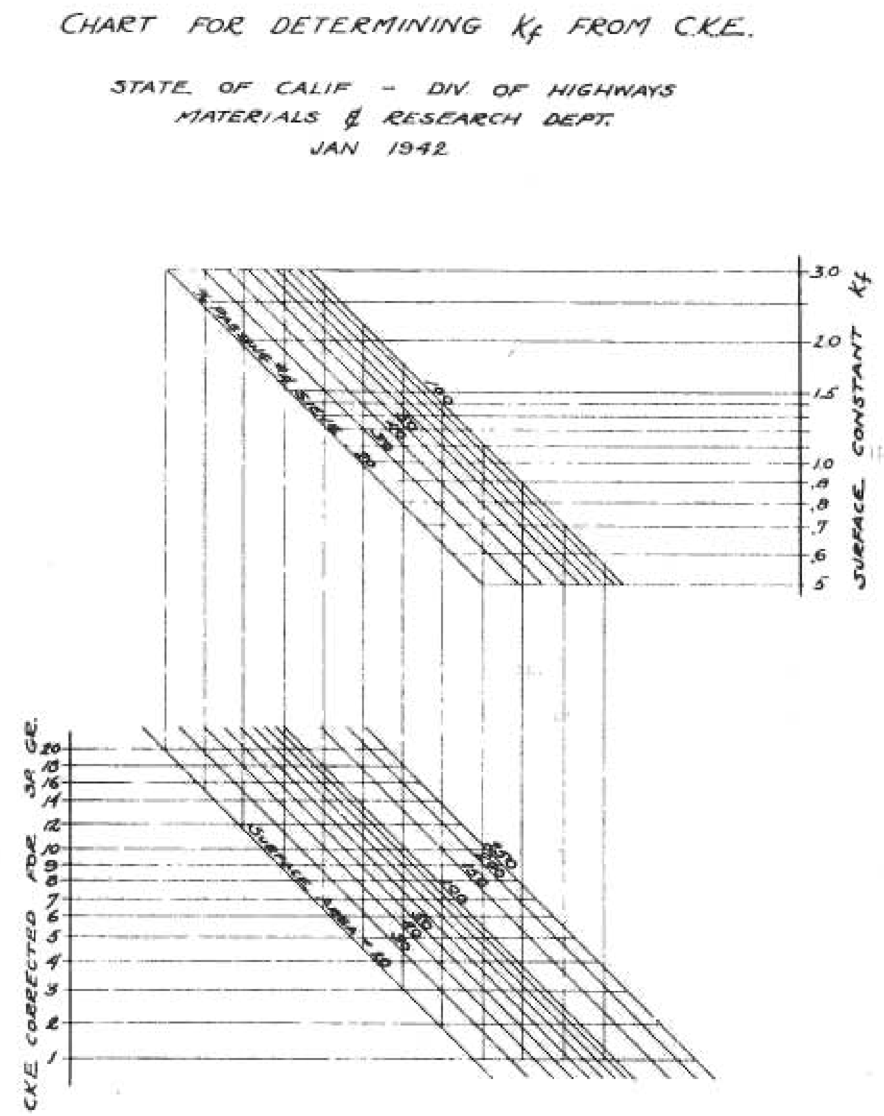


FIG V

direction and magnitude which is reasonably satisfactory and may be used as shown on chart, **Figure VIII,** with the admonition that complete dependence can not be placed on the results whenever the aggregates are highly absorbent, contain unusual quantities of fine dust, or have a very low voids ratio. It is, of course, evident that whenever the voids in the mixture are quite low and the surface capacity is high, a point is often reached where the quantity of asphalt calculated to cover the surfaces becomes greater than the void volume in a particular combination. Regardless of other considerations, the volume of asphalt must be maintained safely below the volume of the voids in the aggregate. Whenever the values of K_m are approximately equal to 1.0 (in other words, an average aggregate) this correction may be applied with considerable confidence. Whenever

K_m is greater than 1, indicating absorbent aggregate, it then appears that the heavier asphalts are not necessarily absorbed to the same degree as are the lighter oils and cutbacks. This condition may reach a stage where no increase of asphalt can be made in line with increasing viscosity. With these precautions the chart, **Figure VIII**, may be used to indicate a correction to the oil ratio previously estimated either by the surface area calculation or by the centrifuge kerosene equivalent method above described.

On chart, **Figure VIII**, by means of a straightedge connect the values on scale A (which represent grade of oil to be used) with values on scale B, representing the calculated surface area of the combined aggregate. Through the point of intersection on line C place a straightedge connecting with the previously determined oil ratio value on scale D. The intersection of the straightedge with scale E represents the oil ratio corrected for viscosity or consistency of the asphalt.

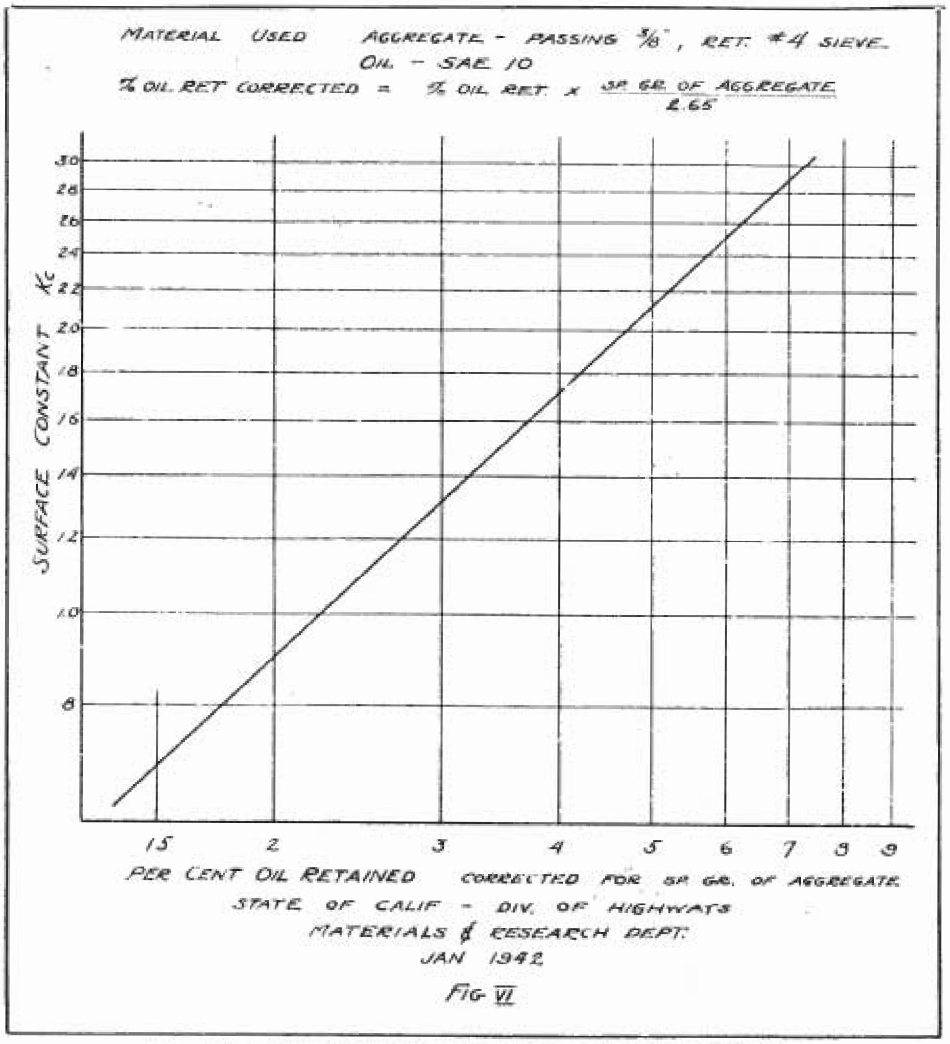
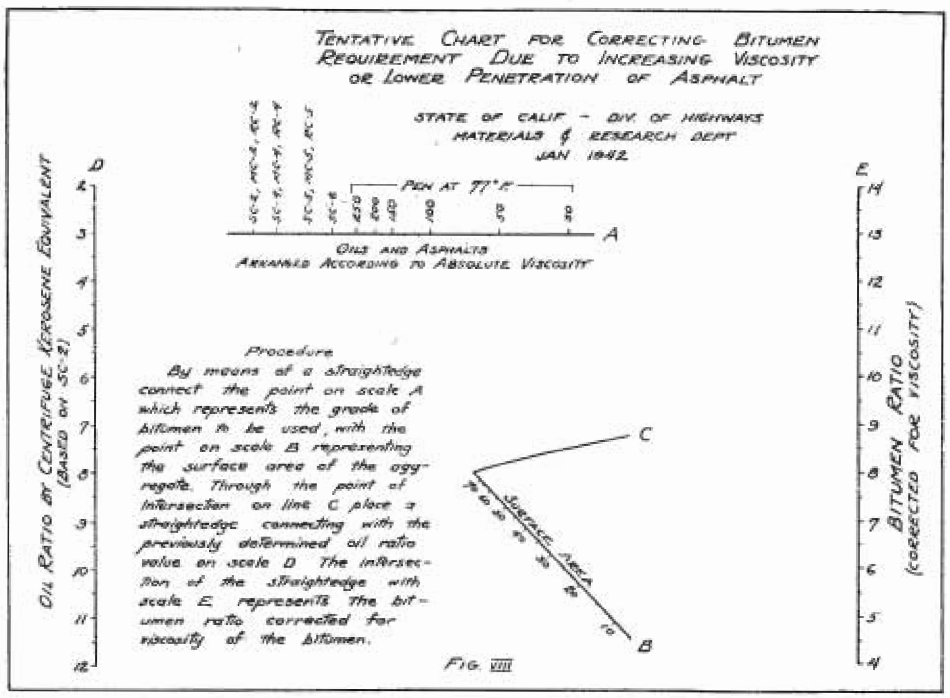


Chart for determining Kc from coarse aggregate absorption

APPLICATION OF METHODS

Case I. In which it is desired to determine the optimum oil ratio (Grades 2-3-4) for an aggregate whose characteristics do not change abruptly on the No. 4 sieve size. This is the most usual case and applicable to all road mix construction with local material, e.g.



(1) By screening determine the per cent by weight of aggregate passing the No. 4 sieve.

(2) Determine C.K.E.

(3) If the specific gravity is less than 2.4 or greater than 3.0 correct the C.K.E. by adding or subtracting the amount determined from the bottom of Figure III, Scale E.

(4) From the per cent of aggregate passing the No. 4 sieve and the corrected C.K.E. the oil ratio may be determined from the alignment chart, Figure III, Scales A, B, and C.

Case II. In which it is desired to find the optimum oil ratio of a fine aggregate having certain surface characteristics combined with a coarse aggregate of different surface characteristics. This is more complicated than Case I, but perfectly general.

(1) From the wash grading calculate the surface area according to the method of Stanton and Hveem.

(2) Determine the C.K.E. by the method described.

(3) Correct C.K.E. for specific gravity of the fines by the following formula:

$$\underset{\text{(Corrected)}}{\text{CKE}} = \underset{\text{(Uncorrected)}}{\text{CKE}} \times \frac{\text{Sp. Gr. fine}}{2.65}$$

(4) Using this CKE (Corrected), the surface area and per cent by weight of aggregate passing the No. 4 sieve determine the surface constant K_f by the use of Figure V.

(5) Determine K_c by the method described, **Figure VI.**

(6) Determine K_m by the use of **Figure VII.**

(7) Using the surface area, average specific gravity of the total mix and K_m, the optimum oil ratio for the total mix is then determined by the use of **Figure III,** Scale D to B.

Note: Theoretically there should be a correction applied to the surface area and per cent of aggregate passing and retained on the No. 4 sieve due to the difference in specific gravity of the coarse and fine. The effect of these corrections is small and partly compensating so that they may be neglected.

Example No. 1—Unblended soil for Road Mix Surface Treatment.

Data:

Per cent passing #4 sieve = 70%
Specific gravity, coarse = 2.4
Specific gravity, fine = 2.6

$$\text{Specific gravity mix} = \frac{1}{\frac{.30}{2.4} + \frac{.70}{2.6}} = 2.54$$

C.K.E. = 5%

(1) From Figure III, Scales A, B, and C Oil Ratio = 5.6%

Note: If the C.K.E. had been corrected for specific gravity of the aggregate, the corrected C.K.E. would have been 5.1% and the oil ratio 5.7%. This small variation in calculated oil content is ordinarily not significant as a range of 0.1 per cent is less than the normal error in construction proportions. Few mixtures are critical within 0.1% either above or below the theoretical optimum.

Example No. 2—Blend of hard dense river gravel retained on No. 4 sieve with quite absorptive fine material passing No. 4 sieve.

Data:

Specific gravity, coarse = 2.65
Specific gravity, fine = 2.25
Per cent coarse = 50%

$$\text{Specific gravity mix} = \frac{1}{\frac{.50}{2.25} + \frac{.50}{2.05}} = 2.43$$

Surface area mix = 45 square feet
C.K.E. = 11.8
Per cent oil absorbed by coarse = 1.5%

(1) $\underset{\text{(Corrected)}}{\text{C.K.E.}} = \frac{11.8 \times 2.25}{2.65} = 10.0$

(2) Figure V, $K_f = 1.8$

(3) From Figure VI, $K_c = 0.7$

(4) From Figure VII, Corr. = -0.3
$K_m = 1.8 - \text{corr.} = 1.8 - 0.3 = 1.5$

(5) From Figure III, Oil Ratio = 7.2%

Assuming that it is desired to use an oil heavier than SC-2 or MC-2, say SC-6, taking Example No. 2 with oil ratio of 7.2 and referring to chart,

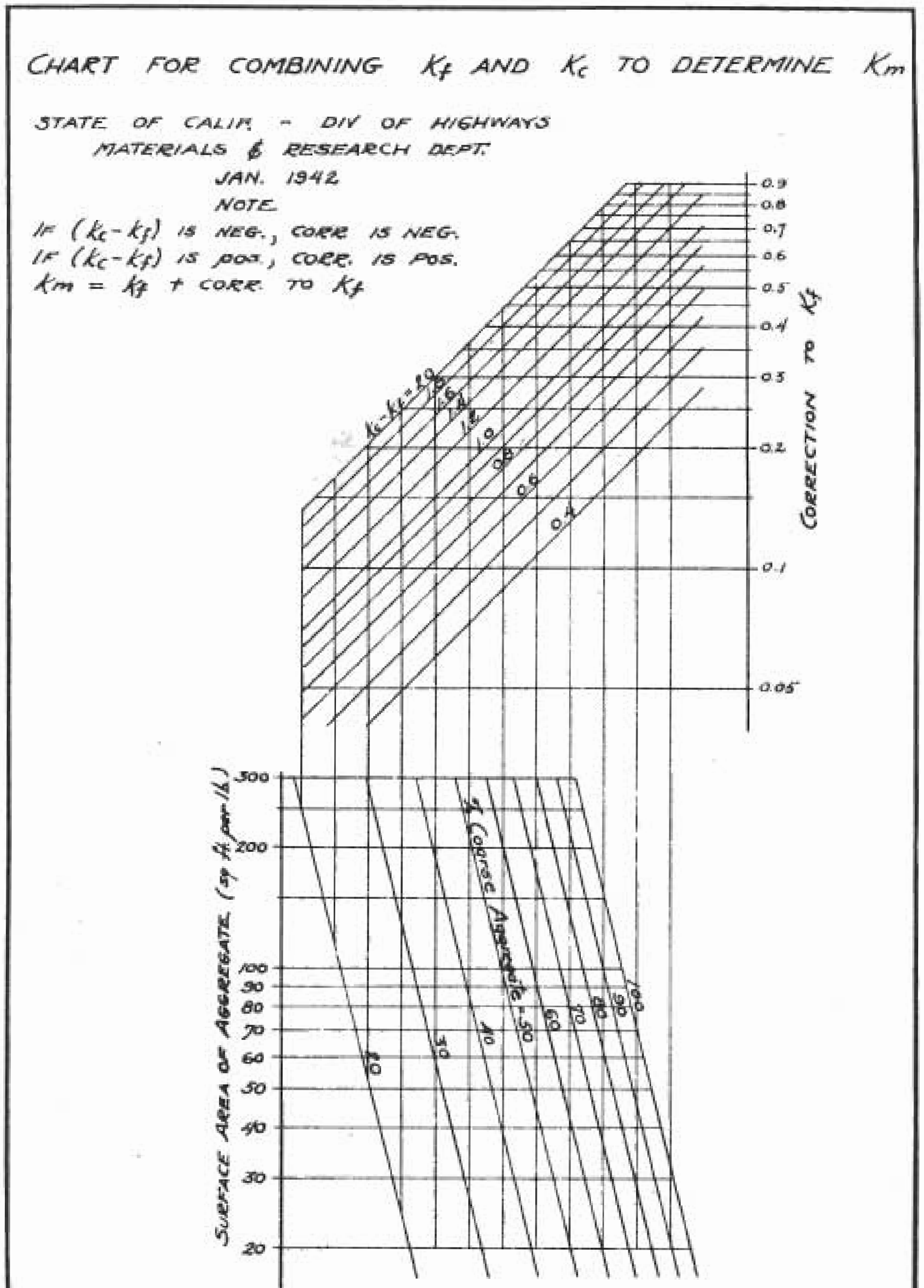
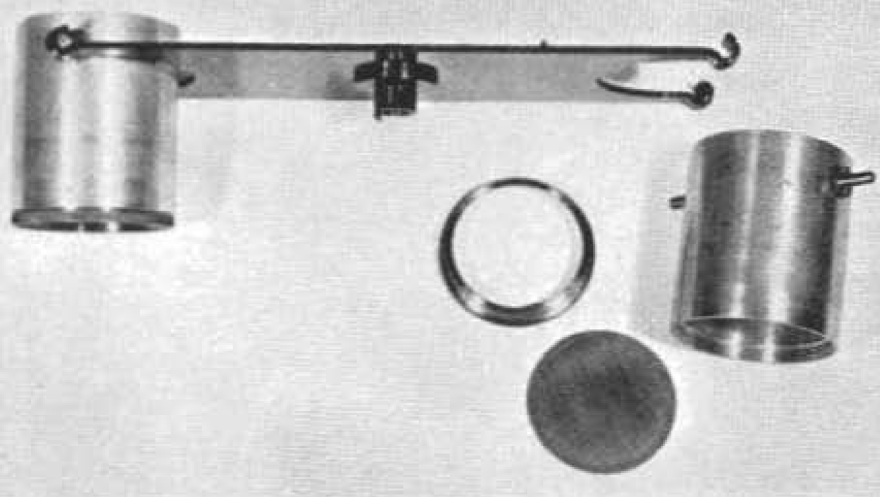


FIG VII



CENTRIFUGE KEROSENE EQUIVALENT APPARATUS

FIGURE IX

Figure VIII, it will be indicated that the quantity will be 7.4; however, as K_m is 1.8, caution must be exercised as the rate of absorption with a heavy oil will probably be so slow as to cause temporary instability on the road.

Taking a case for hot mix plant construction with a graded aggregate having 35 sq. ft. surface area and $K_m = 1.0$ oil ratio calculated at 4.2%, it will be found from chart, **Figure VIII**, that SC-2 will require 4.2%, SC-6 4.7%, 150 penetration asphalt 5.1%, 55 penetration 5.5%. These relative amounts have been used and found suitable in actual practice.

While the foregoing discussion of corrections and special cases may seem to be somewhat involved and complicated, in actual practice the kerosene contrifuge equivalent determination may be performed quickly and is sufficiently accurate except for a few special cases (see correlation on **Figure IV**). There will, of course, remain a few instances wherein no method short of an actual stability test on trial mixes will be adequate. This is due to the fact that any relationship between stability and absorption of a standard liquid or surface measurement calculation is largely fortuitous as in the final analysis the upper limit of permissible asphalt content depends on the degree of lubrication and this can only be positively determined by some test measuring the internal friction of the compacted mass.

All of the foregoing data apply to California asphalts and it should be realized that in using asphalts possessing a more distinct structure, such as Mexican asphalt, for example, the final values indicated herein may need to be increased over the quantity found sufficient for the more truly liquid California product.

In conclusion, the writer wishes to acknowledge the efforts of Mr. Ernest Zube who was responsible for much of the experimental work and to Mr. Robert Carmany who assisted in making the large number of correlation tests and who analyzed the data and developed the mathematical relationships necessary to construct the essential curves and charts.

Errata—In the previous installment of Mr. Hveem's article printed on page 17 of the July issue, the last equation (a) should read:

EQUATION (a)

$$\text{Oil Ratio}_{K_m} = \frac{(0.85\,\text{C.K.E.} + 2.5)\ .0067\sqrt{SA_{K_m}}}{100 \times .0067\sqrt{\dfrac{SA_{K_m} \times 100}{\%\ \text{passing No. 4}}}}$$

Simplifying:

$$\text{Oil Ratio}_{K_m} = \frac{(0.85\,\text{C.K.E.} + 2.5)}{100}\sqrt{\frac{\%\ \text{passing No. 4}}{100}} \qquad (g)$$

1941 Cement Output Largest

During 1941 cement production in California amounted to 19,531,608 barrels, valued at $26,248,694 f.o.b. plant, of which 10,281,489 barrels came from plants in northern California and 9,250,119 from southern California plants. This was the largest output as to amount recorded in the State and was only exceeded in value in 1927. The 1940 output amounted to 13,955,255 barrels, worth $17,673,202.

Shipments during 1941 were made by 12 plants in 11 counties to the extent of 19,833,796 barrels, valued at $27,219,800, as compared with 13,545,306 barrels, worth $17,195,105 shipped in 1940. During 1941 there were seven plants operating in northern California and five plants in southern California. There was an average of 2,790 men employed in the above mills during the year.

Defense Highway Program in California Reached $52,880,000

(Continued from page 1)

State Highway System have to some extent been curtailed; however, the Division of Highways has, at the same time, lost some 300 men to the armed forces and to construction connected with defense industries. This condition has made most difficult concentrated work on the defense highway programs by the available engineering personnel of the department. Nevertheless, even with a depleted staff, the work has proceeded rapidly.

The progress that was made during the first seven months of 1942 in advancing this phase of the war effort is reflected by the following analysis of the status of California projects on August 1st.

ACCESS ROADS	No. of Projects	Miles of Improvement	Bridges	Grade Separations	Amounts	Totals
Projects Certified	67	218.7	22	10	$19,794,500	
Certification Pending	11	54.1	--	--	3,109,100	
Subtotals	78	272.8	22	10		$22,903,600
Contracts Awarded	42	119.8	14	7	$12,400,600	
Day Labor Projects	1	33.4	--	--	210,000	
Projects Advertised	1	3.0	1	--	1,347,000	
Projects Pending Advertisement	4	19.0	--	1	821,500	
Subtotals	48	175.2	15	8	$14,779,100	
9 projects prepared by the Division of Highways built under supervision of the Army, Navy, or WPA						2,643,000
7 access road projects being financed with State and Federal Aid funds						3,100,000
9 projects prepared at request of military but for which certification has been deferred by War Department						14,500,000
Total Access Program						$43,146,600

STRATEGIC NETWORK	No. of Projects	Miles of Improvement	Bridges	Grade Separations	Amounts	Totals
Projects Certified	31	109.6	13	1	$5,836,800	
Certification Pending	4	12.7	--	--	1,325,000	
Subtotals	35	122.3	13	1		$7,161,800
Contracts Awarded	15	67.2	8	--	$2,149,000	
Projects Advertised	1	3.9	--	--	420,000	
Projects Pending Advertisement	8	20.3	3	--	1,448,000	
Subtotals	24	91.4	11	1	$4,017,000	
In addition to the above, 4 projects were certified, advertised and bids rejected as excessive. Decision as to revision and readvertising is now pending						414,600
Total Strategic Network Program						$7,576,400
FLIGHT STRIPS						
4 projects certified, and contracts awarded						$2,157,000
Total Defense Highway Work						$52,880,000

While the location of military establishments has resulted in concentration of construction projects in certain areas, the program as a whole is quite widespread throughout the State. For obvious reasons, the definite locations are not given of this defense work, however, the following breakdown of the foregoing tabulation to various sections of the State shows the distribution throughout California of access road projects and improvements to the strategic network.

	ACCESS ROADS		STRATEGIC NETWORK	
	Projects Certified & Pending Certification	Contracts Awarded, Projects Advertised & Pending Advertisement	Projects Certified & Pending Certification	Contracts Awarded, Projects Advertised & Pending Advertisement
"A" Area				
Number of Projects	18	11	10	5
Miles	61.2	32.0	29.7	15.7
Bridges	2	1	2	1
Grade Separations	--	--	--	--
Amount	$5,898,400	$3,442,400	$2,000,900	$611,900
"B" Area				
Number of Projects	15	11	6	6
Miles	61.6	47.9	45.4	45.4
Bridges	--	--	--	--
Grade Separations	--	--	--	--
Amount	$5,350,600	$4,360,600	$1,233,400	$1,233,400

(Continued on page 18)

View of completed surface on the Feather River Highway in scenic region between Howells and Keddie

Recent Highway Improvements In Feather River Area Total 70 Miles

By F. W. HASELWOOD, District Engineer

THE Feather River or North Fork Highway between Oroville and Keddie, costing about $8,000,000, was opened to traffic in August, 1937. It provided a low grade, relatively snow-free route through the Sierras where none had existed before.

In view of the fact that the area it traverses, or through which its tributaries pass, is well served by railroads, prospective traffic was assumed to be light in weight and not so heavy in volume. A light oil treated surface was constructed to serve the anticipated light traffic for about five years.

The Feather River Highway, originally conceived as connecting Oroville and Quincy, two county seats, by way of the North Fork, has now been expanded in the public mind to include the extension of the route from Quincy to Hallelujah at the junction of U. S. 395 about 20 miles from Reno.

OROVILLE-QUINCY UNIT

The country bordering the highway through the canyon of the North Fork and its tributaries is rugged and scenic but is not adaptable to the kind of development that generates traffic. Probably to a maximum degree for transmountain roads, the Oroville-Quincy unit of the Feather River Highway, 78 miles in length, serves through traffic, the nature and volume of which depends to a considerable extent on its tributaries and their state of improvement, as well as on the extent of improvement of the highway itself.

The Quincy-Hallelujah unit of this highway, about 60 miles in length, traverses a country which generates considerable traffic of a recreational as well as of a commercial nature. Commercial traffic consists largely of transportation of logs from the woods to the mills, of timber products from the mills to market and supplies to the mines.

Major tributaries contributing to traffic on this highway are the Sierra Way, U. S. 395, serving all of northeastern California and the Vinton Feeder Road, which serves Sierra Valley adjacent areas and of supplies for the mining areas.

SIERRA-WAY ROUTE

The Sierra Way was conceived by the U. S. Forest Service as a north and south route through the high Sierras extending from near Mt. Shasta to General Grant Park. Much improvement has been made on it by the Public Roads Administration with Forest Highway funds. It joins the Feather River Highway from the north near Paxton and from the south at Blairsden. There are many sawmills on this route, traffic is heavy and the route in this area takes on a commercial rather than a recreational aspect.

Traffic on the Vinton Feeder Road is largely commercial, theoretically terminating at the railroad but actually continuing east or west on the Feather River Highway.

U. S. 395, from the north, contributes to a lesser degree since traffic on this route, as measured at Hallelujah, is primarily of a through nature, consisting of both passenger and heavy commercial vehicles. However, the Hallelujah-Reno branch of this route is an essential extension of the Feather River Highway. Particularly in winter, when snow conditions are unfavorable on other trans-Sierra routes, much heavy traffic is routed over the Feather River Highway to and from Nevada.

The beginning of the current biennium in July, 1941, after the highway through the canyon had been opened

Above—Completed highway near Keddie. Below—load of logs being hauled from mill on another section of new highway for four years, found the volume of traffic to be about half of that predicted by the enthusiastic and optimistic promoters of the North Fork Highway, but twice that of any departmental prediction for the first five years, and entirely different as to weight of vehicles as well as density.

It was not unexpected that the budget, effective July 1, 1941, should provide for strengthening some of the surface applied in 1937 with the expectation of serving the anticipated light weight and light volume traffic for approximately five years.

ECONOMIC PLANNING

In the design and construction of highways there are but few items that can be considered permanent. Right of way adequate for present development and future expansion of the highway acquired on an alignment not subject to future radical change and so laid out as to anticipate possible minor changes, and the grading and drainage structures on a highway constructed on such well-considered alignment and grade may be classed as the most nearly permanent items of a highway.

Following the old theory of not sending a man to do a boy's work, it has not been found economical or possible in view of the vast needs of our highway system to construct surfaces beyond the capacity of the anticipated needs for a period reasonably in advance of the time of improvement. Regardless of whether it is done consciously and voluntarily, highway surfacing is designed and constructed to meet a known or expected specific requirement and is subject to future expansion in thickness, width and number of traffic lanes as the requirements develop and change and thereby follows a definite pattern of stage construction. The policy of stage construction of highway surfacing is therefore universal and economic as well as financially necessary.

STAGE CONSTRUCTION

Those cases where stage construction of alignment and grade can be justified or excused on the ground of expediency are fast disappearing, although there is a vast need for another and final stage of improvement of alignment and grade on a great proportion of our existing highways. Stage construction of alignment and grade is uneconomical in that it results in a loss of all discarded grade or surface, or a write-off of the value of these two items against the traffic using the road up to the time of the further or final stage of improvement.

Analyzing the Feather River Highways and its tributaries as of 1941, when the growing pains of traffic began to be acute, we find roads of all stages and conditions, from total lack of improvement except dust oiling to permanency as to alignment and grade, with stage constructed surfaces having reached or rapidly approaching a state of inadequacy. Between these extremes, and more particularly between Quincy and Beckwourth, stage construction of alignment and grade prevails to an extent that the road is inadequate in many locations for the present traffic.

The implication that the canyon unit of the Feather River Highway is permanent as to alignment and grade is based on the facts that the ruggedness and instability of the country traversed will, except in very few cases, permit nothing more than minor expansion in width on present alignment and grade.

P. W. A. IMPROVEMENTS

In 1941 the Public Roads Administration had made, or had in progress, improvements that would provide permanent alignment and grade—the same factors applying here as in the North Fork Canyon—and stage construction surface between Lake Almanor and the Feather River Highway at Paxton. The improvements in progress would eliminate posted bridges and would release a considerable volume of long distance hauling of timber products. Similar stage construction was underway by the Public Roads Administration on a unit of the Feather River Highway between Keddie and Quincy.

The problem of the 1941 State Highway budget for relief of distress on the Feather River Highway and its tributaries resulted in several well selected improvements which were all additional increments of surfacing, except the seven-mile unit just east of Quincy. This unit provided an additional and possibly final stage of alignment and grade, as well as an improved stage of surfacing.

The improvement of these inadequate highways to the extent that finances could be made available was accomplished or contracted with one minor exception in 1941, before war conditions had too severe an effect on highway costs.

These accomplishments are now briefly described with location, length and cost.

FEATHER RIVER HIGHWAY—HOWELLS TO KEDDIE, 19.9 miles. The existing surface was a penetration and armor over the natural material in the grade. The improvement consisted of a substantial increment of base and a plant-mix 20 feet wide and 3 inches thick. Hemstreet and Bell did the work, in 1941, at a cost of $149,083.

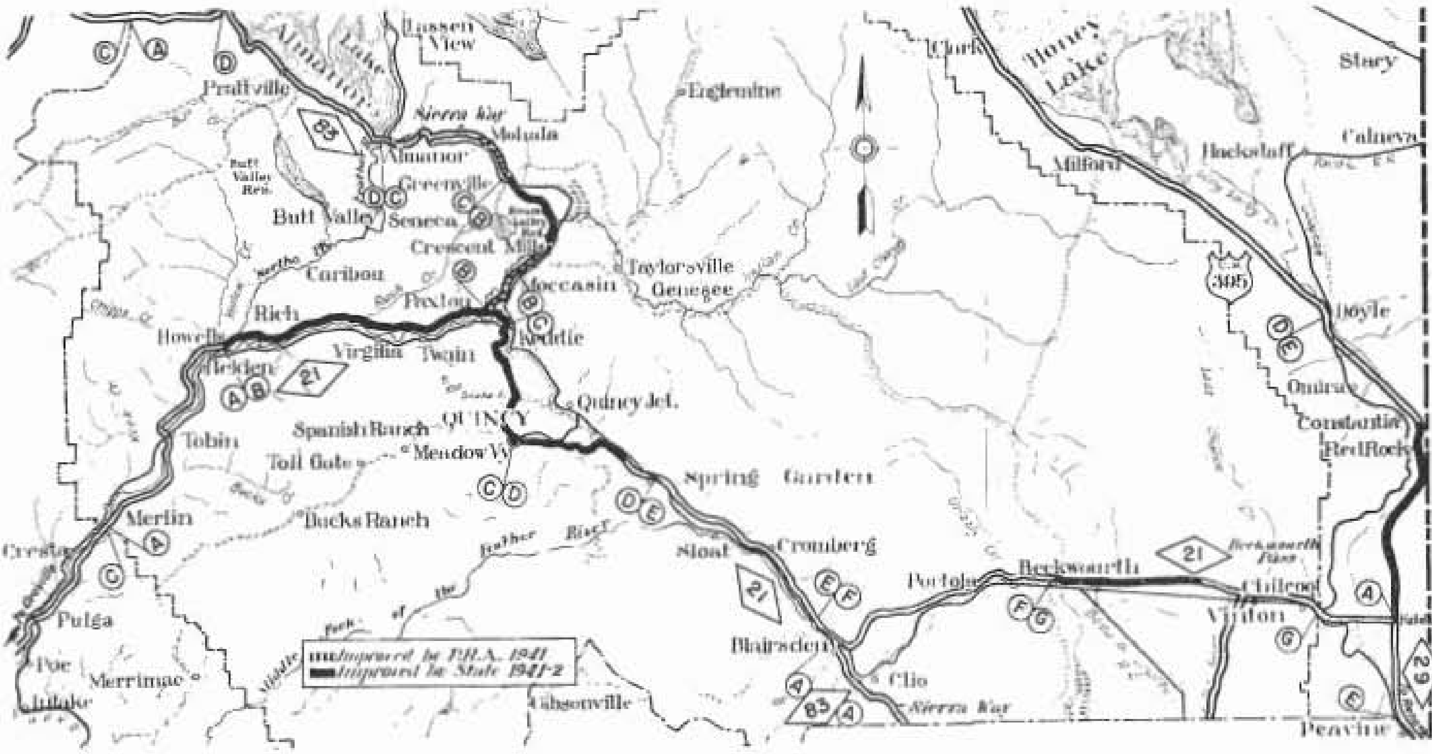
FROM KEDDIE THROUGH QUINCY, 7 miles. The State placed a leveling and reinforcing course of plant-mix over the work completed in 1941 by the Public Roads Administration and over the existing street of Quincy. The thickness varied from one-tenth and the width from 22 feet outside of town to a maximum of 60 feet inside of Quincy. Contract for this work was awarded to Poulos and McEwen in 1942, at a cost of $22,879. The work completed by Public Roads Administration in 1941 between Keddie and Quincy was done by Isbell Construction Company at a cost of $169,559.

FROM QUINCY EAST FOR 6.8 MILES alignment and grade was stardardized and a substantial surface consisting of a gravel base not less than 9 inches thick and a plant-mixed surfacing 2½ inches thick and 22 feet wide. This project was constructed by Harms Bros. in 1941 and 1942, at a cost of $151,888.

FROM BECKWOURTH EAST FOR 9.3 MILES, the existing road brought to final alignment and grade in various stages over a period of nine years, and having been oiled by the penetration method, was surfaced with plant-mix 2½ inches thick and 22 feet wide. This work was done by Poulos and McEwen in 1941, at a cost of $46,663.

ON U. S. 395, BETWEEN CONSTANTIA AND HALLELUJAH, at the junction with the Feather River Highway, 12.1 miles, the existing penetration and road-mixed surfacing was reinforced with plant-mix from 2½ to 3 inches thick and 22 feet wide. This work was done by Fredericksen and Westbrook in 1941, at a cost of $59,412.

ON SIERRA WAY, BETWEEN CRESCENT MILLS AND GREENVILLE, 4.2 MILES, which was originally graded and oiled by the Public



Sketch map showing improvement on the Feather River Highway and tributaries by the State and Public Roads Administration

Roads Administration, an increment of road-mixed surface 2½ inches thick and 22 feet wide was placed in 1941 by Oranges Bros. and is now being sealed by day labor at a gross cost of $19,142.

On the Sierra Way the Public Roads Administration completed in 1941 two units. The work done consisted of grading and providing a stabilized base on which future surface will be required. One unit of 3.8 miles extended from Greenville north and the other of 6.9 miles was between Crescent Mills and the Feather River Highway near Paxton. The approximate cost of the Greenville unit was $64,935 and of the Crescent Mills to Paxton unit $299,702.

The aggregate length of several units of the Feather River Highway, or its tributaries, on which improvement was completed in 1941 or 1942 by the State or the Public Roads Administration is 70 miles and the aggregate cost was $987,184.

IMPROVEMENTS MUST CONTINUE

The work completed on these roads in the current biennial period clears the Feather River Highway of those deficiencies that are the most pronounced at the moment and constitutes a definite and appreciable contribution to better traffic service in and through the area. The type and pattern of the improvement must be continued and extended for an indefinite period if the highway system in the area is to be standardized and strengthened satisfactorily to serve even present requirements.

Conditions as to the inadequacy of this group of highways to meet requirements of a traffic that has outgrown expectations are but a replica of those applicable to any other group of highways in the State and serve to indicate that even the comprehensive program just completed here, while affording much relief, is "too little and too late" to keep up with traffic. This development of traffic occurred in spite of an almost complete lack of development on the most important tributary, the Sierra Way, as of that date. Also on the Feather River Highway itself the unimproved unit between Keddie and Quincy was a very severe deterrent to traffic. This unit, however, was in the process of improvement by the Public Roads Administration as a Forest Highway and was completed to its inital stage late in 1941.

"How come you didn't turn out?" demanded the sergeant. "Didn't you hear the bugle blow reveille?"

"Honest, sergeant, I'm afraid I'm going to be a flop as a soldier. I don't know one durn tune from another."

ALASKA WANTS IT

Territory of Alaska
Office of Highway Engineer
and Superintendent of
Public Works

Juneau, Alaska

Mr. J. W. Howe
California Highways and
Public Works
Sacramento, California

Dear Mr. Howe:

This office would greatly appreciate being put on the mailing list for your interesting publication. Thanking you in advance, I am

Yours very truly,

WM. A. HESSE,
Highway Engineer

RELEASES 200,000 TONS OF STEEL

At a recent Producers Council, Col. R. F. Fowler, Chief, Supply Division, Corps of Engineers, said: "On the new storage depot program alone, we expect to employ around 35,000 wood trusses, thereby releasing more than 200,000 tons of steel. That much steel, it is estimated, will build 7,500 medium tanks."

Smith had heard a conundrum that he thought was very good, so when he arrived home he concluded to try it on his wife.

Smith—Do you know why I am like a mule?

Wife—No, I don't, but I often intended to ask you.

State Sign Route 28 winds through heavy growths of Redwoods between Flynn and Navarro, a narrow road with sharp turns and grades

25 Curves to be Eliminated on Lateral Through Mendocino County Redwoods

By L. R. REDDEN, District Office Engineer

A LIFE span of virtually the entire American period in California—such is the background of a section of the McDonald-to-the-Sea Highway in Mendocino County, between Flynn Creek and Navarro, on State Sign Route 28, the improvement of which was recently placed under contract.

The improvement is located a few miles northwest of the lower end of Anderson Valley, which was settled in 1851. For 10 years thereafter, the only means of access from the valley to the San Francisco Bay area was over a pioneer road by ox team to the southeast to a connecting road at Cloverdale.

Then, in 1861, the road was extended westerly from the valley to the coast at the mouth of the Albion River. The extension was made primarily to provide access for the disposal of agricultural products from the Anderson Valley to the thriving sawmill communities lying along the coast, and incidentally to give a more ready access to the outside world.

The engineering standards were those required of most pioneer works: a passable road with a minimum of work. It was cheaper to go around a tree than to cut it down. The unit between Flynn Creek and Navarro has remained very much without change to this day, except for minor maintenance improvements, oiling and the replacement of bridges.

The route remained under the jurisdiction of Mendocino County until 1919 when it was taken into the State Highway System by the third State highway bond act. Since then, improvements have been made in the route from time to time so that of the few remaining unimproved sections, the Flynn Creek-Navarro unit is by far the most substandard.

The existing road has become entirely inadequate for present day traffic requirements due to the steeply pitching grade, the many sharp crested vertical curves and the almost angular alignment; and in many

places the roadbed is as narrow as 15 feet. The hazards of such a road have increased many fold due to the heavy increase in the movement of lumber by truck and trailer from the Fort Bragg area that began about 1935 with the decline and cessation of coastwise shipping.

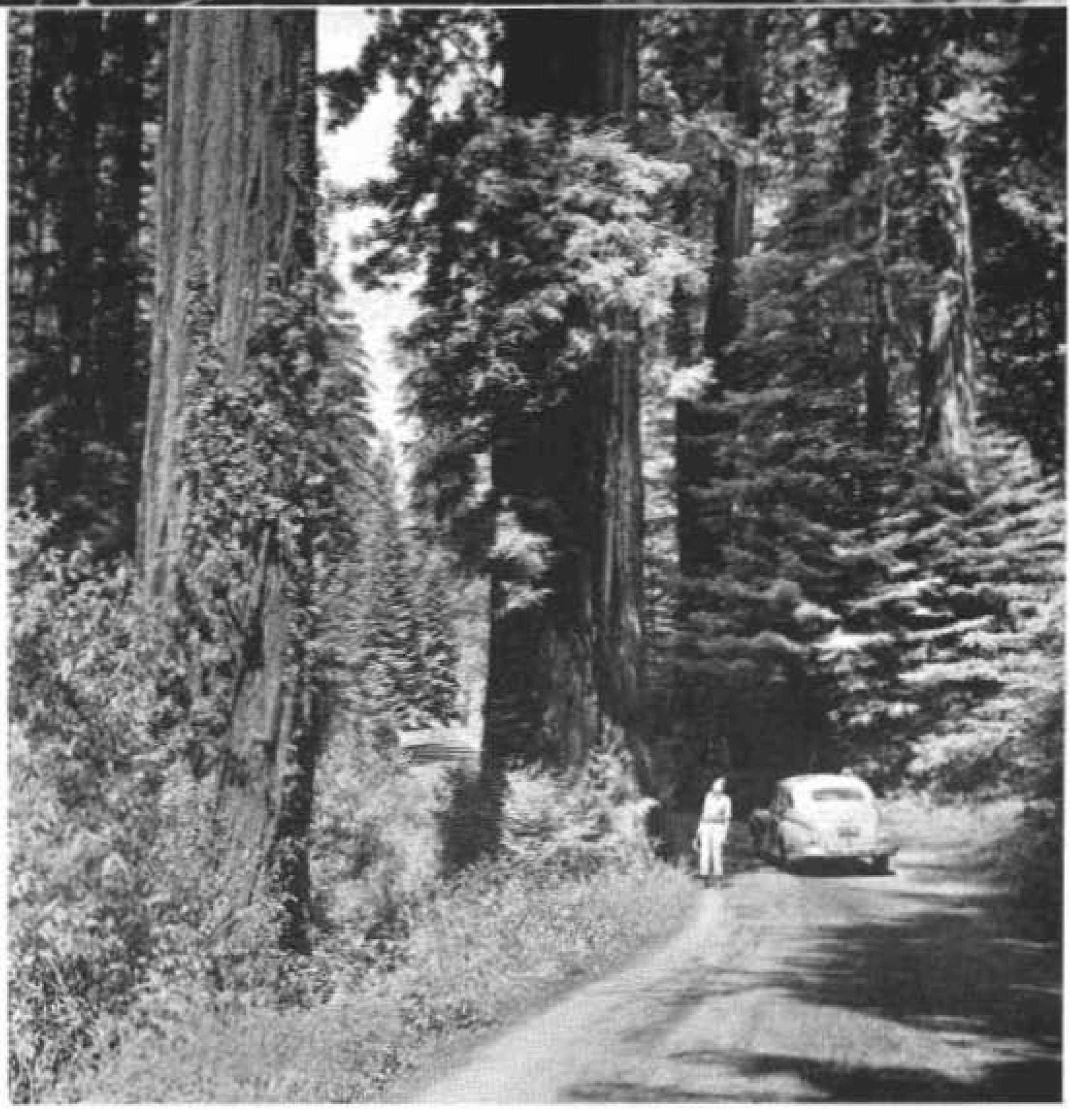
An inspection of the following comparative data will indicate the degree of improvement that will be accomplished on the project:

	Present Road	Reconstructed Road
Length miles	1.89 Mi.	1.90 Mi.
Total curvature	859 degrees	304 degrees
Min. radius	100 ft.	500 ft.
Curves under 500 ft. radius	25	0
Min. vert. sight distance	150 ft.	unlimited
Sight distances less than 275 ft.	4	none
Maximum grade	9.5%	2.5%
Grade over 3%	2725 ft.	none
Adverse grade	2575 ft.	625 ft.

The new road will follow closely the existing route; however, the irregular alignment will be replaced by one of smooth-flowing secondary road standards; and the many undulations in grade will be entirely eliminated so that trucks may readily negotiate the road in high gear.

The planned roadbed is 26 feet wide in cuts and 28 feet wide in fills. An excellent selected material to be obtained from within cut slopes just east of the North Fork bridge is to be placed on the roadbed to depths ranging up to 1.4 feet; over the selected

(Continued on page 19)



A few giants must make room for a modern highway and (above) the logs are being cut into commercial lengths

Defense Highway Program in California Reached $52,880,000

(Continued from page 11)

	ACCESS ROADS		STRATEGIC NETWORK	
	Projects Certified & Pending Certification	Contracts Awarded, Projects Advertised & Pending Advertisement	Projects Certified & Pending Certification	Contracts Awarded, Projects Advertised & Pending Advertisement
"C" Area				
Number of Projects	23	12	6	4
Miles	50.3	11.2	13.5	7.4
Bridges	3	3	4	4
Grade Separations	4	4	--	--
Amount	$7,489,700	$3,672,600	$1,562,900	$777,900
"D" Area				
Number of Projects	12	8	12	9
Miles	61.4	56.2	32.0	22.8
Bridges	5	2	7	7
Grade Separations	1	1	1	--
Amount	$2,161,000	$2,133,400	$2,169,600	$1,394,600
"E" Area				
Number of Projects	10	7	1	--
Miles	38.3	27.9	1.7	--
Bridges	2	1	--	--
Grade Separations	2	2	--	--
Amount	$2,003,900	$1,670,100	$195,000	--

The above tabulations provide ready comparisons between the certified projects and construction set in motion to show the progress made by the Division of Highways in advancing the defense highway programs. The work involved in both access road projects and improvement to the strategic network include practically all phases of highway construction. While most of the road mileage being constructed is of the plant-mixed bituminous surface type, certain projects include portland cement concrete pavement and asphalt concrete pavement. The bridges included in the programs are of various lengths, some reinforced concrete and many are timber structures. The grade separations include separation of the grades of highways on heavily traveled routes as well as railroad separations. The grading involved has ranged from shoulder construction to heavy excavation.

From the data given, it may be seen that California is well into required defense highway construction and that every effort is being made by the Division of Highways to advance this phase of the National war effort.

Caution Urged To Reduce Crossing Accidents

DIRECTOR of Public Works, Frank W. Clark, appeals to motorists to exercise extreme caution at railroad and highway grade crossings.

Director Clark said his appeal was directed especially to defense industry workers in order to reduce the "alarming" death and disability toll which "is making serious inroads on man-power vitally needed for the war effort."

"Governor Olson has asked me" Mr. Clark said, "as head of the State agency which supervises our highways to sound a warning against carelessness which is responsible for accidents which hamper our war program.

"Increasing speed in production and in many other lines of endeavor directly connected with the war program is adding to the accident rate throughout the country.

"Man-power lost by accidental death last year could have built 7,000 heavy bombers, 20 battleships and 200 destroyers."

Clark stated that statistics of the Brotherhood of Locomotive Firemen and Enginemen were as follows:

"There was a 30 per cent increase in grade crossing deaths in 1940 over 1939 and last year there was almost a 10 per cent rise over 1940. One-third of grade crossing casualties are preventable. According to the inter-state Commerce Commission, 35 per cent of such accidents result from automobiles smashing into the sides of trains.

"Last year, 1,931 persons lost their lives in railroad grade crossing accidents; the largest number since 1930. During the same year—1941—4,885 were injured at grade crossings. There were 4,320 of these accidents recorded in 1941, the greatest since 1937. In the first three months of 1942, 562 persons were killed and 1,580 were injured at grade crossings.

"Compared with the first three months of 1941, the number killed was over 7 per cent greater, and the number injured was almost 15 per cent greater than in 1942. Of course, increased traffic heightens the potentialities of accidents. The ton miles of traffic in 1941 were about 2 per cent higher than any year during World War I."

Grumm Loaned to W.P.B. As Priority Consultant

Fred J. Grumm, Engineer of Surveys and Plans of the Division of Highways was appointed Consultant to the Bureau of Governmental Requirements of the War Production Board by Maury Maverick, Chief of the Bureau, on June 1st.

Mr. Grumm was called to Washington to consult with Byron Scott, Assistant to Maury Maverick, in a series of conferences on priority procedure relating to road projects. Mr. Grumm reported to the bureau chief on the result of these conferences. The appointment of consultant without compensation, was made for the purpose of continuing an investigation and study of priority procedure.

In addition, the War Production Board Bureau Chief asked Grumm to represent him at vital annual board meetings in the Federal Region on the West coast. These meetings are held at Salt Lake, Seattle and San Francisco.

Mr. Grumm will attend each of these meetings and make reports to the War Production Board Bureau on projects brought up for discussion and the priority procedure pertaining to them.

Performance of Culverts and Survey of Culvert Practice

By G. A. TILTON, Jr., Assistant Construction Engineer

A series of articles presenting the results of a Joint Departmental Study of Performance of Culverts and Survey of Culvert Practice will be presented in future issues of the California Highways and Public Works Magazine to which the following is a brief introduction.

IN SO FAR as State-wide policies are concerned, highway drainage in California began with the inauguration of the State Highway System in 1912. At that time, rainfall and runoff data throughout California were meager and scattered and generally inadequate upon which to predicate engineering design.

It was not until 26 years later, in 1938, that the first of several general storms of extreme intensity occurred to test the validity of a quarter-century of highway drainage practice.

Although drainage structures in general functioned satisfactorily, there were sufficient inconsistencies in the performance of culverts and drainage facilities to warrant a comprehensive study and survey.

STUDY REQUIRED TWO YEARS

Such a study was ordered and conducted over a two-year period by a joint departmental committee of the Division of Highways, Department of Public Works, composed of the following personnel:

R. Robinson Rowe, Assistant Engineer, Bridge Department.

R. L. Thomas, Assistant Engineer, Surveys and Plans.

C. F. Woodin, Assistant Maintenance Engineer.

G. A. Tilton, Jr., Assistant Construction Engineer.

Field observations and studies covering the entire State indicate that culvert practice has long passed the stage where empirical determination of the size of a culvert opening is the all-important essential of design, emphasized to the point of disregard of other hydraulic and installation refinements.

Suggested and recommended changes in culvert practice resulting from the extensive survey are being presented with the object of engendering and encouraging progressive policies abreast the field of experimentation and experience.

In view of the general interest aroused by the committees' findings, recommendations and conclusions, a series of articles is to be presented in subsequent issues of the California Highways and Public Works Magazine, beginning with the September issue, covering the following subjects pertaining to culverts and drainage on the California State Highway System:

1. **Comparison of hydrology in California and midwestern and eastern United States.**
2. **Debris control at culvert entrances.**
3. **Culvert location and slopes.**
4. **Culvert entrances, headwalls, and drop inlets.**
5. **Culvert outlets and endwalls.**
6. **Siphon culverts and sag-pipe culverts.**
7. **Field installation of culverts.**
8. **Classification of culvert sites and selection of culvert types.**
9. **Rated waterways for culverts.**
10. **Maintenance of culverts and drainage ditches.**

OUR COUNTRY

"Let our subject be . . .
OUR COUNTRY,
OUR WHOLE COUNTRY,
. . . and nothing but
OUR COUNTRY,

And by the blessing of God, may that country itself become a vast and splendid monument, not of oppression and terror, but of wisdom and peace, and of liberty, upon which the world may gaze with admiration forever!"—Daniel Webster.

25 Curves to be Eliminated Through Mendocino County

(Continued from page 17)

material a three inch course of gravel base is to be placed; and finally a one inch wearing course of road-mix is to be constructed on the gravel base to the full width of the roadbed.

Much of the country served by the project was once covered by dense redwood forest land which has largely been cut over. However, a very heavy stand of virgin timber still borders the project.

The heavily timbered terrain abounds with redwood trees ranging up to eight and 10 feet in diameter. Some idea of the cover may be gained when it is stated that the clearing expense for this 1.90 mile project is $15,395 or 26.8% of the entire bid price of $57,357. With so much clearing going on and with the cry of "timber!" echoing throughout the woods, the project takes on the atmosphere of logging operations rather than that of a road improvement project.

The bridge over the north fork of the Navarro River, which is crossed within the limits of the improvement, was built about 1931 and is in good condition. The foresight of the locators in placing the bridge has made it possible to develop the approaches to it under the present improvement without reduction in standard design.

Stability of the country traversed is generally good. Inspection of existing cut slopes, supplemented by soil studies, have led the engineers to design the slopes as steep as ½ to 1.

The project was originally programmed to be constructed in its entirety during the 1942 season, however, delays have resulted in obtaining the necessary release to construct from various governmental defense agencies so that the project will not be completed until 1943. The project is being financed in part with Federal funds.

John Burman and Sons is the Contractor; the work is under the jurisdiction of E. R. Green, District Engineer, with D. E. McCollum as Acting Resident Engineer.

Teacher—"Now, Bobby, tell me where the elephant is found."

Bobby—"The elephant is such a large animal it is scarcely ever lost."

Highway Bids and Awards for July, 1942

CONTRA COSTA COUNTY—Between the intersection with Route 14 in Hercules and ¼ mile west of Christie Underpass, about 3.6 miles to be repaired by placing crusher run base and surfacing with plant-mixed surfacing. District IV, Route 106, Section Her.,A. E. A. Forde, San Anselmo, $75,257. Contract awarded to Lee J. Immel, Berkeley, $73,497.

HUMBOLDT COUNTY—¼ mile north of Dyerville, about 0.2 mile in length, the roadbed to be reconstructed, heavy stone riprap and wire and rock mattress to be constructed. District I, Route 1, Section D. Harold Smith, St. Helena, $69,058; Ralph A. Bell, Eureka, $70,474; Mercer, Fraser Co., Eureka, $73,194. Contract awarded to Schenmann & Johnson, Redding, $66,519.

HUMBOLDT COUNTY—Between Arcata and Eureka, about 11.5 miles in length, portions to be graded and surfaced with plant-mixed surfacing on gravel base, and portions graded and surfaced with gravel base and bituminous seal applied. District I. Ralph A. Bell, Eureka, $381,942. Contract awarded to John Carlin Construction Co., Arcata, $327,827.

KERN COUNTY—Across Grapevine Creek, about 5 miles north of Lebec, an existing bridge to be widened. District VI, Route 4, Section A. R. M. Price, Huntington Park, $51,930. E. E. Smith, El Cerrito, $68,349; R. L. Oakley, Pasadena, $73,400. Contract awarded to Trewhitt Shields and Fisher, Fresno, $51,256.

KERN COUNTY—Between Route 138 and Gardner Field, about 5.6 miles to be graded and bituminous surface treatment applied. District VI, Griffith Co., Los Angeles, $184,340. Contract awarded to Louis Biasotti & Son, Stockton, $157,920.

LASSEN COUNTY—Between Route 29 and Reservation Boundary, near Honey Lake, about 4.3 miles, a base to be constructed of imported borrow and surfaced with road-mixed surfacing. District II. Harms Bros., Sacramento, $43,412; A. Teichert & Son, Inc., Sacramento, $43,845; Clifford A. Dunn, Klamath Falls, $46,830. Contract awarded to Poulos & McEwen, Sacramento, $39,848.

LOS ANGELES COUNTY—Between Centinela Ave. and Slauson Ave., about 0.5 mile to be surfaced with Portland cement concrete pavement. District VII, Route 158, Section B. Contract awarded to Griffith Co., Los Angeles, $42,590.

MERCED COUNTY—Between Route 4 near Buhach and Merced Flying School, about 2 miles to be graded, bituminous surface treatment to be applied to central portion of the roadbed and penetration treatment applied to shoulders. District X. Elmer J. Warner, Stockton, $51,983. Contract awarded to E. A. Forde, San Anselmo, $50,438.

MONTEREY COUNTY—Between Reservation Boundary and 0.7 mile north of Monterey Avenue in Marina, about 1.5 miles to be graded and paved with Class "B" Portland cement concrete. District V, Route 56, Section I. Contract awarded to Walter J. Wilkinson & H. B. Scott, Watsonville, $217,592.

SACRAMENTO COUNTY—Portions between Sacramento city limits and Auburn Blvd., about five miles, shoulders to be constructed and plant-mixed surfacing to be placed over existing pavement. District III, Route 98, Section A. McGillivray Construction Co., Sacramento, $54,942. Contract awarded to A. Teichert & Son, Inc., Sacramento, $48,874.

SAN BERNARDINO COUNTY—Across Day Canyon Flood Channel about 13 miles west of Colton, a reinforced concrete bridge to be constructed. District VIII, Route 26, Section D. Byerts & Dunn, Los Angeles, $29,271; R. L. Oakley, Pasadena, $32,150. Contract awarded to Carl Hallin, Los Angeles, $28,508.50.

SAN DIEGO COUNTY—In City of San Diego, on Barnett Ave. and Lytton Street, between Rosecrans Street and Pacific Highway, about one mile to be graded and paved with Portland cement concrete and Asphalt concrete. District XI, Route 12, Sections S.D., Barnett Avenue. V. R. Dennis Const. Co., San Diego, $131,240; Daley Corp., San Diego, $134,986; Griffith Co., Los Angeles, $136,015. Contract awarded to R. E. Hazard & Sons, San Diego, $126,759.90.

SAN MATEO COUNTY—Between 2 miles south of Tunitas and 1 mile south of Lobitos, about 2.6 miles in length to be graded and penetration treatment applied. District IV, Route 56, Sections B,C. Chas. L. Harney, San Francisco, $297,065. Contract awarded to Harms Bros., Sacramento, $255,768.50.

Highway Division Designs New Traffic Signal Blackout Unit

(Continued from page 5)

The first observation from the air was made from a plane by Lt. Colonel R. T. Lester, U. S. Army Air Corp, attached to Moffett Field. Following is a copy of his report:

"The last check on the blackout bracket check-light at the intersection of Highway 101 and the Moffett Field entrance, proved very successful, the light being visible at three miles and 800 feet.

"I believe you have found the answer to the traffic situation during blackouts and I do not believe a more successful system could be devised."

A second observation was made from a Navy blimp, and the following is quoted from the Pilot's report to Commander Mackey of the U. S. Naval Air Station at Moffet Field:

"1. At 2,020 on the evening of 24 April 1942 conducted preliminary observation tests of the Bayshore highway traffic light system just outside the station (by Tiny's Cafe). Weather was clear, visibility 15 miles.

"2. It was originally intended to commence observation at such a low altitude and distance that the lights were definitely visible and to make succeeding runs at 500 feet increments of altitude up to 2,000 feet.

"3. However, this was not necessary because of the efficiency of the blackout traffic lights. Two runs were made. The first run was started at 500 feet exactly two miles away from the west lights. Complete darkness prevailed until at ½ mile away (500 feet altitude) when a very dull red reflection became visible on the pavement. This red reflection on the pavement, it is believed, would be invisible if pavement were painted black at intersection. At no time during this run were the actual traffic lights seen, although altitude was decreased to 300 feet ½ mile from the lights to directly overhead.

"Second run was made at 500 feet from the south primarily to test efficiency of the amber flashing signal. Complete blackout conditions prevailed on this run until ¼ mile from the amber signal. At this distance altitude was decreased to 300 feet whence a dull amber reflection on the pavement became visible (at no time was light seen). Altitude was increased from 300 to 500 feet and the dull amber reflection on the pavement disappeared and total darkness prevailed.

"No other runs were made at this time. All observations were made through powerful 7/50 power binoculars and with the naked eye by co-pilot and myself."

As a final check, arrangements were made for an officer of the Fourth Air Force to observe the installation. All sign lights, street lights, and other conflicting lights near the intersection were turned off before observations were made.

Lt. Colonel Kinzie reported that several flights at varying elevations from several directions were made over the intersection and at no time were the traffic lights visible from the air.

Candidate: "How did you like my speech on the agricultural problem?"

Farmer: "It wasn't bad, but a good day's rain would do a heap more good."

State of California
CULBERT L. OLSON, Governor

Department of Public Works
Headquarters: Public Works Building, Twelfth and N Streets, Sacramento

FRANK W. CLARK, Director of Public Works

ROBERT H. ROOT, Assistant Director

MORGAN KEATON, Deputy Director

CALIFORNIA HIGHWAY COMMISSION

LAWRENCE BARRETT, Chairman, San Francisco
IENER W. NIELSEN, Fresno
AMERIGO BOZZANI, Los Angeles
BERT L. VAUGHN, Jacumba
L. G. HITCHCOCK, Santa Rosa
L. L. PENFIELD, Secretary

DIVISION OF HIGHWAYS

C. H. PURCELL, State Highway Engineer
G. T. McCOY, Assistant State Highway Engineer
J. G. STANDLEY, Principal Assistant Engineer
R. H. WILSON, Office Engineer
T. E. STANTON, Materials and Research Engineer
FRED J. GRUMM, Engineer of Surveys and Plans
R. M. GILLIS, Construction Engineer
T. H. DENNIS, Maintenance Engineer
F. W. PANHORST, Bridge Engineer
L. V. CAMPBELL, Engineer of City and Cooperative Projects
R. H. STALNAKER, Equipment Engineer
J. W. VICKREY, Traffic and Safety Engineer
E. R. HIGGINS, Comptroller

DISTRICT ENGINEERS

E. R. GREEN, District I, Eureka
F. W. HASELWOOD, District II, Redding
CHARLES H. WHITMORE, District III, Marysville
JNO. H. SKEGGS, District IV, San Francisco
L. H. GIBSON, District V, San Luis Obispo
E. T. SCOTT, District VI, Fresno
S. V. CORTELYOU, District VII, Los Angeles
E. Q. SULLIVAN, District VIII, San Bernardino
S. W. LOWDEN (Acting), District IX, Bishop
PAUL O. HARDING, District X, Stockton
E. E. WALLACE, District XI, San Diego
HOWARD C. WOOD, Acting Bridge Engineer, San Francisco-Oakland Bay, Carquinez, and Antioch Bridges

DIVISION OF WATER RESOURCES

EDWARD HYATT, State Engineer, Chief of Division
A. D. EDMONSTON, Deputy in Charge Water Resources Investigation
HAROLD CONKLING, Deputy in Charge Water Rights
G. H. JONES, Flood Control and Reclamation
GORDON ZANDER, Adjudication, Water Distribution
MARK S. EDSON, Hydraulic Engineer Water Rights
SPENCER BURROUGHS, Attorney
GEORGE T. GUNSTON, Administrative Assistant

DIVISION OF ARCHITECTURE

ANSON BOYD, State Architect
W. K. DANIELS, Assistant State Architect
P. T. POAGE, Assistant State Architect

HEADQUARTERS

H. W. DeHAVEN, Supervising Architectural Draftsman
D. C. WILLETT, Supervising Structural Engineer
CARLETON PIERSON, Supervising Specification Writer
J. W. DUTTON, Principal Engineer, General Construction
W. H. ROCKINGHAM, Principal Mechanical and Electrical Engineer
C. E. BERG, Supervising Estimator of Building Construction

DIVISION OF CONTRACTS AND RIGHTS OF WAY

C. C. CARLETON, Chief
FRANK B. DURKEE, Attorney
C. R. MONTGOMERY, Attorney
ROBERT E. REED, Attorney
FRANCIS J. CARR, Attorney

printed in CALIFORNIA STATE PRINTING OFFICE SACRAMENTO, 1942 GEORGE H. MOORE, STATE PRINTER 14450 8-42 18,700

California Highways and Public Works
Division of Highways
P. O. Box 1499
Sacramento, California
Return Postage Guaranteed

CALIFORNIA STATE HIGHWAY SYSTEM