CALIFORNIA HIGHWAYS AND PUBLIC WORKS

EARL WARREN, *Governor of California*

JANUARY, 1943

CALIFORNIA HIGHWAYS AND PUBLIC WORKS

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Table of Contents

Planning for Constructive Public Works After the War is Aim of New State Administration

By EARL WARREN, Governor of California

WITH our Nation at war, we, as Californians, must give our first thought to rendering full and efficient assistance to the war effort. We must, in all departments of State Government, center efforts upon perfecting and streamlining State cooperation in the war effort.

While we face no greater immediate challenge than to turn loose the full power of State energy in the development of contributions to the war effort, we must also keep in mind the companion problem of preparing for the let-down which inevitably follows a war. I hold that it is possible to plan now in a manner which will add to our strength when these post-war tests occur.

Each department of State Government is now confronted with a dual problem—the streamlining of efforts to speed the day of victory in the war and the planning for the peace to come. Patriotic duty is now causing dislocations which will later sorely test our recuperative powers. As we plan now for the full utilization of manpower in war effort we must, therefore, also plan for the full utilization of manpower in the days of peace to come.

As Governor, it is my intention to afford Mr. C. H. Purcell, the new Director of Public Works, all support possible in the advancement of solutions of problems covered by this broad policy. Whatever is required in bridge and highway construction and maintenance for the transportation of troops, materials and supplies to advance the successful prosecution of the war, will be done by the Department of Public Works. The department will continue, through its Division of Water Resources, to afford every protection possible to transportation and communication systems and to farm lands and cities in need of protection from winter floods.

As a planning agency of State Government, the Department of Public Works, will have an important function to perform in helping to streamline our preparations for the post-war period. Vast shipbuilding, aircraft and war material industries are changing our economy. If we are to move forward rapidly after the war, we must plan those things now which attract and hold industrial effort which affords employment for our manpower. Proper highway and natural resource development will play an important part in encouraging such industrial activity.

The Department of Public Works can also make an important contribution to State welfare by planning safeguards against actual unemployment during the period of transition between war economy and peacetime economy.

Many phases of public works are adaptable to a construction program designed to relieve conditions of unemployment which are certain to occur during the post war adjustment. Construction of public buildings presents some opportunities. Highway construction will play a large part in such a program as it is one of the most flexible of all public works improvements. The units of a highway program may be changed in types of construction and to fit in with varying ratios of available men and machinery. A well planned highway program may be carried forward and stopped at most any point and the benefits to the public of the investment immediately realized as far as the improvment goes.

These projects will afford not only employment but an opportunity for the resettlement of returning veterans and those affected by the post-war shift away from industrial centers.

With all phases of construction now curtailed to projects needed for the war effort, the principal activity of the Department of Public Works is one of maintenance and planning. The use of available funds and personnel in preparation of well planned and properly correlated programs for the future is important. Planning now, so essential to proper and useful expenditure of public funds to be made during the adjustment period, will involve careful consideration of many factors.

The complexion of California is becoming more and more industrial. The 1940 census, giving the State a total population of 6,907,000, revealed an increase of nearly 22 per cent during the thirties. On January 1st a year ago the population was authoritatively estimated at 7,350,000; today the estimate is about 7,600,000, an increase of more than 11 per cent in the last three years. Analysis of the figures upon which these totals were compiled shows definitely that the greater increases occur in the industrial areas—Vallejo, the bay counties, Burbank, Long Beach, Los Angeles and San Diego.

Trends indicated by these changes must be given proper consideration in planning future public works. Transportation facilities must be planned particularly in relation to the trunk system of highways; the accessibility to the principal thoroughfares within that system; arterials into, through and around metropolitan areas; secondary roads; new bridge facilities; and replacement of inadequate bridge structures and special attention must be given highway problems linked with opportunities for development with our mineral resources.

Under this plan, California will be prepared to pass through the period of adjustment following the war, with a public works program consisting of properly designed projects to meet the needs of the State as it climbs back to a balanced economic status.

C. H. Purcell, State Highway Engineer Becomes Director of Public Works

AFTER fifteen years service as State Highway Engineer of California, Charles H. Purcell, builder of the San Francisco-Oakland Bay Bridge, on January 5th assumed the office of Director of the Department of Public Works under appointment by Governor Earl Warren.

Born in North Bend, Nebraska, January 27, 1883, Mr. Purcell attended Stanford University for one year in 1902. The death of his father caused him to go to Chicago, where he took the first job that was offered, which happened to be messenger in the Grain Pit.

He had early set his heart on becoming an engineer, so after twelve months in Chicago, he gave up his position and enrolled in the University of Nebraska. He was graduated as a civil engineer in 1906.

He gained his first engineering experience during his sophomore and junior years by working Saturdays and during vacations as a draftsman for the Burlington Railroad. After receiving his diploma, Mr. Purcell became an instrument man and later was appointed resident engineer for the Union Pacific in Wyoming. Here he built his first bridge. It was a 200-foot, steel girder, concrete-foundation structure across Bitter Creek. From that time on bridges were his hobby.

Charles H. Purcell
Director of the State Department of Public Works of California

WENT TO PERU

From Wyoming, Mr. Purcell went to Ely, Nevada, where the Guggenheims were building a $17,000,000 smelter. The chief engineer was Tom Cox. He gave young Purcell a job never dreaming that one day Purcell, as chief engineer of the most famous bridge in all of the world would send for him and place him on his staff of engineers.

About the time that the Guggenheim smelter was completed, American capital was looking with interest toward the mines of South America and Mr. Purcell, with a small company of men who had worked with him at Ely, went to Peru, where for two and one-half years he acted as principal assistant chief engineer for the Cerro de Pasco mines in charge of design and erection of steel buildings.

His job in Peru finished, Mr. Purcell went to New York and then in 1910 came to California. He went to Marysville to design steel work for gold dredgers then being built in the Oroville district. From here he went to Oregon and took a job as chief engineer of a Columbia River logging railroad. Oregon at this time was building a number of road bridges of steel construction. Mr. Purcell proposed that concrete bridges be built across the smaller streams.

BUILT COLUMBIA RIVER HIGHWAY

As a result of this work, Mr. Purcell was appointed the first bridge engineer for the then newly organized Oregon State Highway Department, later becoming assistant to the State Highway Engineer in designing and constructing Oregon's first paved highway in Jackson County.

Leading citizens of Portland were dreaming of a great highway along the Columbia River and they turned to Mr. Purcell to help them build it. Mr. Purcell resigned from his State position and became the bridge engineer of the Columbia River Highway project.

When this task was completed he returned to his post as State highway and bridge engineer. He remained for a year and then for two years was bridge engineer for the

(Continued on page 11)

Report Tells Many Drastic Changes In Highway Activities Caused by War

PREFACING the Thirteenth Biennial Report of the Division of Highways, covering the period from July 1, 1940, to June 30, 1942, Charles H. Purcell, who was elevated by Governor Earl Warren from the post of State Highway Engineer to the office of Director of the Department of Public Works, calls attention to post-war highway problems which must be anticipated and the need for careful study and planning for future highway development.

Referring to the last biennium and its effects upon the Division of Highways, Mr. Purcell says:

"During this period, the country has undergone the severe transition from a peace time economy to one geared to the necessities of all-out war effort. Concurrently with this transition in National life, the activities of the Division of Highways have undergone drastic and rapid changes.

"For many years improvement to the California State Highway System has been on a definite development program aimed to provide adequate facilities for the motor vehicle transportation of the entire State and highway budgets have been prepared on this basis.

"The budget for the biennial period July 1, 1941, to June 30, 1943, was so prepared and adopted by the California Highway Commission on December 30, 1940. During 1941, as the possibility of war became more imminent and the National Defense Program rolled into action, construction costs rose rapidly so that a complete revision of the budget became necessary. To meet the rising costs required shortening or changing the design of some budget projects and elimination of others. This revised budget was adopted by the Commission on November 10, 1941.

"It is now apparent that, with the shortage of rubber, speed limitation and the rationing of gasoline in the west this Fall, revenue from the State gas tax will be greatly reduced. It is anticipated that further reduction in the State Highway Budget in a sum of between five and six million dollars will be necessary before the budgetary biennium ends on June 30, 1943, so that projects financed with State funds will be within the decreased revenue.

"During the years of 1940 and 1941, the Division of Highways and the Public Roads Administration working in conjunction with Commanding Officers of the Army, Navy and Marine Corps establishments in California, prepared a comprehensive program of projects approved by the War or Navy departments for the construction of roads serving as access to military and naval establishments and to industrial plants engaged in defense construction. As most of these access road projects are situated off the State Highway System, it was impossible to use State highway funds for either construction, engineering, or right of way on such work. Under a 1940 amendment to the Federal Aid Highway Act, it was possible, however, to finance surveys and plan preparation from Federal Aid and Federal Aid Secondary funds apportioned to California. On November 19, 1941, the President approved the Defense Highway Act which provided funds for construction of Access Roads.

"By the outbreak of the war on December 7th, California had so advanced the preliminary engineering on the access road program, that of the total program in this State of nearly $45,000,000 in projects requested by the military, surveys had been completed and plans prepared on work to the value of more than $20,000,000. The $150,000,000 in Federal funds authorized for access road construction throughout the Nation became available about the first of the year and the first certification for construction of a California project was received late in January and bids opened on February 18, 1942. Since that time a large percentage of the work of the department has been in advancing construction on certified access projects.

"While the access road program was proceeding, needed improvements were being made on the Strategic Highway Network, which consists of existing highways officially designated by the War Department as essential to defense and military operations. This National network was adopted after several years of joint study by Army officials, the Public Roads Administration and the State highway departments. The strategic highways are shown on a National diagrammatic map revised to May 15, 1941. In general, the network is located on the Federal Aid Highway System and on State highways and that portion situated in California comprises approximately 5,900 miles.

"During the late Spring of 1941, when it became evident that drastic curtailment was necessary in the peace time use of materials which were needed for war purposes, the Federal Administration inaugurated the priority system for control of the use of critical materials. Foreseeing possible restrictions on highway activities from the lack of materials, the Division of Highways immediately assigned engineers from the Headquarters staff to a study of the situation and of required procedures for securing adequate priority preference ratings for materials needed in highway construction. Assignment of these engineers has proven to be of the greatest benefit to the work of the Department and their knowledge of priority procedure has prevented many delays, which might have seriously impeded construction operations.

"The increasing Federal restrictions placed on the normal use of materials, equipment and processes began having a marked effect on highway construction during the Fall of 1941. On April 9, 1942, Conservation Order L-41, and its amendment L-41-600, promulgated by the War Production Board, placed nonessential construction under rigid control. Under the requirements of this order highway activities, amounting to a

(Continued on page 18)

New Combination Bank Protection Constructed on Eel River near Dyerville

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

DURING the winter of 1939-40, after a long period of stability, the Eel River at the confluence with the South Fork, for some reason yet undetermined, decided to change its course.

At the beginning of the meander in 1939-40 the bank of the river was 400 feet away from the highway. The winter of 1940-41 saw this distance cut to 200 feet. Finally in the 1941-42 season the incursion had reached and attacked the highway at a point immediately below Dyerville on the famous Redwood Highway. It was evident that another winter season would find the roadbed washed out.

COMPROMISE DESIGN USED

Immediate studies were made and designs considered to prevent threatened destruction of the highway. Design proposals incorporating excessive amounts of critical materials needed for the war effort were discarded. Finally a compromise design was accepted that would give maximum protection with a minimum use of critical materials already on hand.

The adopted design was a new combination bank protection consisting of medium rock riprap 2 feet 9 inches thick, normal to a 1½:1 embankment slope, and 6 inch x 25 foot flexible rock and wire mattress 5 feet above the toe of the rock riprap.

The bank to be protected consisted of alluvial silt extending to a depth of 15 feet below the stream bed. Borings indicated that the silt was underlain with an undetermined depth of gravel. Experience on the Eel River indicated that any design which did not provide against scour at the stream bed or for 15 feet or more below the stream bed level, would be subject to damaging scour and failure.

35-FOOT FLOOD HEIGHT

Although low water discharge of the Eel River in the dry season is comparatively small, high water discharge during winter and spring flash flows, approximates 300,000 second-feet and rises 30 to 35 feet above the low water stream bed at this point.

To protect a bank against the tremendous forces exerted on the outside of such a bend demands first-class A-1* bank protection.

In the case of easily erosible material as existed in this case on the outside of a bend, maximum scouring occurs, not near the surface, but near the bottom of the bank at stream bed level. As has been demonstrated by experiment, there is a diagonally downward flow of water on the face of a steep bank on the outer side of a bend.

DIAGONAL VELOCITY DEVELOPED

Head developed by superelevation of the water surface next to the outer bank induces a diagonally downward velocity of the current. This current causes particles of solid material to become dislodged from the bank and these particles are acted upon by the force of gravity in addition to the downward velocity of the water, causing increasing scour towards the bottom.

Since this downward current causes scour along a more or less inclined bank, a horizontal obstruction is a most direct means of intercepting and destroying it before it undermines the installation.

The rough surface of the rock riprap tends to create turbulence of stream flow and lessens the effect of the downward velocity. The horizontal rock and wire mattress 5 feet

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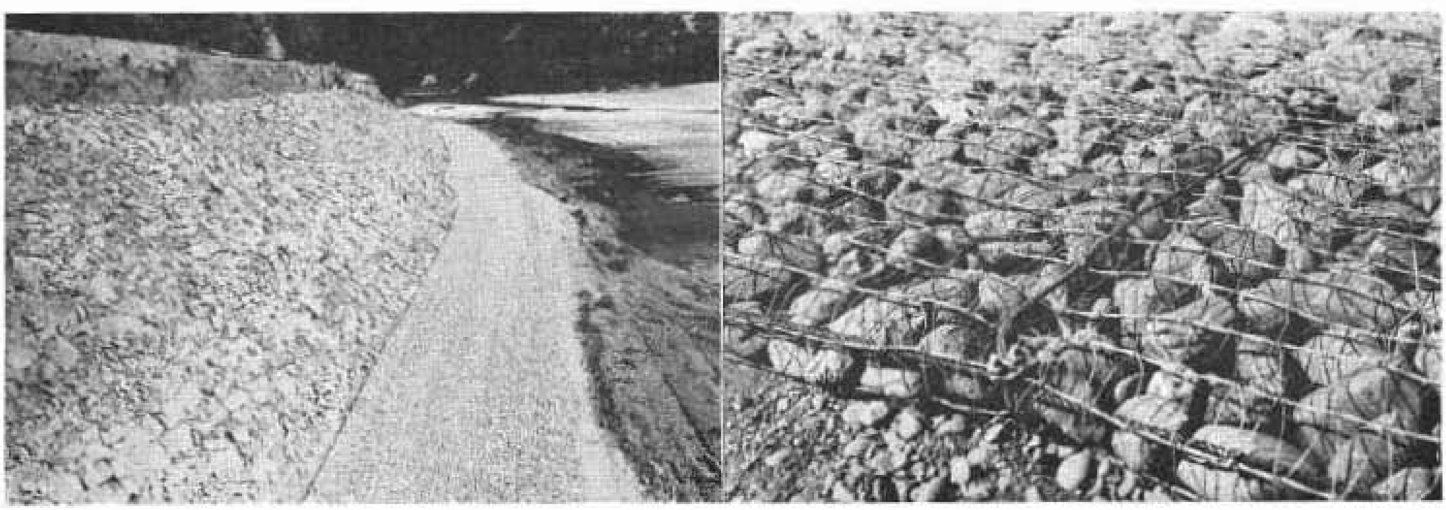
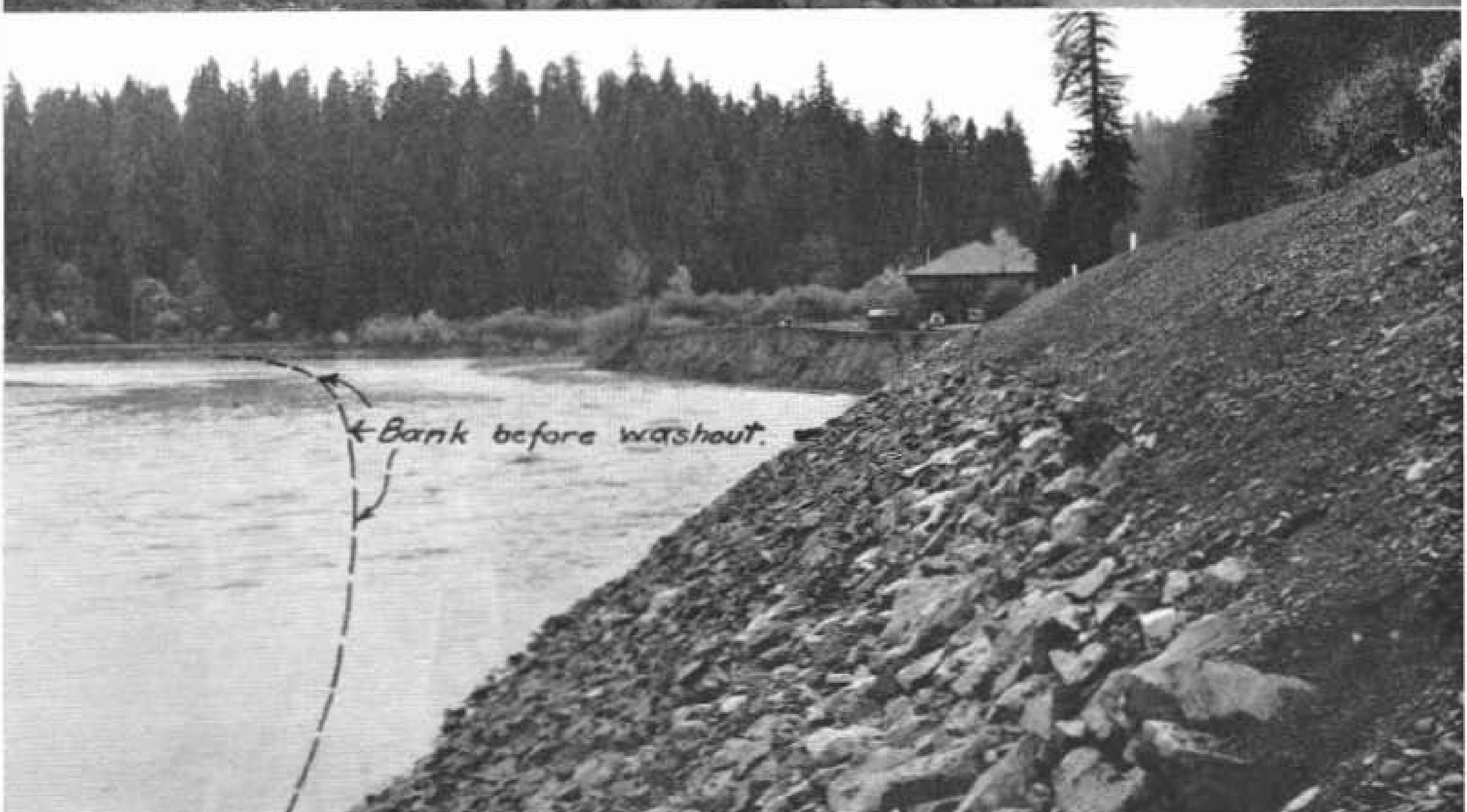
*See July, 1939, issue California Highway Public Works Magazine.



Rock riprap and wire mattress protection of left bank of Eel River below Dyerville. Left: general view, looking downstream Right: detail of mattress and cable tie.



Left bank of Eel River, looking upstream toward Dyerville. Top: general view, showing extent of erosion since 1939 threatening highway which is marked by white posts. Bottom: high bank of alluvial silt has been cut to steep slope; note eddy salient in right center.

Culvert Outlets and Endwalls On California Highway System

By R. ROBINSON ROWE, Assistant Engineer, Bridge Department and
CLARENCE F. WOODIN, Assistant Maintenance Engineer

FOREWORD

This is the fifth of a series of technical abstracts from a joint departmental review of culvert practice of the California Division of Highways, by a committee composed of G. A. Tilton, Jr., Assistant Construction Engineer; Robert L. Thomas, Assistant Engineer, Surveys and Plans; and the writers. Following the preliminary outline of subjects in the August number of the California Highways and Public Works, the series opened with: September issue—Comparative Hydrology Pertinent to California Culvert Practice; October issue—Debris Control at Culvert Entrances on California Highways; November issue—Highway Culvert Location and Slope from a Review of California Practice; December issue—Culvert Entrances and Headwalls on California Highway System.

The series continues with a study of factors influencing designs of outlet works. For reasons given, these factors at any one site are variable with time and beyond control by the designer. Hence the type of works must be selected by judgment rather than rule; and maintenance should modify the works rather than restore the initial conditions.

THE outfall of a culvert is functionally the antithesis of its approach. One is an accelerating transition channel, the other a decelerating transition. One accumulates potential energy in its forebay and transforms it to kinetic energy; the other must dispose of the excess energy by dissipation or transformation. The entrance is usually an artificial, permanent control for the stream channel; hydraulics at the outlet depends upon downstream controls, usually natural and often unstable.

Constructing the outfall works identically the same as the approach does not satisfy the reversed conditions, for reasons which are worthy of review, but the Committee found that a large proportion of culvert appurtenances were designed in this way. Particularly, if the headwall is straight, U-shaped, flared or warped—so is the endwall. If there is a paved approach apron with deep cut-off, then the outfall apron and downstream cut-off will match it. If headwalls protect embankment against a stage 3 feet above crown of culvert, then so do the endwalls. Occasionally the symmetry of upstream and downstream protection appears as ridiculous as would a debris barrier at outlet to match one at entrance.

However, it was encouraging to find that this illogical symmetry was more typical of the older than the newer installations. More recent construction showed a rational trend in the design of outfall works. Performance of these newer designs was observed for this report, although many have not yet experienced extreme floods.

Design Variables

For many sites, there will be natural security of culvert outfall because of some combination of small discharge, low velocity, maturity of channel or durability of channel perimeter. For others, the design of outfall works must consider the following variables:

1. The energy of effluent. This may be expressed as energy head above mean elevation of invert. If more than one-third of this energy head is kinetic, then velocity is supercritical and the momentum equation will govern in the outfall transition. On the sketch of typical profiles **(Fig. 29)** the plus signs above vectors indicate supercritical (shooting) and minus signs, subcritical (streaming) flow. These terms derive from the accepted conception of "critical flow," when total

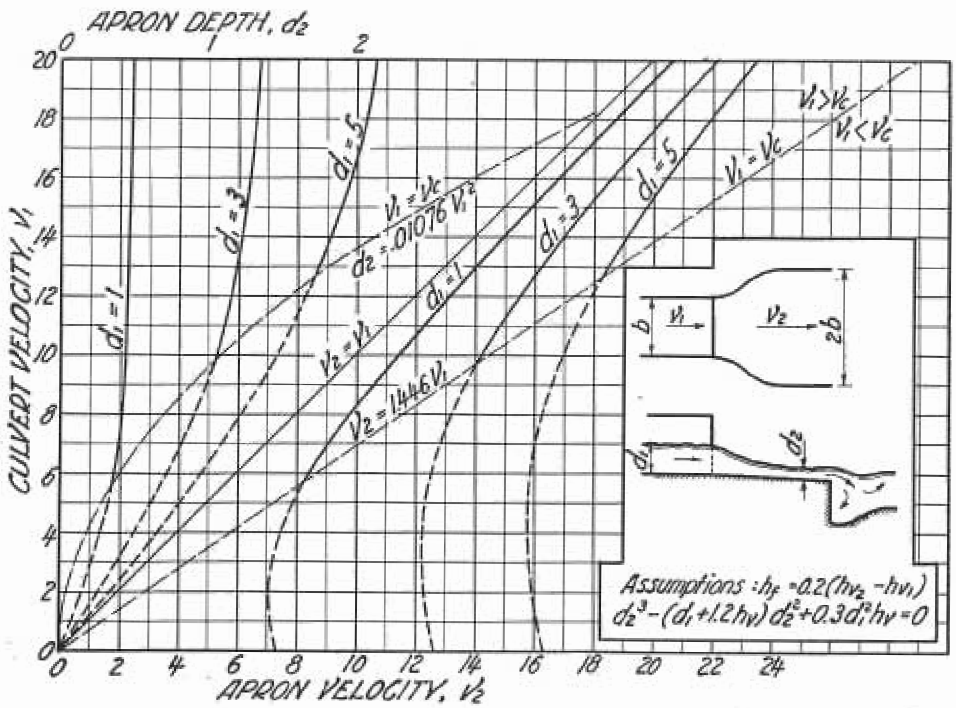


FIG. 30. Guide Chart, for estimating free-outfall depth and velocity on apron from depth and velocity at culvert outlet

energy is a minimum and mean depth is double the velocity head.

2. The get-away of downstream channel. In **Figure 29** three conditions are recognized — submerged, controlled, and free—and the influence of these conditions is shown qualitatively. If get-away is poor, the outlet will be submerged and flow full, so transition velocities will be slow or moderate. If get-away is good, the outlet will be free and high velocity will be maintained or developed in the transition. For intermediate get-away, action of the transition must be studied to distinguish between accelerating flow **(Case B)** and the hydraulic jump **(Case F)**.

3. The security of bed against scour. Bed scour may be expected at any free outlet, but not necessarily at ends of all steep culverts. In **Case F**, for instance, the jump may occur on the apron or within the culvert conduit; downstream from the jump, velocity should be lower than the ruling velocity of the stream—hence endurable by the bed. Durability of the bed depends on the hardness and consolidation of an erosion surface or on coarseness of overlying products of erosion.

4. The security of banks against scour. Banks may expose strata of diverse durability. Scour is most serious if the softer layers are near mid-depth, when upper layers will be undercut. Soft layers near bed level will be intermittently protected by talus from above. Scour may progress from direct attack of oblique flow in the expanding transition, or by eddy action if the transition is too rapid.

5. The future control of stream flow. For a channel of nearly constant width, elevations of rock ledges or coarse bars will control stages for some distance upstream. If such are lacking, the bed level is probably unstable and the trend (scour or deposit) should be determined. Submerged outlets may become free, and vice versa. If width of channel is far from constant, the control may be a constricted section. Riparian vegetation is a potent factor, but permanence should be questioned.

Free Outlet Transition:

The typical free-outlet culvert is about half as wide as the natural

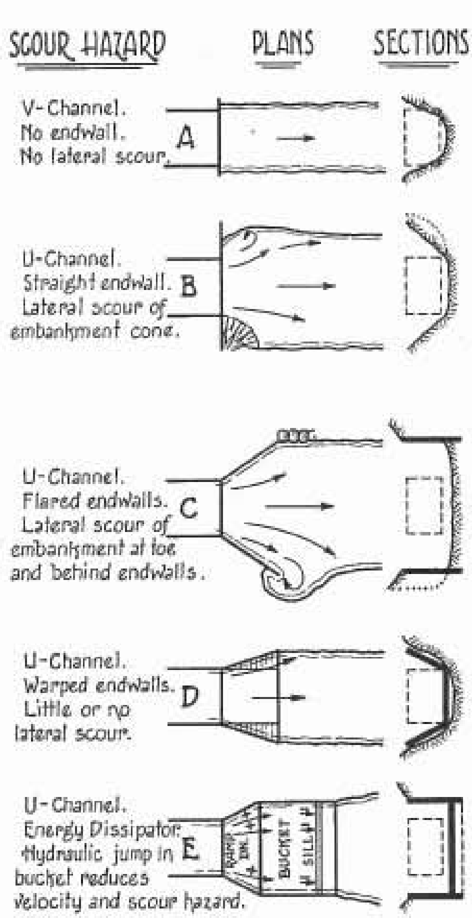


FIG. 32. Influence of transition shape on hazard of lateral scour

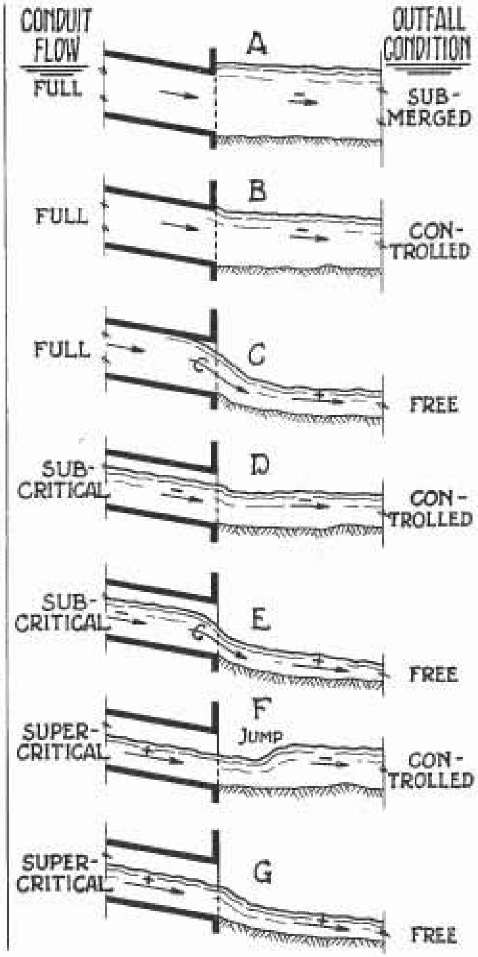


FIG. 29. Typical combinations of conduit flow and get-away

channel. As shown in **Figure 29, C, E, and G,** the water surface must drop because of freedom. This drop will increase velocity and reduce area of wetted section; hence depth must be less than half that in the culvert. Since the energy equation (Bernoulli's Theorem) governs accelerating flow, the reduction in depth and potential energy must be compensated by an increase in kinetic energy and velocity.

The compensation is not complete because of turbulence, eddies, and boundary friction—amounting ordinarily to 20 per cent of the change in velocity head. (In efficient transitions, this can be greatly reduced, but an inefficient transition is more desirable for culverts.)

Figure 30 has been drawn as a guide for estimating apron depth and velocity from outlet depth and velocity, the relations depending upon the cubic equation shown. The curves at the left give the depth over the apron for three depths at outlet and the three curves at the right the corresponding velocity. Each set is divided by a line representing critical flow at the culvert outlet. Above this line, all flow is shooting and the curves are reliable. Below, the flow is streaming as it leaves the culvert, contracts to critical flow with little loss of energy, and then becomes shooting. Probably the aggregate loss of energy will be less than assumed, so that velocity will be greater and depth less than indicated by the dashed portion of the curves.

As an example of the use of this guide, suppose that culvert effluent has been computed at 15 feet per second for a depth of 3 feet. Then on the apron (if twice as wide as culvert) velocity will increase to 17.8 feet per second and depth will be only 1.26 feet.

In particular, if the effluent is just critical, the velocity will increase 44.6 per cent. Percentage increase will be more for streaming flow and less for shooting flow. Not shown on the curves but deductible from the same premises is the fact that critical effluents minimize apron velocities. In the example, had the same discharge been streaming, say 5 feet deep at 9 feet per second, apron velocity would have been 16.6 feet per second. But if just critical (effluent velocity 11.36) apron velocity would have been 16.4 feet per second.

Free Drop Outfall

As an extreme, the free outfall may be a free drop, as was illustrated **(Figure 12[1])** for Modified Bottom, Sidehill, and Top Locations; for these, the foregoing transition computation is not applicable, of course. The scouring power of free drops is well understood, but experience **(Figure 31a)** has taught that the effluent trajectory must clear the embankment slope by a safe margin or the embankment will slough into the tailwater pool. The critical trajectory will be that for a small discharge.

Also, an ordinary free outfall may become a free drop by degradation of an unstable channel. Even rock sections may be eroded rapidly by boulder-loaded streams accelerated by long culverts **(Figure 31b)**. While it may be economy to add outfall works after such conditions develop (if such a trend be uncertain) it would be prudent to allow for this contingency in cost comparisons of alternative designs.

Controlled Outfall Transitions

Future conditions are most uncertain if the downstream channel is naturally controlled at some point beyond the right-of-way line. The control may have been naturally unstable, or a physiographical balance may be upset by the culvert. Such an upset may result from the acceleration of flow, change in channel alignment or grade, or modification of detrital loads.

Since future change is difficult of prediction, it is not sound economy to provide expensive works to guard against all contingencies. However, initial works or maintenance should assure against damaging alteration through property of others, or sudden loss of highway structure or embankment.

Obviously the best assurance is construction of a transition which will discharge the flow **at all stages** just as the former channel did. Granting that such provision is rarely possible or economical, it is a matter of judgment to determine the tolerable departure. As a rule, bed scour is less serious than lateral erosion. The former leads to a free outfall **(Figure 31b)** and can be corrected by maintenance betterment of the outlet structure; but lateral erosion may be progressive downstream, so that modification of outlet works can not provide a remedy.

Endwalls Influence Lateral Scour

Endwalls serve the dual purpose of retaining the embankment and limiting the transition. Older designs, such as the straight or flared walls **(Figure 32B, C)** were economical retainers but poor transitions. Use of these below small or submerged outlets is satisfactory, but embankment cones at ends of these walls are frequently cut at controlled outlets.

Erosion of embankment toes can usually be traced to eddy action, as sketched. **Figure 33** shows an extreme case, where the angle of flare was too great and transition too short. Severe damage has been recurrent, during floods of less than half the design discharge. At this site, the design discharge was 1,200 second-feet, anticipating moderate effluent velocity, as outfall channel seemed stable with fair controls and culvert gradient was only 0.8 per cent. Prior to 1942, the old-style high wingwalls (see construction joints in photos) were lost and apron was undercut. Although discharge did not exceed 640 second-

[1] See November, 1942, Issue (Page 5) California Highways and Public Works.

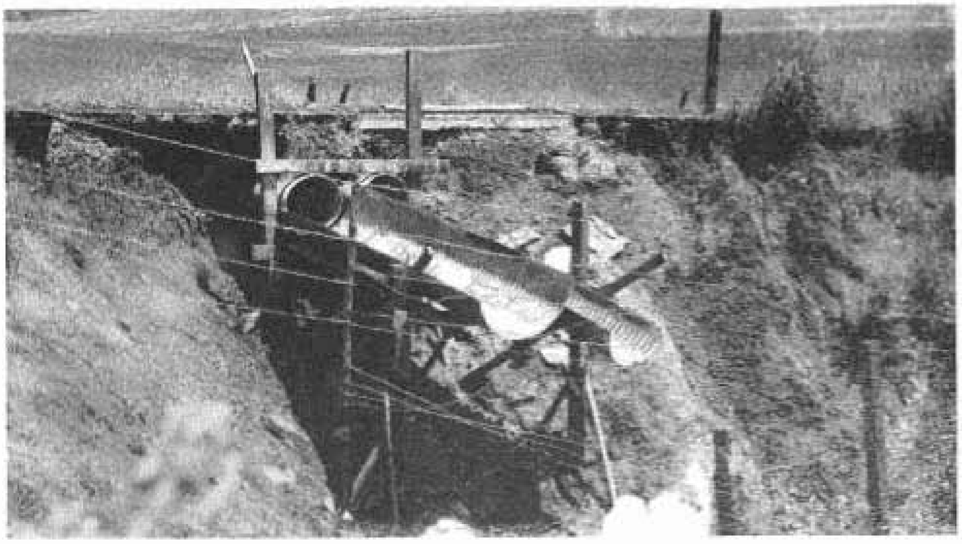


FIG. 31a. Projecting culvert with temporary extension, added after serious loss of embankment

FIG. 31b. Soft bed rock has been scoured rapidly by accelerated boulder-laden flow

feet, effluent velocity reached 14.3 feet per second. The later pictures show further damage to wingwalls, apron, and uncompleted jetties in the 1,000-year storm of 1942, when discharge of 2,000 second-feet created effluent velocity of 18.6 feet per second. At end of apron, velocity probably reached 25 feet per second, producing underscour and powerful lateral eddies.

An ideal transition is a complicated ogee expansion, fitted to the variable momentum, dissipating very little energy. This is not satisfactory for a culvert outlet, where it is advantageous to reduce energy. A flared transition is very effective, if proportioned so that eddies induced by the effluent jet do not continue beyond the end of the wing or overtop a sloped wing. As a guide, it is suggested that product of velocity and flare angle should not exceed 150. That is, if effluent velocity is 5 feet per second, each wing may flare at 30 degrees from the thread of the stream; but if velocity is 15 feet per second, the flare should not exceed 10 degrees.

The warped endwall **(Figures 32D and 34)** has been very successful as a transition, because it releases the flow to a trapezoidal section. Wider use is recommended, especially if the apron must be paved anyway, but it should be designed to greater length and less flare (at top) than similar walls used at culvert entrance. Even for free outlets, there will be little acceleration in this type of transition, so Figure 30 should not be used to compute apron velocity.

The energy dissipator is still in the experimental stage. Apparently successful for a free outfall followed by a sharp bend is the hydraulic bucket **(Figure 32E)** adapted to the outfall of Salt Creek **(Figures 35a and b)**. A free drop qualifies in this respect; as a surge pool must follow, there is advantage in locating the drop ahead of the outlet **(Figure 36)**.

Cost of transition structures may be reduced by suiting the material to the velocity. **Figure 37** shows warped wings of reinforced concrete followed by broken-slab riprap to a bend in the channel. On the bend, the riprap is continued on the outside only, the inside bank being stable. This transition was

FIG. 33a. Nojoqui Creek culvert in 1940, after discharge of 640 second-feet

FIG. 33b. Nojoqui Creek culvert after 2000 second-foot flood of December 1941

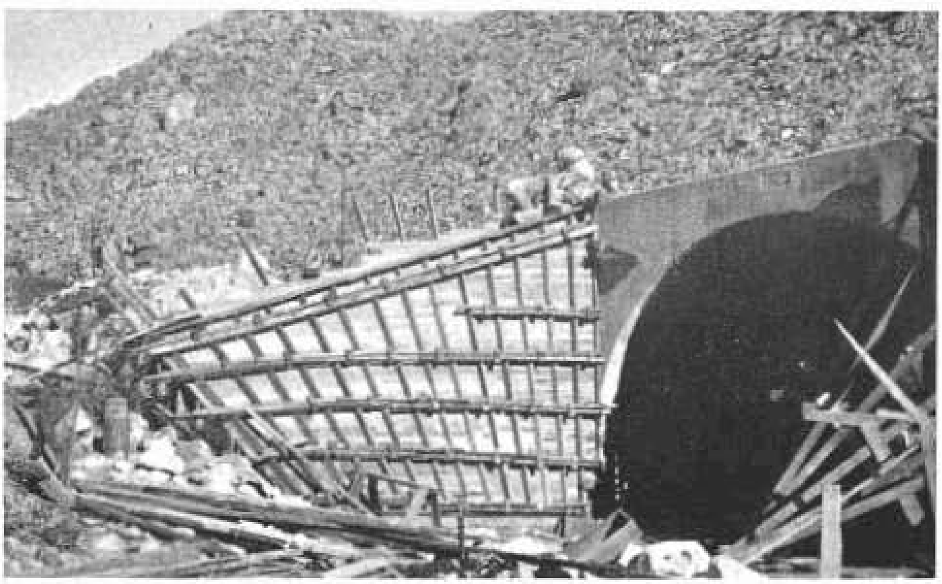


FIG. 34. Construction of warped end wall

developed by progressive maintenance.

Maintenance and Supplemental Design

Such developments are economic. In so many cases, the uncertainty of future channel controls will make a **safe** design very expensive. Rather than to anticipate the worst possible conditions, the designer may take ordinary precautions to provide a reasonable security.

Subsequently, following a critical test under storm conditions, the design of the outlet works may be revised intelligently and reconstructed by maintenance forces. This procedure should be considered "supplemental design" and is not "maintenance" as defined by the Highway Code. However, the maintenance personnel are the first to discover the damage after floods, and should properly initiate the corrective work.

At such times, patchwork should be the minimum necessary to restore roadway and prevent further damage. Conditions should be studied carefully while evidence of scour is clear. After the study, a report with recommendations should be forwarded to the designer for review, so that a supplemental design may be prepared.

For example, scoured fill cones along banks at outlet may be a warning that a large volume of embankment is threatened. If restoration and protection is confined to the slightly damaged area, the repair may prove temporary. Careful analysis of other evidence of scour might have predicted impending damage to the highway, structure, or downstream property.

Recommendations

Summarizing its findings, the committee recommends generally that:

(1) Unless it can be shown with reasonable assurance that no damage will result, the outfall works should provide a transition for the 100-year flood without freeboard (balanced design), from the culvert outlet to a section in the natural channel where natural stage, width, and velocity will be restored, or nearly so.

(2) If an outfall structure is required for the transition, it will not be a counterpart of that required at the entrance.

FIG. 35a. Bucket outlet deflects Salt Creek through angle of 70°

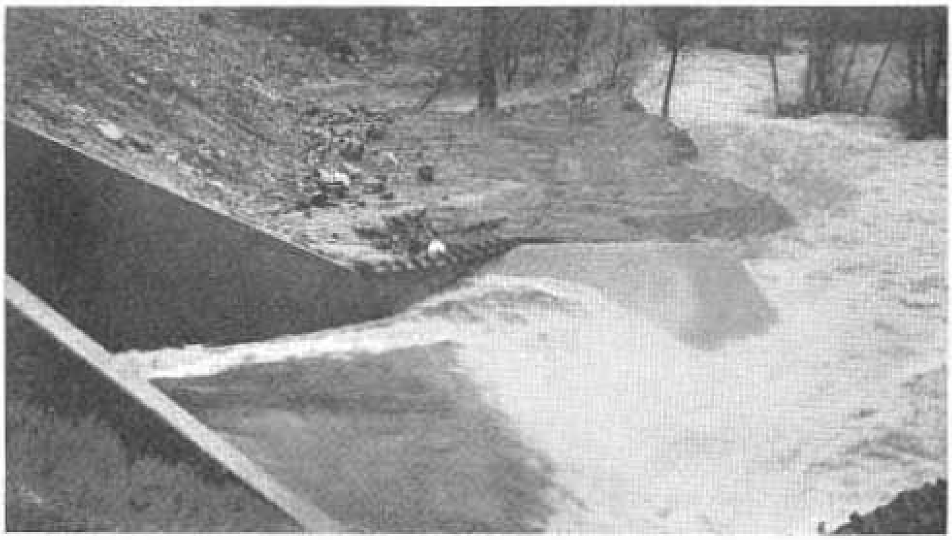


FIG. 35b. Close up of Salt Creek outlet, shooting at 22 feet per second

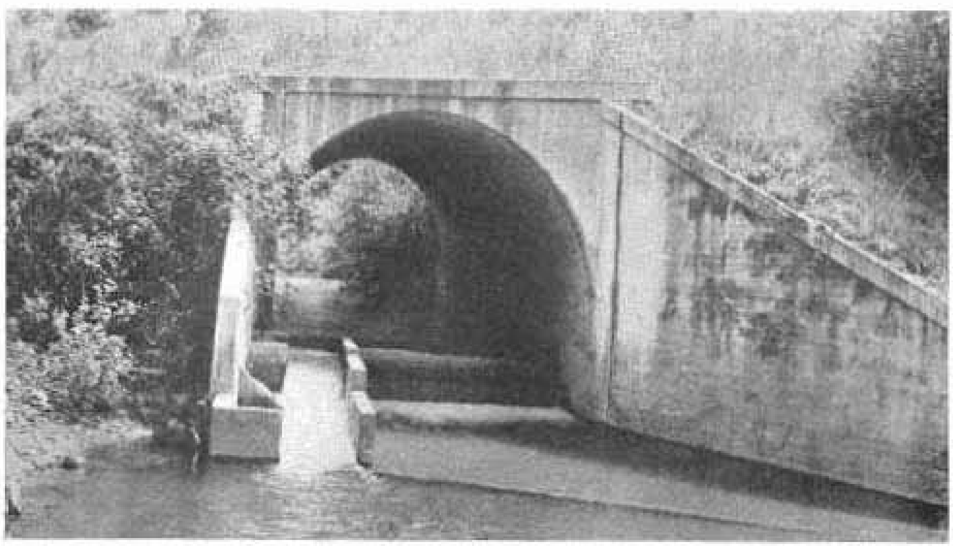


FIG. 36. Rattlesnake Creek, with drop inside the arch culvert. Note fish ladder at left

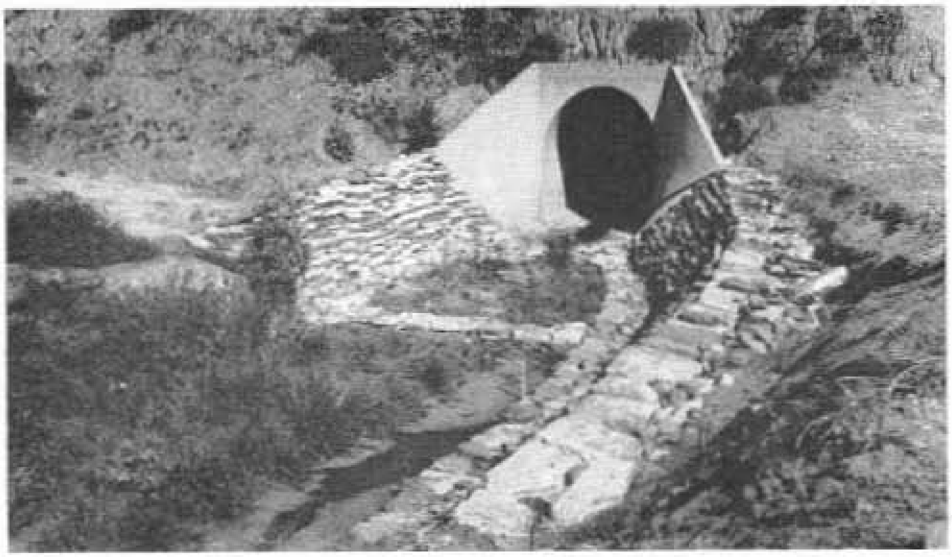


FIG. 37. Warped endwall proved too short. Transition extended by supplemental design

(3) The outfall works must be considerate of energy of culvert effluent, get-away and stability of natural channel, and security of bed and banks against scour.

(4) Wingwalls, if intended for an outfall transition, should not flare at an angle (in degrees) greater than 150 divided by the outlet velocity in feet per second.

(5) Warped endwalls can be designed economically to fit trapezoidal or U-shaped channels, as transitions for moderate-to-high velocity (10-18 feet per second).

(6) For extreme velocity (exceeding 18 feet per second) the transition can be shortened by use of an energy-dissipating structure. Design should be guided by observation of experimental structures, such as drops and buckets.

(7) Where future control of outfall is uncertain, the initial design with reasonable security should be modified by progressive supplemental design. Pending review of seasonal damage, repairs should be held to the minimum.

Governor Warren Appoints Purcell Director of Public Works

(Continued from page 2)

United States Bureau of Public Roads, with headquarters in Portland.

In 1920 he was appointed district engineer of the Bureau of Public Roads in charge of District No. 1, embracing Oregon, Washington, Montana, Northern Idaho and Alaska and for seven years supervised the spending of fifty-five million dollars of Federal money on national forest and national park highway and bridge work.

In February, 1928, Mr. Purcell was appointed State Highway Engineer of California and in the 15 years has supervised construction and maintenance work on highways involving the expenditure of $561,000,000.

In addition to this he supervised the construction of the San Francisco-Oakland Bay Bridge, the total cost of which was $73,000,000.

When Mr. Purcell was offered his California post by Governor C. C. Young and Bert B. Meek, then Director of the Department of Public Works, he was told that he would be expected to make a comprehensive report on state-owned toll bridges, including the proposal to bridge San Francisco Bay.

This was greatly to Mr. Purcell's liking. It was right down his alley. It was in line with his dreams. It was to make him the greatest bridge builder of all time.

Mr. Purcell is an associate member of the American Society of Civil Engineers, and a recognized national authority on public highways. He is also a member of the National Executive Committee of Ten of the American Association of State Highway Officials and is a representative of the United States on the Permanent International Commission of the Permanent International Association of Road Congresses.

APPOINTED BY PRESIDENT

In May, 1941, President Roosevelt appointed Mr. Purcell a member of the Interregional Highway Committee of seven men to make a study of post-war development of an improved system of national highways.

Mr. Purcell was appointed a member of a committee of 12 nationally known highway engineering experts by Secretary of Agriculture Henry Wallace in June, 1937, to promote maximum safety and highway utility; official title—Special Committee for the Consideration of Administrative and Design Policies for Highways.

FORMER PRESIDENT A.A.S.H.O.

In November, 1937, Mr. Purcell was appointed Executive Officer, California Commission for the 1939 Golden Gate International Exposition. He served as president of the American Association of State Highway Officials in 1938.

He holds honorary degrees of Doctor of Laws from the University of California; and Doctor of Engineering, University of Nebraska.

MEXICO PLANNING A BIG ROAD PROGRAM

Mexico's Ministry of Communications has announced the biggest road-building program in Mexican history to be undertaken with United States' financial aid in order to facilitate raw material shipments to this country for war production.

A network of hundreds of miles of new roads will be built, linking Mexico's east-west coast and connecting with Arizona and New Mexico. The plans also call for completion of the Pan-American Highway to Guatemala. The program is to be financed by a $30,000,000 United States loan, plus several million dollars which Mexico will receive from the new lend-lease agreement.—*Highways of Happiness Magazine.*

December Survey Shows Gas Rationing Cut Traffic to 65 Per Cent of 1941 Figure

As a result of gasoline and tire rationing, December traffic on California State highways was approximately 65 per cent of the 1941 volume, a survey conducted by the Division of Highways revealed. Gas rationing became effective in this State on December 1st.

This reduction in motor vehicle travel corresponds very closely to the percentage which the Baruch Committee held to be the essential traffic which should be maintained to prevent serious dislocation of the Nation's transportation system.

Californians not only are limiting their driving but also are conforming generally to regulations calling for reduction in speed, the survey revealed.

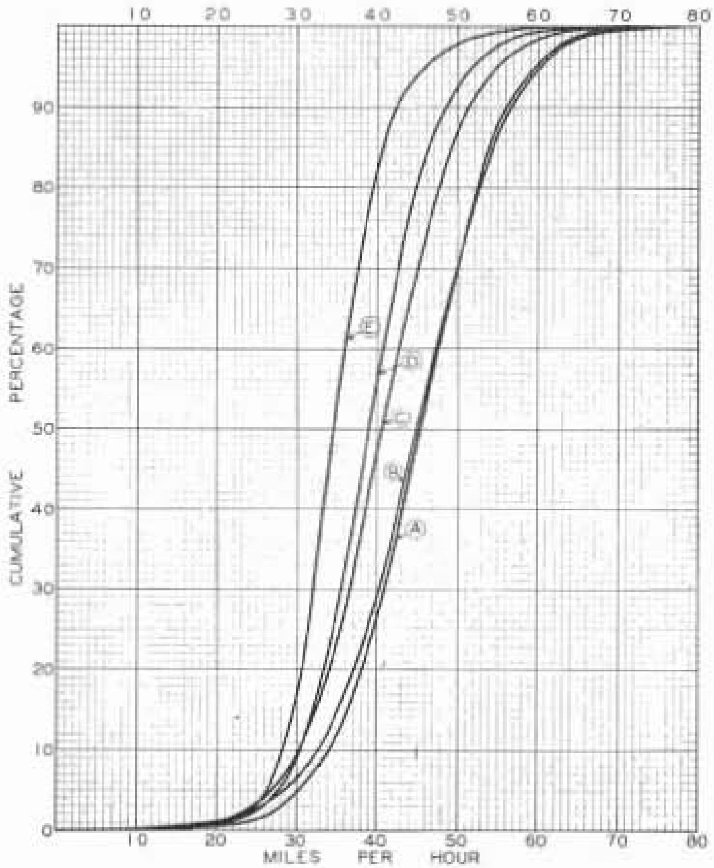
In the June, 1942, issue of this magazine an article entitled "Interesting Trends in Wartime Traffic Shown by Survey" told of changes in highway traffic which had been noted as resulting from our entry into the war.

Accompanying the article were two charts prepared to illustrate graphically these changes with respect both to traffic volume and traffic speeds.

The Traffic and Safety Department of the Division of Highways has for many years conducted traffic counts regularly once each month throughout the year at numerous representative locations covering the entire State, and the results of these counts for the remaining eight months of the current year have now been added to the original chart.

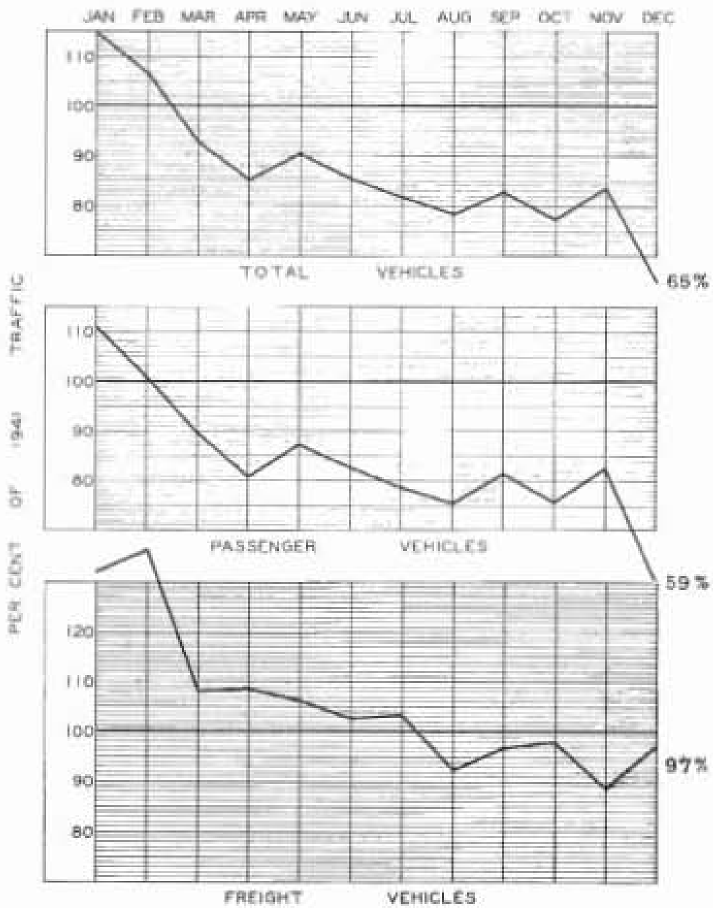
Up until that time such changes as had occurred in traffic speeds were the result of purely voluntary action on the part of the motorists. Later a direct appeal was made by the President that speeds should be kept under 40 miles per hour, and still later, after the issuance of the Baruch report, a universal speed limit of 35 miles per hour was proclaimed.

Checks were taken to determine the reaction of California motorists to each of these requests for further reduction in speed, the first check being made in August and the second in November. The results of these speed surveys, together with the three shown in the original article, are to be found on the present chart in curves "D" and "E" respectively.



	AVERAGE SPEED	CRITICAL SPEED
Ⓐ PRIOR TO JUNE 1941	47.7	53.8
Ⓑ NOVEMBER 1941	47.3	54.3
Ⓒ MAY 1942	43.3	49.2
Ⓓ AUGUST 1942	39.9	46.3
Ⓔ NOVEMBER 1942	35.6	40.7

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
TRAFFIC AND SAFETY DEPARTMENT
SPEED CURVES
RURAL STATE HIGHWAY SYSTEM



STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
TRAFFIC AND SAFETY DEPARTMENT
1942 TRAFFIC TRENDS
STATE HIGHWAY SYSTEM

Steel Scrap From Old Highway Bridges Salvaged to Build New Structures

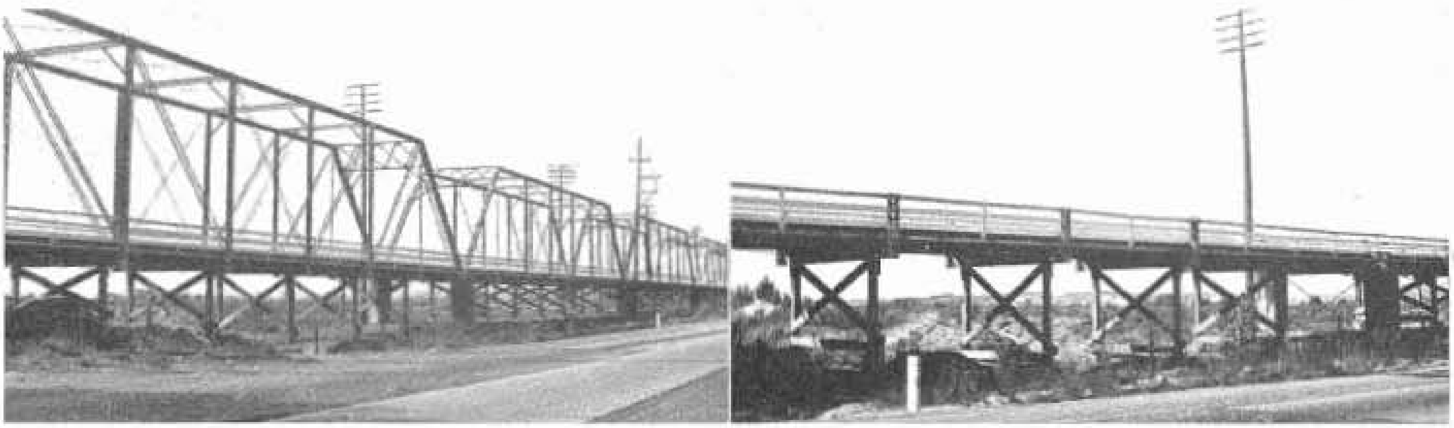
By W. A. DOUGLASS, Senior Highway Engineer

FOR the past 18 or 20 months steel in all forms—structural, reinforcing, bolts, hardware, nails, etc.—has been severely restricted for civilian use. Where normally the Division of Highways would use hundreds of tons each year in the construction and repair of all types of bridges, the work during the past several months necessarily has been restricted to projects of direct benefit to the war effort and those absolutely essential to the maintenance of highway service.

In the manufacture of steel, both iron ore and scrap steel are used. The scrap steel is essential to production of satisfactory new steel. The Government therefore has urged that all scrap which can be spared be turned in for that purpose. **Accordingly, several months ago the State made careful inventory of all stock piles and released the scrap and salvaged steel not scheduled for re(-)use in the near future. In addition, steel trusses which had become obsolete as trusses and were used as trestles, with supplemental bents, were disposed of in order that the steel might go to the mills as scrap.**

An example of this was the steel truss bridge across the old channel of the Santa Maria River in Santa Barbara County. There the portion of the trusses above the floor no longer served a useful purpose on the bridge and was removed to add to the Nation's steel supply.

A large tonnage of scrap steel thus was contributed by the Division of Highways, but probably a more important contribution was effected by the use of salvaged steel where normally large quantities of new steel would have been used. In this regard there was not only a large saving in new steel, but the mill capacities were thus released for production vitally needed by the armed forces.



Before and after views of steel truss bridge across old channel of Santa Maria River in Santa Barbara County from which steel above floor was salvaged.

TIMBER BRIDGES REPLACED

An old timber truss across the Salmon River on the Klamath River Road had served its period of usefulness—had, in fact, failed during the construction of the new bridge. This was replaced by a new truss fabricated of portions of a steel truss just taken down from the Robinson Ferry Bridge across the Eel River. The timber bridge across Bull Creek likewise was on the point of failure, and is now being replaced by a salvaged steel truss.

At the Boat Channel Bridge on the Harbor Drive project in San Diego, structural steel was salvaged from an abandoned bridge in that city, thus avoiding the use of many tons of new steel.

A similar idea was followed in preparing plans for the Casmalia and Schuman separations, on the road from Santa Maria to Camp Cooke in Santa Barbara County. In this case, arrangements have been made to purchase a number of plate girders owned by the Western Pacific Railroad but unused for a number of years. From these girders the longer spans required in the new structures will be fabricated to the required length.

WIDENING PROJECT POSSIBLE

The urgently needed widening of Washington Underpass at the western entrance to Sacramento also may be made possible by use of salvaged girders from an abandoned railroad bridge near Port Chicago.

On the State Highway System are a number of steel truss bridges designed and built, in most cases, by other agencies before present heavy truck traffic became general. While these trusses are in good condition and serviceable for many years, they are too light to carry full legal loads, and frequently this condition restricts the service on many miles of

At left, old Salmon River Bridge at Somesbar, Siskiyou County. At right, how it looks rebuilt with steel salvaged from Eel River bridge at Scotia.

highway. At present, many of the secondary roads have become very important due to the development of minerals necessary to production of arms and munitions.

One example is a State Route, west of Red Bluff, which serves large deposits and a number of sawmills. Four light steel trusses on this route are to be strengthened by the addition of salvaged steel plates to permit hauling full legal loads.

To further avoid the absorption of large quantities of vital steel production, a number of steps have been taken. For instance, plans have been developed and are now in use for mass concrete arch culverts in lieu of the usual reinforced concrete design. Likewise mass concrete abutments for bridges are now commonly used.

The State is also using scrap railroad rail of the lighter sections not in demand as rail. These rails are used either full section, split, or rerolled into reinforcing steel. Although the slightly higher cost does not make use of these rails for reinforcing steel attractive in normal times, it is felt the huge saving in steel mill capacity is worth the additional effort.

Furthermore, tests have indicated that the steel rerolled from these rails is uniformly higher in yield point and ultimate strength, which justifies a higher working stress in the design. This higher stress tends to offset any additional cost involved. Also, higher stresses are used wherever possible for structural and intermediate grade reinforcing steel in order to reduce to a minimum the use of new steel. The Bridge Department has been constantly on the look-out for salvaged steel which could be substituted to avoid use of new steel. In fact, a State-wide survey has been conducted, during which a considerable number of steel spans have been located.

Some of these were used directly in State-designed projects; others were made available to the Federal Government for use on the Alaska Highway.

The State has been making every effort to reduce to an absolute minimum the use of critical materials on highway projects. Until normal conditions again prevail, our engineers will exercise all their ingenuity and resourcefulness in building and maintaining bridges essential to the national war effort.

War Department Praises Porter Runway Report

A REPORT by O. J. Porter, Senior Physical Testing Engineer, of the Division of Highways, on the Stockton Runway Test Section having to do with the California method of determining the relative bearing value of soil and its application to design of highways and air field runways has called forth high praise from the War Department.

In a letter to State Highway Engineer C. H. Purcell, Col. James R. Stratton, Corps of Engineers, War Department, says concerning the Porter report:

"This is an excellent report and it is anticipated that the information contained therein will be of great value to the department. It is desired, therefore, that arrangements be made for printing the report for distribution to the department and other interested agencies at an early date. It is estimated that approximately 500 copies will be required."

Porter's report described in the May, 1942, California Highways and Public Works issue dealt with various types of subgrade failures on highways and airports. A comparison was made between highway and runway service requirements, including intensity and repetition of loads, influence of dynamic reactions of trucks and planes, and the effect of these factors on pavement and subgrade design.

Representatives of the United States Army Engineer offices from many sections of the country attended a lecture course and conference on these subjects in Sacramento last April 6-10. During their session, the Army Engineers inspected the runway test pavement at the Stockton air field, and attended courses of instructions at the State Materials and Research Laboratory of the Division of Highways. The exploration of soil deposits by hand boring methods, including soil augers and the California type soil sampler, were demonstrated.

At that time much interest was evinced by the Army Engineers in the electrical equipment developed by the

(Continued on page 20)

Ending Hazardous Situation on U. S. 99 North of Bakersfield

CONSTRUCTION is under way to relieve a hazardous traffic situation on a section of U. S. 99 north of Bakersfield in Kern County.

Due to the building and operation of Minter Field, traffic on this portion of U. S. 99 has increased to such an extent that the present two-lane road is carrying a load 30 per cent in excess of its practical capacity.

A contract has been awarded to the Union Paving Company of San Francisco for grading and paving with Portland cement concrete, four and nine-tenths (4.9) miles of this highway. The project extends from Snow Road to a point 2½ miles south of Shafter Road. Priority ratings have been granted by the Federal Government.

The work will consist of grading and placing a 23-foot pavement parallel to the existing highway, but entirely separated from it. Upon completion of the work a four-lane divided highway will be the result.

The newly constructed roadway and pavement will carry northbound traffic while the existing two-lane highway will carry southbound traffic only. The two traveled ways will be separated by a strip 42 feet wide. The row of trees along the easterly side of the existing highway, whose branches have been allowed to grow close to the ground, will serve as a screen between north and southbound vehicles. Drivers will be relieved of headlight glare along this stretch of highway.

The contract as awarded does not provide for the proposed construction to be extended as far north as Minter Field. However, the Highway Commission, appreciating the need for extending the proposed four-lane divided highway, voted additional funds for this purpose.

Priority ratings have been requested for the two and one-half mile extension to Shafter Road, where a large volume of traffic leaves U. S. 99 to enter Minter Field.

1—Looking North along center line of proposed new 4-lane divided highway North of Bakersfield. 2—Present State highway will become southbound roadways of new highway. 3—Existing trees will form a screen between the two roadways. 4—Trees on right have been permitted to grow down to ground to form screen.

Section of 4-lane divided highway through Buena Park on State Highway 171 in Orange County.

Orange County Highway Is Realigned

By A. N. GEORGE, District Construction Engineer

ROUTE 171 in Orange County makes a straight north and south connection between Route 174 and Route 60. Passing through only one town—Buena Park—this constitutes a link in one of the main highway routes between Los Angeles and San Diego and is destined to carry an increasingly heavy traffic.

Alignment of this route has been marred by a right angle jog at Lincoln Avenue, and its use has been further impaired by the fact that a popular roadside restaurant is located on a narrow portion of the road and so many cars leave and reenter the highway at this point as to cause very serious congestion, especially on holidays.

The combined condition of the right angle jog and the interference with traffic at the entrance to this roadside restaurant has been corrected by constructing a diagonal connection between the portion of the road north of Lincoln Avenue and south of Lincoln Avenue.

The improvement consisted of a divided highway providing two roadways each with 23 feet of surfacing, separated by approximately 30 feet of graded unsurfaced area. Where the new work follows the old road a row of shade trees was preserved in the center dividing strip. The surfacing consisted of 6 inches of cement treated base 25 feet wide, on which was placed 3 inches of asphalt concrete surfacing.

Bituminous surface treated shoulders were provided on each strip, the left shoulder being 3 feet wide and the right shoulder 7 feet.

As the improvement was constructed through an area of almost level ground which has rather poor drainage, the new highway was raised above the existing ground by means of imported borrow. The source for this imported borrow was a settling basin in the Orange County Flood Control system and the material was a sand with very little binder.

The same material was used for the cement treated base except that some very fine sand which carried a high percentage of minus 200 was added to the mix. This material, together with 20 per cent of commercial gravel, was mixed in a pug mill and hauled to the grade.

The lack of binder in the imported borrow made it impossible to maintain a subgrade under the trucking necessary to transport the cement treated material to the subgrade. Stabilizing it with water proved ineffective so an expedient was resorted to of mixing 3 pounds of cement to the square foot into the top 6 inches of this subgrade.

At top—View of realigned portion of State Highway Route 171 avoiding a congested intersection point protected by curbed, triangular traffic island. At bottom—View of 4-lane section through orange orchards.

Report Tells Many Changes in Highway Activities Caused by War

(Continued from page 3)

value of more than $5,000, were limited to access roads and projects on the Strategic Network certified for construction, maintenance work, and projects off the Strategic Network which are individually approved by Federal authorities as essential to the war effort. In addition to this order, use of practically all construction materials is curtailed by the priority system and highway improvement and maintenance is further restricted by orders M-208 and L-218 limiting lumber and by Office of Defense Transportation Recommendation 45-A on asphaltic products.

"The result of these orders to the highway program has been the indefinite deferment of many projects remaining in the current State Highway budget which, while desirable for civilian highway use, can not be justified at a time when the entire resources of the Nation must be used for the prosecution of the war.

"It is anticipated, however, that construction and improvement necessary to provide for the heavy traffic on many California routes resulting from war activities will require greater expenditures than the rapidly shrinking State highway revenue will finance. Reduction of civilian travel induced by the program of rubber conservation and the rationing of gasoline is already being felt in reduced revenue and it is quite apparent that within a few months this reduction will reach some 50 per cent of last year's income.

"In addition to these problems confronting the Department, is the depletion of the Division of Highways staff by personnel leaving to enter military service or to take up work with war industries. During the past biennium over 1,200 employees have left the Division of Highways to join the military forces or war industry."

Concerning the post-war highway program, Mr. Purcell says:

"One phase of highway transportation which is being given consideration at this time is preparation for highway needs after the war. It is highly probable that the social and economic scheme of things at that time will not resemble any of the conditions which this Nation has faced in the past. The adjustment from a war economy to a peace time economy will require some time. Demobilization of the armed forces will flood the Nation with men whose greatest need will be employment. Adjustment of industry from the manufacture of war machines and equipment to production needed for peace time life will release a host of skilled and unskilled civilian labor.

"While all forms of construction will be far behind the needs of the new economy, highway development in particular, will necessitate a rapidity of expansion which will exceed even the demands of the last decade.

"To prepare for this period of transition, the present preparation of a plan of attack is essential. The President has called attention to this present need for preparation and has indicated that he looks to an enlarged public works program as the principal method of dealing with the slump when it comes. The Federal Works Reserve, a unit of the National Resources Planning Board, is now functioning and is cooperating with the several States in building up a list of desirable public works projects to provide work after the cessation of hostilities.

"Highway construction will play a large part in furnishing suitable projects for this reserve shelf of public works. Highway construction provides one of the most flexible opportunities for unemployment relief as it may be varied in type of construction to fit in with varying ratios of available machines and manpower. It may be carried forward and stopped at convenient points and the benefits of the investment immediately realized by the public.

"As a unit of this program, the President has established the Interregional Highway Committee to coordinate the programs developed within the several States so that an adequate interregional highway system will be developed.

"In cooperating with this National plan, the California Division of Highways, along with its wartime construction and maintenance, intends to use its facilities for careful study and planning essential to the proper and economic expenditure of funds for development of adequate transportation needs in the postwar period. Surveys, plans, and specifications for desired improvement will be prepared and, where possible, needed right of way acquired.

(Continued on page 20)

Trucks Play Vital Part in Daily Life of U.S. Citizens

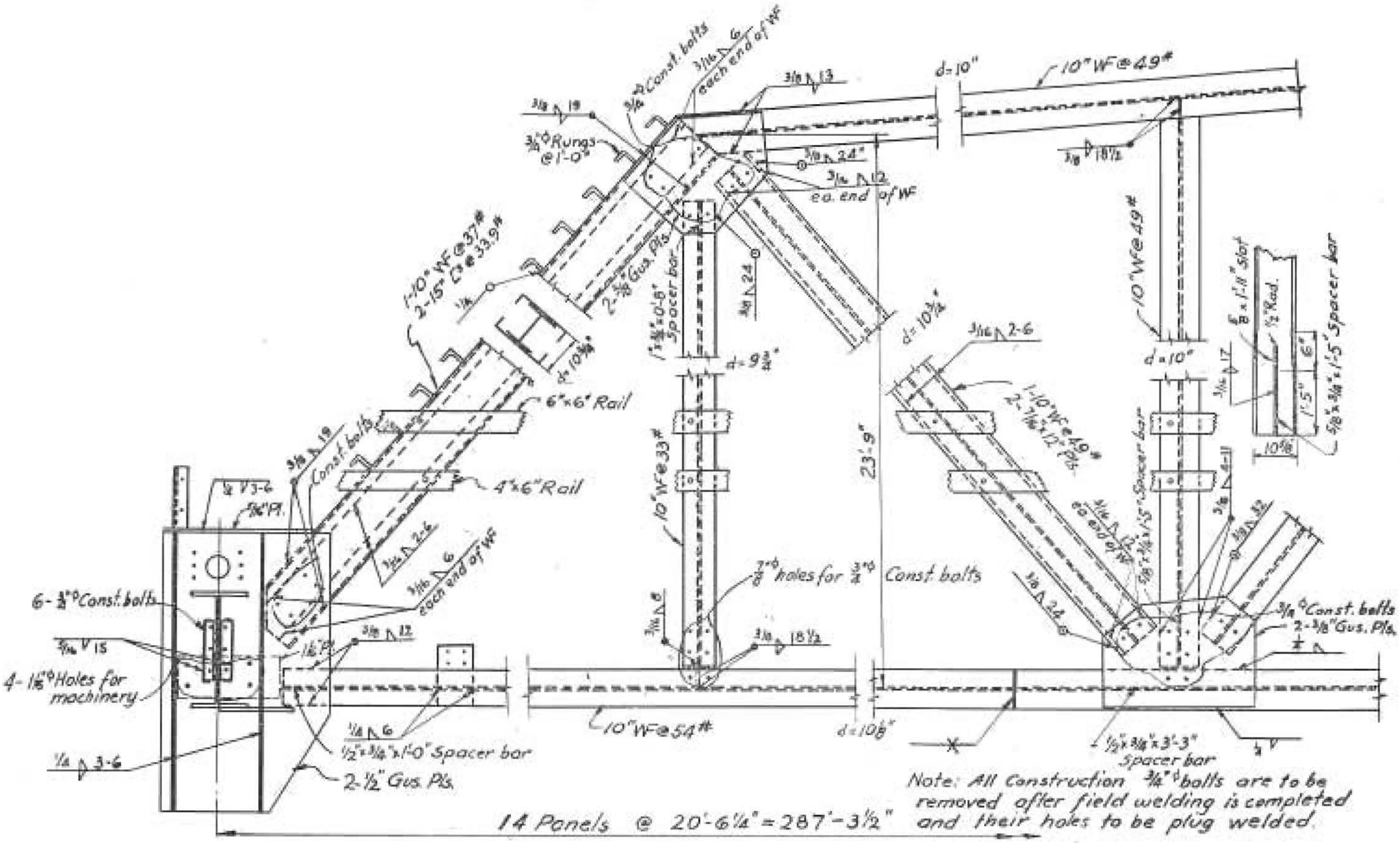
The average American citizen has little opportunity to be familiar with the vital part that highway transportation plays in his daily life. Remove the trucks from the highways and immediately there would be no gasoline, little or no milk, the flow of meat and vegetables would stop. Prices of these and other articles would soar. In spite of our great American railroad system there are 48,000 commodities which must depend on highway transportation alone—and this is one-third of all the communities in the United States. During the year 1940 over 58,000,000,000 ton-miles were carried by trucks on the rural roads of the country.

The network of American highways totals approximately a million and a half miles. Of this mileage about 86 per cent is hard surface.

Of the trucks in the United States about 86 percent are privately owned. About one out of four is farm owned. Engaged in interstate commerce on a "for-hire" basis are approximately 200,000 units, the bulk of which are truck-trailer combinations. In addition to these there are 400,000 other units engaged in interstate, local and intercity commerce.

It is this group of 600,000 trucks and truck-trailers which provides America with a motor transport system that is not only responsible in many ways for our high standard of living but which is now proving itself to be invaluable in the business of war.—*Motor Transportation.*

Engineer Again Wins Welding Design Award



Sketch shows a part elevation of an all-welded truss

ANOTHER $200,000 "Industrial Progress Award Program" was held this year by The James F. Lincoln Arc Welding Foundation, similar to the one held in 1938.

The object and purpose of the contest is to encourage and stimulate scientific interest and scientific study, research and education in the development of the arc welding industry through advance in the knowledge of design and practical application of the arc welding process.

The 458 awards were given to persons who by reason of the excellence of their papers upon this subject were selected as most worthy to receive such awards. The scope of the contest covered all fields of industry where arc welding can be applied as a primary process of manufacture, fabrication, or construction of products and structures.

Twelve main classifications were set up, and were further subdivided into 46 divisions. On account of the war, only four countries participated in this year's contest—the United States, Canada, Australia and Ireland. The papers received were judged by a jury composed of engineering authorities from universities and colleges.

In subclassification on "bridges" an award was given to B. M. Shimkin, Associate Bridge Engineer, Division of Highways. In 1938 he received an award from the same organization for a paper on a welded railroad bridge design. This year the prize-winning paper presented the design of an all-welded truss for a swing bridge.

The bridge described is now built, as a riveted structure, across Mokelumne River at Terminous. Arc welding was used to a limited amount in the original design as specified by the American Association of State Highway Officials Specification. Only 483 pounds of electrodes or 2032 feet of $\frac{5}{16}$ by $\frac{5}{16}$ inch welds were used in this structure. The built-up members and fillers for gusset plates were shop welded and no field welds were used in construction of the present bridge. Mr. Shimkin redesigned this bridge as a full-welded bridge, using the American Welding Society Specification as a guide.

The presence of the draw-rest in a swing bridge creates the most ideal conditions for the erection of a full-welded structure. No shelf angles were used in the all-welded structure as all the floor girders, stringers, and other members are supported directly upon the unyielding draw-rest. Assembly starts from center of bridge and symmetrically proceeds to ends which allows a free expansion of welded members and by that minimizes locked-up stresses.

No filler plates are used in full-welded trusses. They are replaced by the spacer bars, which gave simpler details and eliminated ambiguous design for filler plates, and can be seen on the accompanying drawing.

The foregoing indicates that a fully welded structure shows a considerable saving in metal and cost, over a conventional riveted bridge.

Broken Glass on Highways Becomes Serious Problem

AN alarming increase in amounts of broken glass and jagged fragments of bottles on main traveled highways, particularly strategic roads in the vicinity of defense plants and army encampments, has aroused in the mind of State Highway Engineer C. H. Purcell a suspicion that deliberate sabotage may be involved.

With the urgent need for construction of tires, undermanned crews of the Division of Highways are working overtime to meet the new emergency of sweeping glass off the roadways, according to T. H. Dennis, Maintenance Engineer.

Similar deplorable conditions are reported in the San Diego, San Luis Obispo, Monterey and San Francisco Bay Area and other districts.

"The Division of Highways," Purcell said, "is doing everything possible, handicapped as it is by a shortage of manpower, to cope with the situation, but we must have the full cooperation of the Army, Navy, defense plants and the citizens of California.

"It may be necessary to ask the Legislature to increase the penalty for throwing on any street or highway any glass, nails or other substance which might injure tires. Section 601 of the Vehicle Code makes such acts unlawful.

Report Shows Drastic Cut in Highway Works

(Continued from page 13)

"For the two years from July 1, 1940, to June 30, 1942, the mileages, by types of construction, for contracts awarded during that period and the total miles in the State Highway System on June 30, 1942, are shown in the accompanying tabulations, and on the following pages will be found statements and statistics on State highway progress.

"The normal activities of the Division of Highways have been carried on as far as possible, although largely affected and seriously curtailed by war time demands."

Bids and Awards for December, 1942

PLUMAS COUNTY—Near Chester, at a site 0.5 mile southeast of the junction of Routes 29 and 83, crushed and screened gravel to be produced and stockpiled. District II, Route 29, Section A. Contract awarded to Harms Bros., Sacramento, $16,410.

LOS ANGELES COUNTY—Chavez Ravine Road, Coronel St. and connections between Figueroa Street and Lilac Terrace, 0.5 mile, graded and surfaced with plant-mix surface. District VII, Chavez Ravine Road. West & Sommer, Lynwood, $45,085. Contract awarded to Griffith Co., Los Angeles, $39,838.

SAN FRANCISCO COUNTY—Funston Avenue approach to the Golden Gate Bridge, a barbed wire fence to be erected at various locations within the limits of the Presidio of San Francisco. District IV, Route 56, San Francisco. Anchor Post Fence Co. of California, San Francisco, $829. Contract awarded to Cyclone Fence Division (American Steel & Wire Co.), San Francisco, $807.

SAN JOAQUIN COUNTY—Between Kellogg Road and Ludwig Road, about one mile to be graded and bituminous surface treatment to be applied. District X, Chrisman Road. Elmer J. Warner, Stockton, $22,045; M. J. Ruddy & Son, Modesto, $24,655; M. J. B. Construction Co., Stockton, $32,785; A. J. Clausen, Berkeley, $35,267. Contract awarded to Louis Biasotti & Son, Stockton, $21,590.

War Department Praises Porter Runway Report

(Continued from page 14)

Division of Highways for measuring the pavement deflection and subgrade crusher under moving loads and particularly the results obtained on the test section with a heavy bomber, which showed the influence of the dynamic reactions for warm-up and take-off motor speeds.

In forwarding to Purcell the commendation of the War Department, Col. Clay Anderson of the United States Engineer Office, Sacramento, said:

"It is desired to express the appreciation of this office for your cooperation in making Mr. Porter available to conduct the tests and to prepare the report. This office desires to add its commendation of the splendid work rendered by Mr. Porter in this connection."

"Why so out of sorts, Jones?"

"Oh, I've had a very trying day. My office boy tried that old one about wanting the afternoon off to attend his grandmother's funeral and I decided to teach him a lesson, so I said I would go with him."

"Well, was it a good ball game?"

"It wasn't a ball game at all. It was his grandmother's funeral."

Combination Bank Protection on Eel River Constructed

(Continued from page 4)

above the bottom of rock riprap tends to deflect the remaining downward current horizontally into the main body of the stream where it causes no damage.

FLEXIBLE MATTRESS EFFECTIVE

If there is a tendency to scour at the outer edge of the flexible mattress, it is abruptly stopped when the mattress folds into the scoured section. Experience with installations of similar design in California, but of different combinations, indicates that the mattress can fold into scoured sections until hanging almost vertically below the toe of the slope protection. In many cases the mattress is of sufficient weight to prevent underlying material from displacement.

Rock riprap consists of sound rock with a specific gravity of 2.40 in the top portion and 2.28 in the lower portion, ranging in size from ¼ ton to 2 tons, chinked with smaller stone.

The length of the slope protection is 820 feet. Rock riprap is 2 feet 9 inches thick normal to the 1½:1 embankment slope for a slope height of 66 feet—9 feet on the slope being below the mattress at stream bed level and 57 feet above.

Heavy key sections built well into the bank are required at the lower end of slope protections of all types, to prevent erosion and destruction of the end from eddy action.

Rock and wire mattress is 6 inches thick and 25 feet wide, consisting of two layers of galvanized wire fencing with a 6 inch rock filling between, laced every 12 inches with 14 gauge galvanized wire into four 6 foot 3 inch by 6 inch cable-connected thin sausages.

The mattress is anchored with 7/16 inch galvanized cables every 10 feet to log and rail deadmen placed in the embankment. Experience indicates that the upstream end must be anchored to prevent it from curling up.

Scheumann & Johnson completed the contract in November, 1942 under the supervision of A. M. Nash, District Engineer, C. P. Sweet, District Construction Engineer, and Harold Hansen, Resident Engineer.

State of California

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