CALIFORNIA
HIGHWAYS AND PUBLIC WORKS

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CALIFORNIA HIGHWAYS AND PUBLIC WORKS

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California's Highway Builders Will Welcome American Association Of State Highway Officials

THE MEN who build California's highways are all set to welcome the road builders of the United States, Alaska, Hawaii and Puerto Rico at the Thirty-second Annual Convention of the American Association of State Highway Officials which will be held in Los Angeles, December 17th-20th.

With a $155,000,000 postwar highway construction program well launched, State Highway Engineer George T. McCoy and his engineering staff and the members of the California Highway Commission, headed by Director of Public Works C. H. Purcell are looking forward to the opportunity that will be afforded to exchange ideas on improved highway planning with the highway officials of other states and of the territories.

In the group meetings which will be an important feature of the convention, the department chiefs of the Division of Highways anticipate they will receive as well as give instructive information.

Just what the convention will mean to them is best expressed in the following symposium of their views:

By RICHARD H. WILSON
Office Engineer

THERE is probably no member of a state highway organization who is confronted with as great a variety of detail problems as the office engineer.

In most state highway departments, the operations under his supervision involve the problems of financing and portions of budget control; federal aid contacts and responsibility for coordinating state requirements with latest rulings of the Public Roads Administration; preparation and correlation of plans and specifications in the light of newest design standards and ever changing construction practice and procedure; together with multitudinous other details of both internal and external administration.

There is probably no greater aid to the adequate functioning of work under the supervision of the office engineer than the business sessions of A. A. S. H. O. meetings where the multifarious problems which are common to all state highway administrations are reviewed and discussed.

This is particularly true with regard to working out federal aid matters. In advancement of a construction program involving federal funds, numerous occasions arise which require opinions or rulings from the Public Roads Administration in Washington. In most all of these instances, time is the important element if the work is to progress, and the time consumed in correspondence through the district office, the division office, the regional office, and thence to the right individual in the Washington office, results in delays which play havoc with progress.

It is in the business sessions of the annual convention where the state administration can meet the P. R. A. official and discuss his problems. The exchange of viewpoints, those of the state on one hand, the P. R. A. on the other, compels discussion of many phases of highway matters, resulting in better mutual understanding; promotes democratic willingness toward compromise; and produces a healthy spirit of cooperation.

Such discussion and exchange is of inestimable value in getting things done in highway development.

By J. W. VICKREY
Traffic Engineer

THE MEETING of the American Association of State Highway Officials during December will be at Los Angeles, the city recognized to have the worst traffic situation in the world. This meeting will provide the opportunity for the Nation's traffic engineers not only to view and examine this snarl of motor vehicles first hand but also to sit down together and compare notes and ideas on what can be done about it. Certainly such an opportunity should prove to be of more value to all those who can take part than any other way of spending the necessary time.

We tell ourselves and others that highways are provided for the one purpose of moving people and their goods in a safe and orderly manner, and we strive to bring that about. Prior to the war here in California we thought we were making pretty good progress, and I believe that we were. But this postwar traffic boom has set us back on our heels. It certainly has taught us that there is yet much to be done by traffic engineers toward making streets and highways orderly and efficient traffic facilities.

The importance of motor transport in the general economy of the Nation is no longer a question in the mind of anyone. The problems presented by motor transport to highway engineers in general and to traffic engineers in particular are tremendous and far-reaching. Their solution will require the combined thinking of the best minds the Nation can produce. The Los Angeles meeting will provide the first postwar opportunity to get together for an all-out start on this job.

If you have not already done so, plan to attend the Los Angeles meeting. We are very sure that it will be well worth your time and will prove to be well worth the cost to your organization.

By R. M. GILLIS
Construction Engineer

A WINTER meeting is ordinarily a poor time to see much construction work in actual progress, but this year as hosts to the visiting highway officials we are particularly happy that the convention will be with us when the State has an unusually large amount of construction work under way and that the meeting is to be held in the center of an area where many contracts that we believe will be of interest to our guests are under way.

Because of the postwar program we have in the last year awarded over $60,000,000 and many of the larger of these contracts are still in operation in the Los Angeles vicinity and Southern California.

The program committee has arranged a trip for Friday that will view a few of the contracts in progress in Los Angeles. In addition to the work that will be seen on this trip, there are a large number of projects being built in the Bakersfield, San Bernardino, and San Diego areas, any of which can be viewed in a one-day trip. In addition, either of the two prison camps operated by the Division of Highways can be reached in less than 100 miles. The contracts include many bridges, heavy grading, and some paving work.

The full day of December 19th has been assigned for the meeting of the Committee on Road Construction, and we are looking forward to the value of the more or less formal discussions that will be held then. We want to give you fair warning that we also expect to make the most of all the time that the convention affords to find out what you are doing and how and why you are doing it. We are looking forward to some highly profitable off-the-record discussions with our guests: we know that we are all going to have a fine time in the process.

HIGHWAY COMMISSION GREETINGS TO A. A. S. H. O.

By FORD A. CHATTERS, Secretary State Highway Commission

CALIFORNIA'S seven-man Highway Commission, headed by Director of Public Works C. H. Purcell, joins in a unanimous and enthusiastic state-wide welcome to members of the American Association of State Highway Officials when they meet in Los Angeles, December 17th-20th.

Much progress has been made in California's highway construction program since the association last met here ten years age. This in spite of the war when military necessity limited work largely to maintenance operations and to access road construction, both sizeable tasks in so important a theatre of the Pacific War.

During the war, at the request of Governor Earl Warren and backed by a $12,000,000 legislative appropriation, California Highway Department engineers were busy on actual construction plans for postwar work estimated to cost $125,000,000. Rights of way, in many instances, were purchased so that, by October of this year, contracts had been let for some $60,000,000 worth of work. Normal annual new construction before the war totaled about $22,000,000.

It is the aim of the commission to keep planning well ahead of construction. In a State whose population has increased more than 2,000,000 in the last four years, and is steadily growing; in a State where much of its produce is moved by motor transport; in a State where seashore, mountain, and desert attract tourists almost the year 'round, there is a peculiar and always-pressing problem. Highway planners must be far-seeing.

California has 14,000 miles of State highways, a distance greater than from the North Pole to the South Pole. Weather conditions almost as varied are encountered—from the floor of Death Valley, traversed by a State highway, to almost perpetually snow-covered summits of the High Sierra. The State has 3,500 miles of highway on which snow removal is provided for in the budget. California highway engineers meet many perculiar and interesting problems.

The California Highway Commission appreciates the attention the forthcoming Los Angeles sessions will focus on highway planning and construction, in the West and throughout the Nation.

Joining Chairman Purcell in a genuine welcome to visiting officials are the following other commission members: Harrison R. Baker, Pasadena; Homer P. Brown, Placerville; James A. Guthrie, San Bernardino; F. Walter Sandelin, Ukiah; C. Arnholt Smith, San Diego, and Chester H. Warlow, Fresno.

By C. C. CARLETON
Chief Attorney

THE LEGAL staff of California's State Highway Department is most hopeful that at the Los Angeles meeting there will be an unusually large attendance of legal counsel representing the state highway departments of other states and territories.

At the American Association of State Highway Officials' annual meeting held at Salt Lake City, Utah, in 1931, it became apparent that there should be a regular panel of state highway counsel in attendance at each subsequent meeting, and as a result the Committee on Legal Affairs was duly created.

The committee, augmented by other highway counsel who are able to attend from time to time, has regularly met since its formation and besides the program papers and discussions at the committee meeting itself, there has been a steady exchange of information on legal and right of way subjects throughout the year among the attorneys who have become acquainted through this medium.

Members of California's legal staff have enjoyed the privilege of attending a number of the annual meetings in the past, and in addition to the pleasure of fraternizing with men engaged in similar pursuits, have never failed to bring back vital information obtained from discussing highway cases and situations with their fellow attorneys both in and out of the regular sessions of the Legal Affairs Committee.

Moreover, the visiting attorneys are always given the opportunity of meeting and hearing top-flight highway executives and engineers from all over the country who speak on subjects with which the attorneys themselves are so deeply concerned.

It is becoming recognized that the legal and right of way activities related to highways are becoming increasingly complex.

The creation of freeway systems of highways is multiplying legal and acquisition problems and it is expected that, among other subjects, the now

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San Francisco-Oakland Bay Bridge Completes Ten Years of Operation

By O. R. BOSSO, Associate Bridge Engineer

THE San Francisco-Oakland Bay Bridge with a record of traffic volume unsurpassed by any other vehicular toll structure in the United States, celebrated its tenth anniversary on November 12, 1946, by continuing to serve as the major transportation artery between the two metropolitan centers of San Francisco and Oakland. On this anniversary it is appropriate to review some of the outstanding features of 10 years of operation.

Ten years ago, on November 10, 1936, Chief Engineer C. H. Purcell, now State Director of Public Works, made a final inspection trip of the bridge accompanied by Bridge Engineer Charles E. Andrew, Engineer of Design Glenn B. Woodruff, and members of the Board of Consulting Engineers.

Long before dawn on Thursday, November 12, 1936, motorists had lined up to be the first to cross the bridge. By 12.30 p.m., the actual opening hour, streets and highways leading to the east and west approaches were jammed with vehicles.

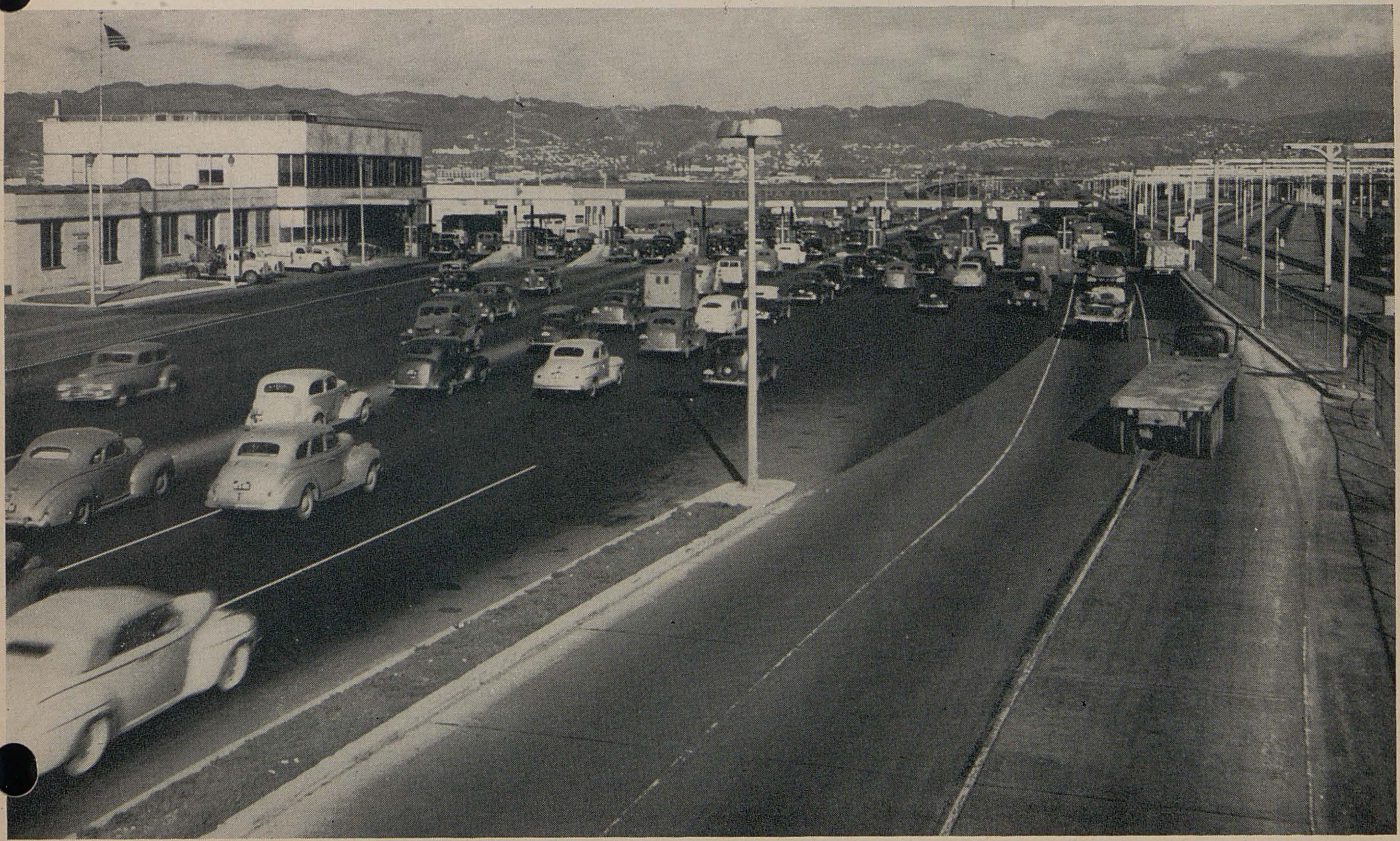
Included among the many notables at the official opening day ceremonies were former President Herbert Hoover and former Governor C. C. Young, who were jointly responsible for the appointment of the Hoover-Young San Francisco Bay Bridge Commission.

On that memorable day of November 12, 1936, Mr. Purcell said: "This bridge stands today ready for motor transport with a saving of over $6,000,000 under the estimated authorization for its construction. It is available for the use of the public six months in advance of the scheduled completion date with a saving in cost of interest on bonds during construction of over $1,500,000."

Another speaker, RFC Director Charles Henderson, declared: "Great and magnificent as this structure is, it will not convey to the men, women and children crossing on its decks the unseen obstacles encountered in its building.

"Those whose engineering skill and science have created the bridge, the men far above the waters who have done the work, deserve the highest praise. It is not only a monument to the genius of Charles H. Purcell, the engineer in charge, it is a symbol of the unlimited capacity of modern men

Looking east toward San Francisco-Oakland Bay Bridge Toll Plaza. While this photograph was not taken during peak traffic, it shows to some degree the necessity for the additional toll-lanes which are to be constructed on the span



Looking west on the San Francisco-Oakland Bay Bridge from Yerba Buena Island. This photograph was taken a few days after the bridge was opened to traffic in 1936

This view of the Bay Bridge taken from almost the identical spot as the picture on the preceding page, shows how traffic on the span has increased in a ten-year period working together through government to unify the physical world around them."

The City of Oakland which had started its celebration on Armistice Day, November 11th, continued its fiesta. The opening of the bridge signalized the start of the San Francisco celebration which lasted four days.

The United States Government coined a 50-cent piece commemorating the event and cachets were issued by the Post Office Department.

TRAFFIC INCREASES

In the first three and one-half days after the opening, the bridge carried a total of 228,913 vehicles.

During the first year of operation, the daily average number of vehicular crossings was about 25,000.

On August 12, 1937, by order of the Railroad Commission, toll schedules on the ferries were reduced to approximately one-half of those in effect on the bridge. As a result of this drastic reduction of tolls on the competing ferries, the traffic over the bridge during the year of 1938 dropped to about 23,600 vehicles daily.

With the opening of the Golden Gate International Exposition in February of 1939, and a reduction in bridge tolls from 50 cents to 40 cents per automobile in June of the same year acting as a stimulus, the traffic jumped to an average for the year of over 30,000 vehicles per day.

During 1940, with the continuation of the Golden Gate International Exposition, bridge tolls reduced from 40 cents to 25 cents, the discontinuance of the competing ferries, and the initial effects of America's defense preparation, bridge traffic increased to a daily average of 41,820 vehicles.

VEHICLES AVERAGE 60,000 DAILY

A sharp increase in the use of the bridge resulted from the tremendous expansion of industrial and military activities around San Francisco Bay during 1941 and 1942. Traffic reached a peak during the latter part of 1942, when, for several months, the daily average number of vehicular crossings exceeded 60,000.

With the extension of gasoline rationing to the Pacific Coast in December of 1942, bridge traffic suffered a sharp drop. In December, 1942, and January, 1943, the daily averages were 43,637 and 45,871 vehicles respectively. Recovering from the first impact of gasoline rationing, the bridge traffic gradually leveled off to an average of about 53,000 vehicles per day. Offsetting the restrictions on the use of private cars during the war period, the truck and bus traffic increased greatly to maintain a high traffic volume. The first month after VJ day, the bridge traffic jumped to 71,000 vehicles per day and, with slight variations, has continued at that level.

A record for a single day's traffic was established on Easter Sunday, April 21, 1946, when 79,016 vehicles crossed the bridge.

In 10 years of operation, the bridge has carried 166,910,000 vehicles and 191,440,000 interurban train passengers, and collected approximately $58,377,500 in tolls.

INTERURBAN TRAIN TRAFFIC

Interurban train service across the bridge was inaugurated on January 15, 1939. During the first two years of operation, the trains carried an average of 53,502 passengers per day. As a result of the abandonment of service over certain lines, a low point was reached in 1941, with a daily average of about 38,500 passengers. However, with the increase of industrial activities and the effects of the gasoline and tire shortage, the travel on the interurban trains increased at a high rate, reaching an average of more than 102,000 passengers per day during the year of 1945. With the removal of gasoline rationing and tire restrictions after VJ day, and the reduction of war activities during 1946, interurban train travel decreased to an average of approximately 78,900 passengers per day.

FINANCING

The bridge was originally financed by the sale of revenue bonds in the total amount of $73,000,000 to the Reconstruction Finance Corporation. In addition, an allocation of $6,600,000 was granted from the State Highway Fund to be used for the construction of the bridge approaches, subject to the requirement that, after the redemption of all revenue bonds, this amount would be refunded to the Highway Fund out of toll collections.

In 1939 a refinancing was effected and a new issue of 4 percent bonds, in principal amount of $71,000,000, was sold to a syndicate of investment houses. The specified redemption date of the last of these bonds was 1976. As of March 1, 1944, the California Toll Bridge Authority had outstanding $57,070,000 of these bonds subject to call and redemption as a whole on March 1, 1945.

On May 5, 1944, the California Toll Bridge Authority adopted a resolution authorizing the creation of an issue of not exceeding $60,000,000 principal amount of San Francisco-Oakland Bay Bridge Toll Bridge Revenue Bonds. On May 22, 1944, the authority, after due notice, sold $56,000,000 principal amount of the bonds, due September 1, 1962, at an average interest rate to maturity of 1.96613 percent, effecting a saving of $5,097,000 in interest cost.

BOND REDEMPTION

The purpose of the new issue was to provide funds which, together with other funds available for that purpose, were sufficient to redeem all of the outstanding bonds at the redemption price current on March 1, 1945. All of the bonds are redeemable as a whole by the authority on any date on or after March 1, 1950, and prior to maturity. Should revenues continue at the 1946 level, all outstanding bonds will have been retired by 1952.

In addition to making it possible to advance the date on which the bridge bonds will be redeemed, the large traffic volume has also resulted in a series of reductions of automobile tolls from the initial rate of 65 cents per car plus 5 cents per passenger in excess of four passengers to the present rate of 25 cents per car with no charge for additional passengers. Corresponding reductions have been made in other vehicle classifications.

BRIDGE MAINTENANCE AND OPERATION

The various maintenance and operation departments of the bridge, after four years of struggling with manpower shortage, gradually are regaining their prewar strength. During the war, 74 employees of the bridge maintenance and operation staffs served in the armed forces of the United States.

Since the opening of the bridge on November 12, 1936, 9,050,000 government vehicles, and 31,316,000 government personnel on interurban trains, have crossed the bridge without payment of bridge toll. The larger part, by far, of this free traffic took place during the war years.

The amount of government toll-free traffic tells only a small part of the story of the contribution of the bridge to the war effort. Without the bridge the war industries and shipyards in the San Francisco Bay area would have been hampered enormously and their

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Stockton-Lodi Limited Freeway Postwar Project Well Under Way

By P. O. HARDING, District Engineer

CONCRETE paving operations are well started on one of District X's most important postwar projects which lies between the Calaveras River, four miles north of Stockton, and Lodi on State Route 4 which is also a portion of U. S. 99 and U. S. 50.

This contract is 8.2 miles in length and includes the construction of two additional lanes of concrete pavement, which with the existing two lanes will provide, on its completion, a four lane, divided limited access freeway.

State Highway Engineer McCoy in his article in the last issue of "California Highways and Public Works" shows a traffic gain for the year 1946 over the year 1945 on State Route 4 of 69.51 percent on Sundays and 48.56 percent on Mondays. This traffic is considered typical of the section of road in question, which is presently carrying over 8,000 vehicles average daily traffic or some 3,000,000 vehicles annually. This provides some 25,000,000 annual vehicle miles of travel of which about 20 percent is truck traffic.

This mixed traffic has been condusive to numerous accidents, some 72 percent of which have involved two or more vehicles, which is typical of a congested highway. As a matter of fact, two county roads between Stockton and Lodi, namely, the Lower Sacramento Road (the old original state highway route) and West Lane are purposely used by many local residents in preference to the state highway route because of the heavy congestion on the latter.

It is estimated that upon completion of the present project much of this local travel using county roads will normally return to the highway and cause an immediate jump in traffic.

Using the year 1970 as a basis of project design, peak daily travel is estimated at 25,000 vehicles with a peak hourly traffic of 2,500 vehicles, for a design speed of 60 miles per hour for this mixed traffic.

Axle weight distribution data indicates over 11,000,000 equivalent 5,000-pound wheel load repetitions, in a 10-year period, in one direction, calling for a pavement design of the heavy industrial type. Our experience with the heavy faulting occurring at the joints of the existing two-lane pavement (which was brought to such forcible attention on all concrete pavements throughout the war period) substan-

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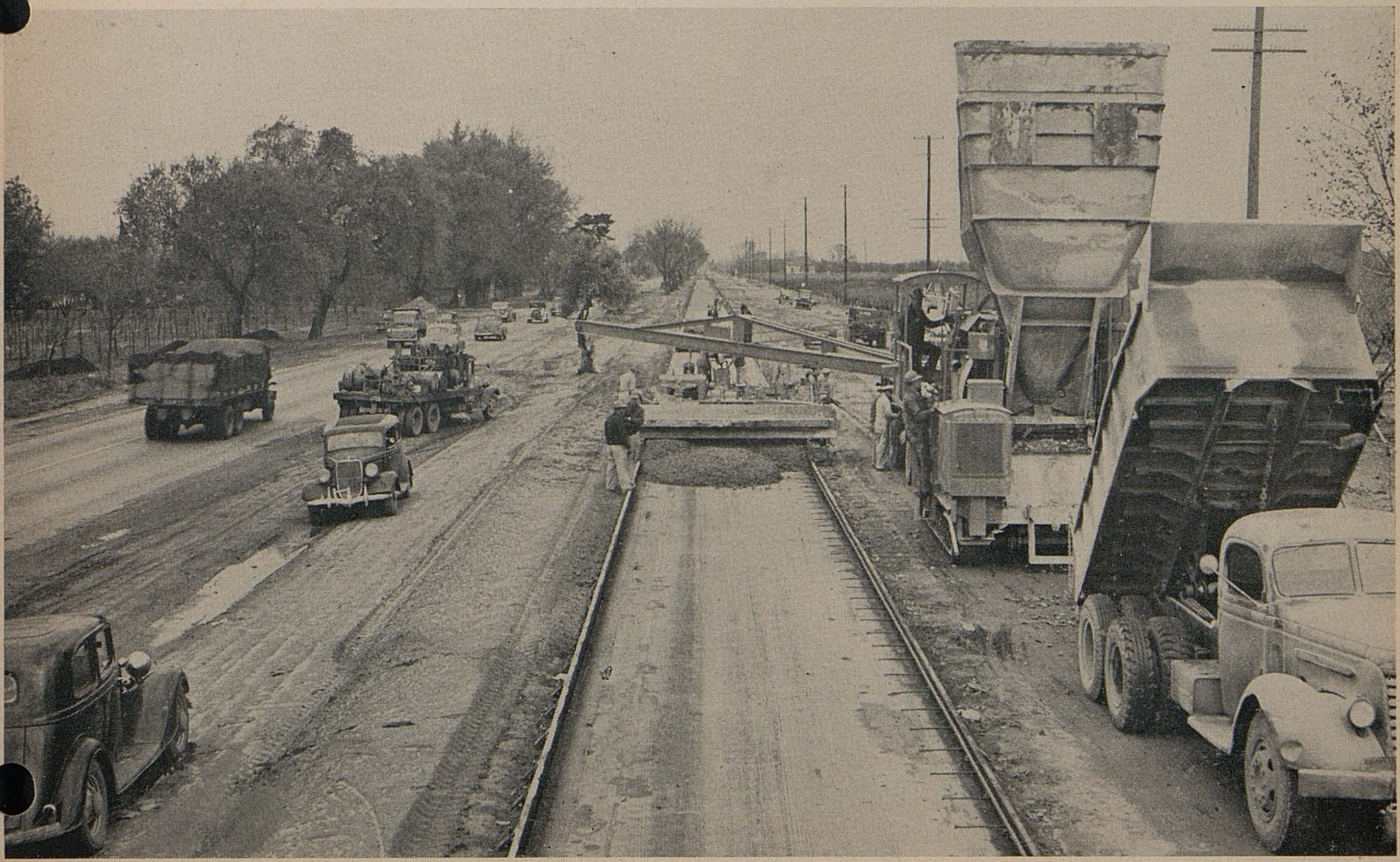
Showing mixer charging. Also front view of spreading machine



Looking northeast from beginning of project, showing relocation in Auburn. Placer County Court House on right

Old "Diggins" Scene of Road Work

By J. L. PIPER, District Construction Engineer

WHERE Auburn Ravine flows through the City of Auburn, the California Division of Highways is constructing a limited access highway through the early day "diggins" of placer miners. Several million dollars in gold was taken from the same area where huge carryall scraper units, air compressors, and power shovels have taken the place of the picks, shovels, and sluice boxes of the pioneer toilers. To accommodate the high standard alignment on this project the old channel has been filled in and a new channel excavated through solid rock formation.

The work now under way lies between one-tenth of a mile west of Nevada Street and one mile east of Auburn, 2.56 miles in length. It consists of grading and paving with Portland cement concrete a four-lane divided highway with a 6 foot division strip through the City of Auburn. Where the new construction joins the existing roadway of U. S. Route 40 the four-lane pavement is tapered to two-lane construction. The width of each lane of pavement will be 22 feet, exclusive of the gutter. A curb and gutter around the division strip will provide an additional one foot of effective pavement width to obtain a total width of 23 feet or 12 feet on the inside lane. The concrete pavement will be uniformly eight inches thick. Shoulders will be eight feet wide, two feet of which will be surfaced with plant-mixed material.

Under previous contracts, awarded early in 1946, an undercrossing was constructed at Walsh Street, and overhead crossings are being built at East Street and across the Southern Pacific Railroad tracks. The completion of the latter two structures has been delayed due to the inability of the contractor to obtain the necessary structural steel girders. It is anticipated these two

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Upper—Grading equipment constructing fill near Southern Pacific Overhead. Lower—Looking west across Walsh Street Undercrossing during construction

Last Unconstructed Unit of Road Between Susanville and Reno Built

By H. B. MILNER, Resident Engineer

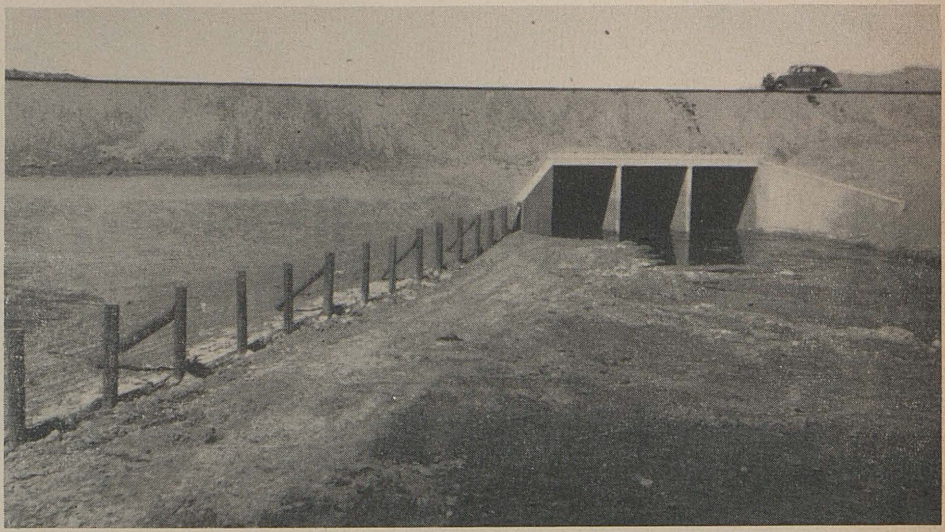
THE FIRST highway project in District II under the postwar construction program was completed by the Utah Construction Company on September 13th at a cost of $236,888.98. This contract, awarded January 17, 1946, called for grading and surfacing of 7.49 miles of Route 29 in Lassen County between Bird Flat and Doyle.

This was the last unconstructed unit of the interstate road between Susanville and Reno and its completion is a marked service to traffic. This road is also a part of U. S. 395 commonly known as the Three Flags Highway and connecting Canada and Mexico.

The old route between Bird Flat and Doyle was the original county road taken over for maintenance by the State in 1926. Except for the eventual establishment of a two-lane oiled mat and one minor line change, no improvements were made on this road of low standard alignment and grade in 20 years. Winter conditions on this road were particularly poor since the traveled way was almost entirely in a trench which so readily filled with snow and which was so difficult to drain.

The new route, avoiding the meanderings of the old one, runs directly between the termini with one 14,000-foot radius curve around a low ridge that projects into the valley near the center of the project and a 5,400-foot radius curve at Doyle. The grades are light and long sight distances permit a safe speed.

In order to secure direct alignment, two crossings of Long Valley Creek were necessary. This creek drains a comparatively large area of land east of the Sierras extending well into Nevada. Tripple 12-foot by 10-foot concrete box culverts which proved to be the economical type, were selected as adequate after detailed study of flood behavior since 1914, and a less detailed review extending back to 1878 when the Nevada, California and Oregon railroad was constructed. The average grade of the stream is about .04 per-



Triple concrete box in Long Valley Creek. The wing fence is to promote silt deposit on flat to the left

cent and a continuous bed load of granitic sand is carried even in periods of low water. The long wing walls are curved at the junction with the culvert and are designed to improve flow conditions at the entrance and to reduce turbulance at the outlet. The wing fence shown in the photograph is intended to promote the deposit of sediment in the broad area back of it, formerly occupied by the meanderings of the old channel.

The soil traversed by the road is granitic in various stages of weathering to deposits containing a large percentage of sound particles up to three-eighths inch in diameter. The base was generally made of native soil with such selection and cross haul of the better material as was necessary to obtain the required stability.

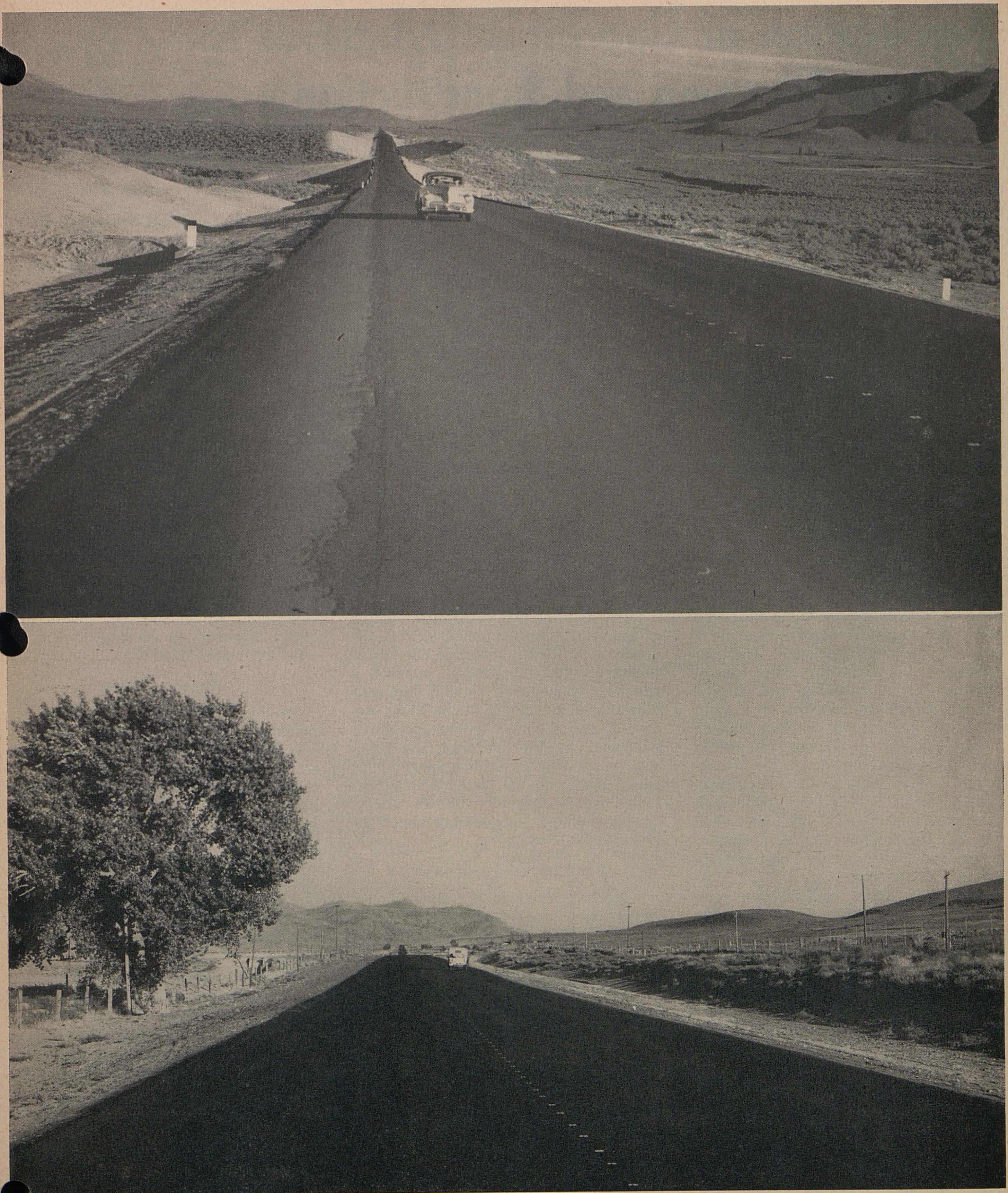
The low ridge which extends into Long Valley and is cut by the road is composed of angular to worn rock or gravel deposits intermixed with the coarser three-eighths inch granitic aggregate. During the construction of the Sierra Ordnance Depot at Herlong, four miles from Bird Flat, in the early years of the war, enormous quantities of aggregate, variously estimated as approaching 1,000,000 tons, was removed from this ridge.

The centerline of the highway crosses the ridge where the upper 10 feet consists entirely of the three-eighths inch granitic aggregate. The grade at this location was lowered to provide in the roadway cut sufficient aggregate for the plant-mixed surface and for strengthening some of the base. This lowered grade line also provided the desired sight distance at the vertical curve.

This granitic aggregate is nonplastic and mixed with asphalt meets the stability requirements. Asphalt of 200-300 penetration was used. A type "D" or flush seal was applied to the completed surface.

The graded width of the roadway is 32 feet. The pavement is 22 feet wide and 0.33-inch thick. Shoulders were surfaced to a width of five feet, the thickness tapering to 0.17-inch at the outer edge.

The Utah Construction Company of Salt Lake City did the construction work. Harry T. Walker was superintendent for the contractor. The State was represented by H. C. Amesbury, District Construction Engineer, and H. B. Milner, Resident Engineer.



Two views of recently completed improvement project on State Route 29 in Lassen County, between Bird Flat and Doyle. Upper—Looking east toward Doyle from a point 7.4 miles west. Lower—Looking east toward Doyle from a point 4.3 miles west

Application of Coordinate Methods to Freeway Planning and Construction

By G. M. LEATHERWOOD, Assistant District Location Engineer

The following article explains the adaptation and use of the coordinate method of ground control to the survey, design and construction of Metropolitan Freeways by District VII of the California Division of Highways.

In projects as complex and of the magnitude of the metropolitan freeway systems now being planned and designed in many cities of the United States, it may well be that other state highway departments or planning agencies have utilized this ancient and flexible system in their freeway or parkway planning. If they have not, the advantages outlined in the following article appear to indicate that the flexibility, accuracy and economy of the methods outlined are worthy of widespread use. The nature of the procedure has been amply demonstrated by the Division of Highways of the State of California in developing the designs for a number of complex projects in the Los Angeles area.

FRED J. GRUMM,
Assistant State Highway Engineer

THE development of super highways emphasizes the need for a centralized source of engineering survey data. The magnitude and complexity of such highways requires specialized branches of highway engineering to synchronize their efforts in order to maintain equilibrium in a constantly changing scheme. Highway design encompasses numerous special branches of engineering and during the earlier stages remains in a fluid state until the various features become fixed. It is evident during this period that a common base for calculations should be available to all. A desirable base is one that will lend itself with equal facility to both office and field use. For this purpose the plane rectangular coordinate system appears to suit conditions best.

The coordinate method has been widely used in most engineering fields, including highway engineering. The purpose here is to illustrate its interdepartmental value and to point out the need for common control for field as well as office use. In order to illustrate the methods used from the beginning of surveys to construction a theoretical example will be used.

THEORETICAL EXAMPLE

Consider that the project runs diagonally across a highly developed section of the city. The routing has been adopted and all that remain are surveys, design and right of way engineering. The importance and magnitude of the project are such that surveys are planned in detail. Base maps of the city are obtained and strip maps covering the routine are made. These strip maps, outlined in color, are furnished to the survey crews for field control.

One set of prints shows the outline of the city street system involved, another is outlined showing the outer perimeter for topography control, a third set is colored showing the city street system that is to be cross-sectioned, and a fourth set indicates the proposed construction area. The latter set is used to establish permanent bench marks in the clear of construction and temporary bench marks within the area for convenience of the cross-section crews.

WORK OF TRAVERSE CREWS

The first crews in the field are assigned portions of the street system to traverse. They generally develop the center lines from data furnished by the local engineering agency responsible, i.e., city engineer or county surveyor. The traverse crews work to an accuracy of 1:20,000. Their efforts are directed toward measuring distances and angles encompassing the system. They paint the stationing on the center line of street as the work progresses, for use of the topography and cross-section crews.

The largest perimeter within the system of the portion assigned is traversed, then the individual streets within this perimeter. This information is forwarded to the office where it is analyzed, adjusted and coordinated. The bench level, topography and cross-section crews follow, forwarding their data to the office as the work progresses. They color the base maps of their section, showing the portions completed in order that additional crews may work in the same area without duplication of effort.

SKELETON MAPS

In the interim, office engineers are preparing skeleton maps. These maps are single line drawings on tracing cloth. They show the proposed route, center lines of the street system, measured distances, adjusted distances, bearings and coordinates to all intersection and angle points. These coordinated skeleton maps are distributed to other agencies that have an interest in the project. These agencies normally consist of the departments within the organization and also outside agencies such as city, county and public utility engineering departments. The various agencies mentioned use the coordinated map values to tie in and compute whatever work they are doing, the final result being a set of plans and maps containing coordinate values to all important control points.

The maps mentioned in the above paragraph are shown in **Figures 1 to 4** inclusive. **Figure 1** is a coordinated base control map of a highly developed portion of the city, with a uniform rectangular street system. The single diagonal line is the proposed parkway

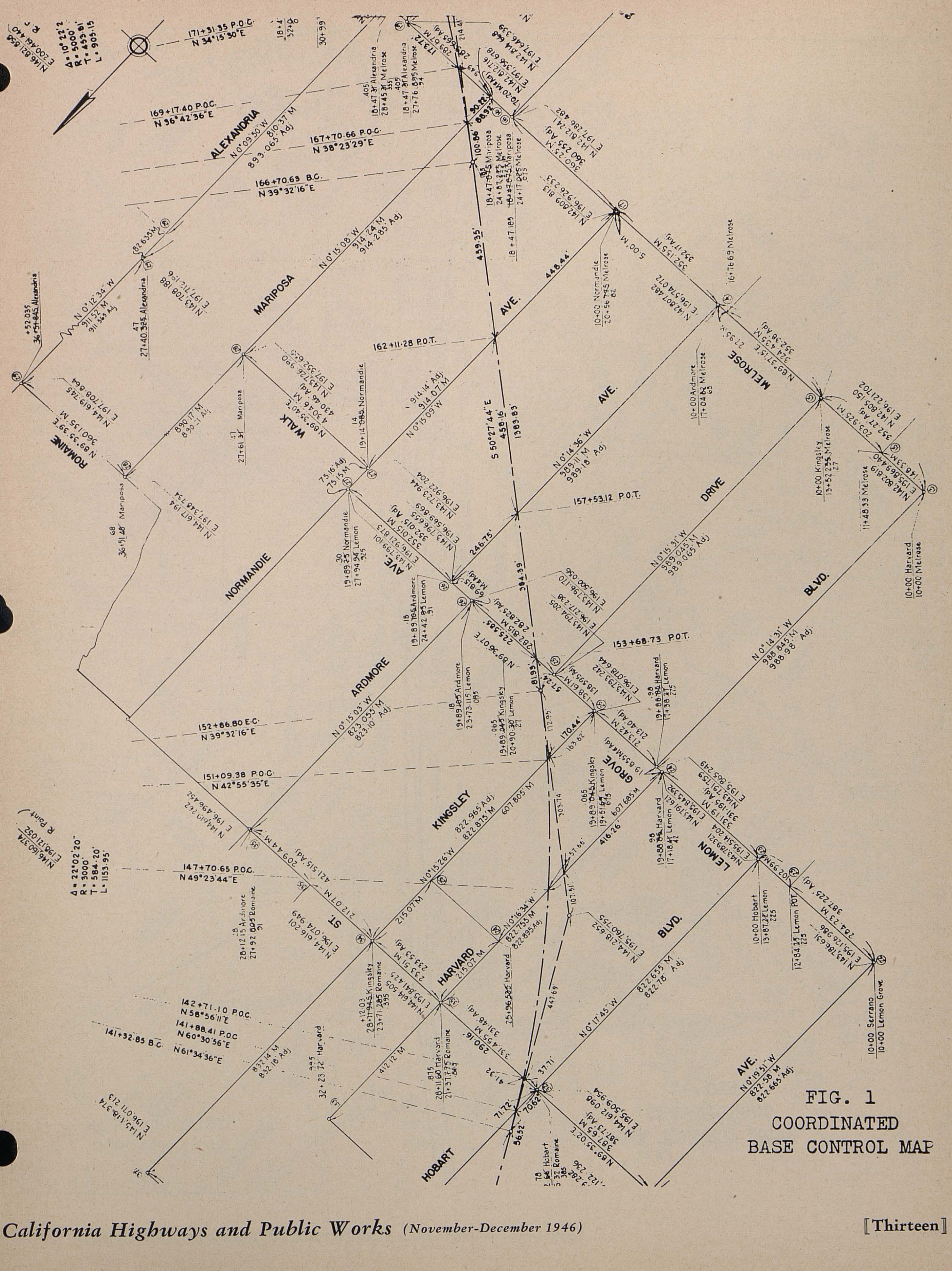


FIG. 1
COORDINATED BASE CONTROL MAP

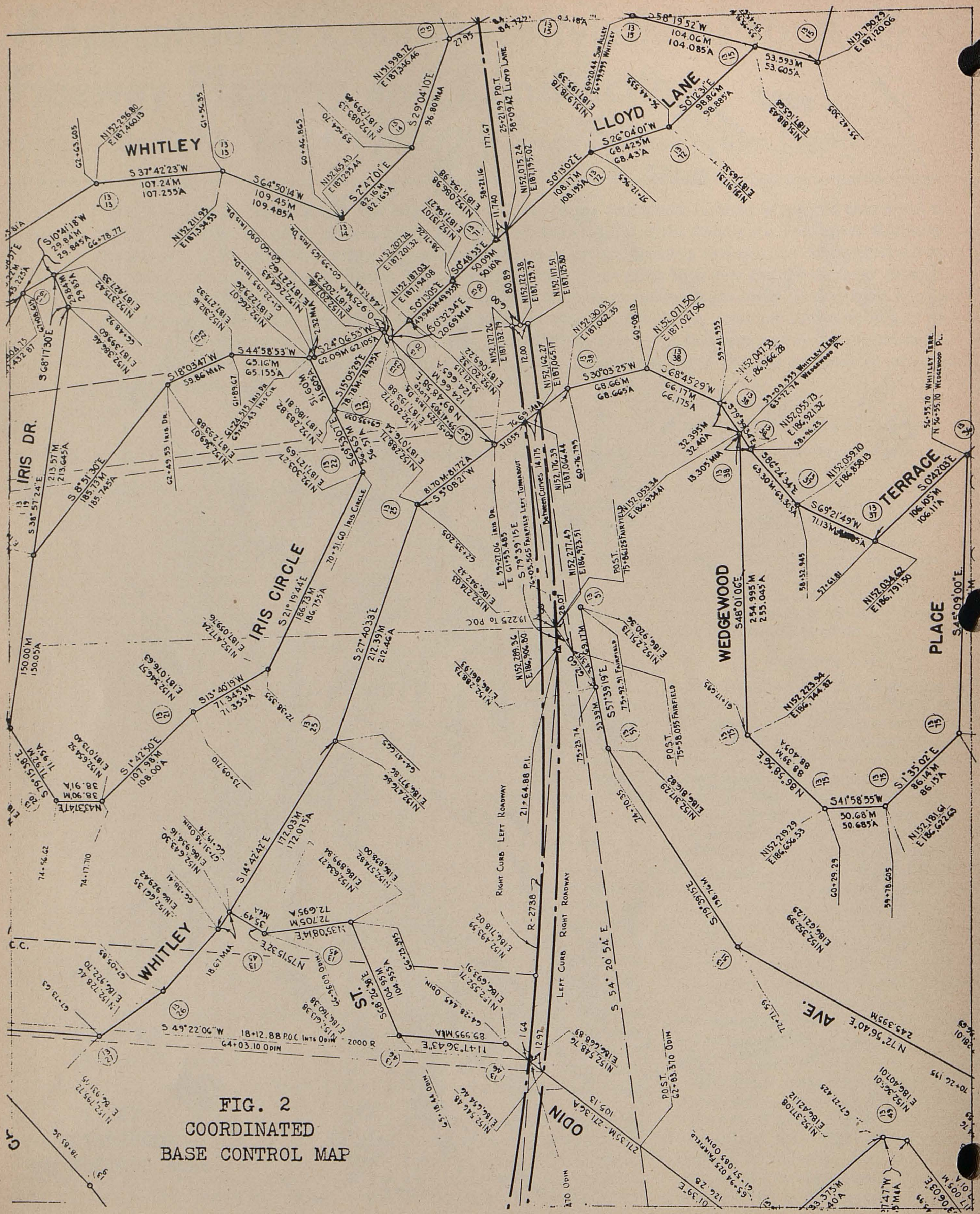


FIG. 2
COORDINATED
BASE CONTROL MAP

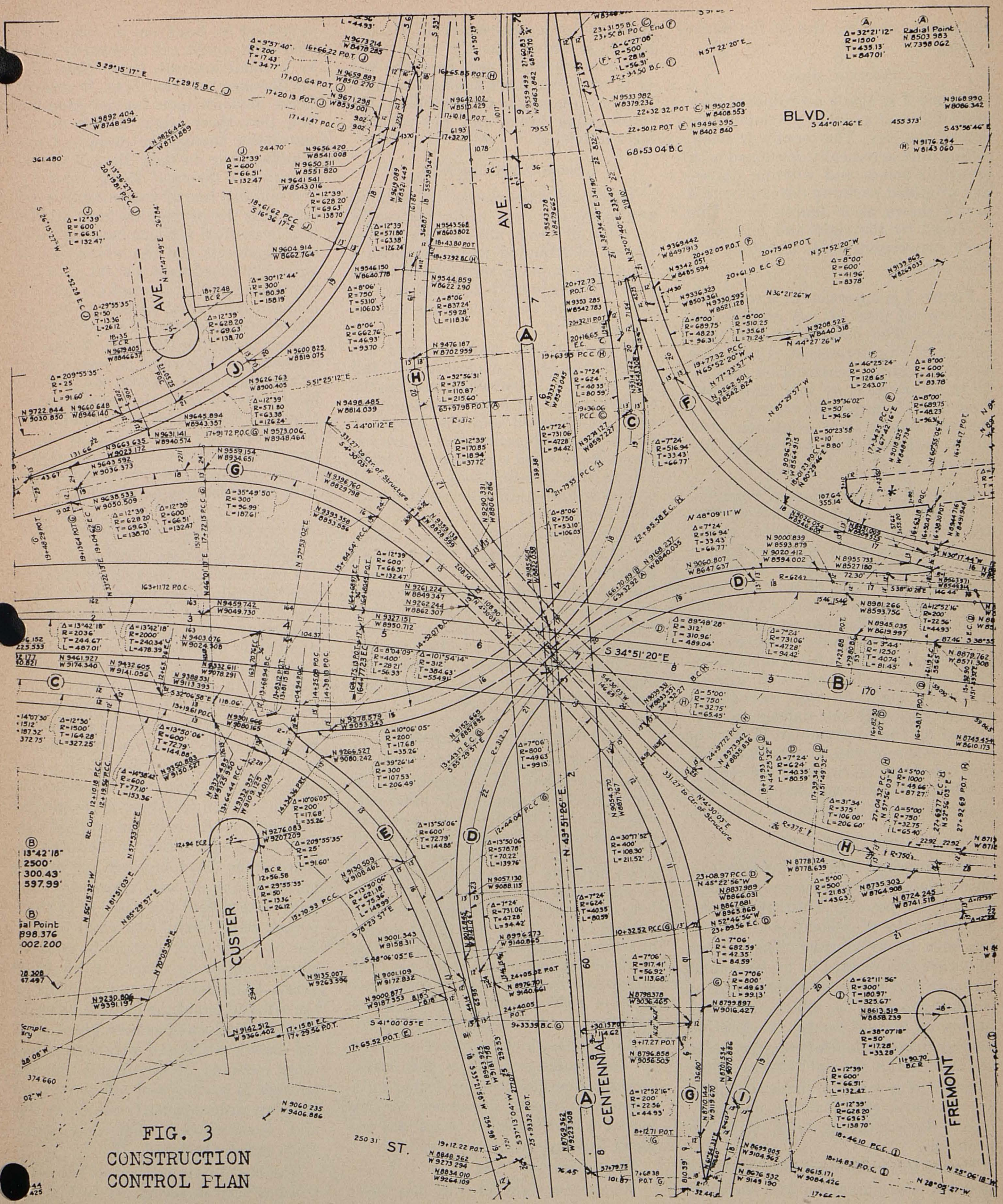


FIG. 3
CONSTRUCTION
CONTROL PLAN

alignment, showing ties to the street system.

CONTROL MAPS

Figure 2 is also a coordinated base control map of a highly developed portion of the city. The terrain is steep, rolling hills, artistically developed with beautiful homes and winding drives. The proposed parkway development is partly shown as a double line. This is caused by the right and left roadways converging and therefore not concentric.

Figure 3 is a portion of a construction control plan of two intersecting parkways. The magnitude and complexity of an intersection of this type requires positive construction control. Close observation of this figure will show that all important control points are coordinated and alignment and curve data sufficient to replace any portion.

Figure 4 is a coordinated construction plan. This plan differs from **Figure 3** inasmuch as all control values are shown and there is no need for a construction control plan. It should be noted that the right of way line consists of an irregular line that would ordinarily be difficult to establish, particularly on the outer roadway between Station 91 and Station 92 where provision had to be made to save an oil well. The right of way line offsets around this well and damage is prevented by the construction of a reinforced concrete wall. It should be further noted that all construction control points have been coordinated and are shown enclosed in rectangular blocks.

PRACTICAL USES

The practical use of these coordinated plans and maps is endless; but, for the purpose of illustration, consider that the aforementioned project has been let to contract. The various plans are complicated by underground structures of all types with attendant surface connections, under and overpasses, on and off ramps, deceleration and acceleration lanes, retaining walls, etc. Add to this the right of way which consists of a series of irregular jogs, curves, bays, etc., that are necessary due to design, damage and ownership problems.

Under the conditions explained, the skeleton base map along with the coordinated plans permits the construction survey crew to retain survey control. It is no longer necessary to tie out points in order that the center line may be replaced. In most cases chained or intersecting ties cannot be used effectively, due to the wide widths of the construction areas and the contractor's activities.

COORDINATE METHOD

The coordinate method of staking any particular item on the contract is to take off from any known undisturbed coordinated point, establish a temporary point in the vicinity of the item or items to be staked, and then tie into a second known undisturbed coordinate point.

If these points have not been disturbed, the error of closure will fall well within 1:10,000 which satisfies the construction accuracy. The temporary point is occupied and the necessary points for construction control are set. How simple when compared to restablishing of center line, base line or layout lines under difficult construction conditions.

Coordinate control is a valuable asset. If not mishandled it permits small increments of a contract to be staked with the knowledge that all the parts will fit together as it nears completion. Points may be set to whatever accuracy that is needed. An endless variety of combinations, using coordinates, may be used depending upon conditions at the time of need.

RIGHT OF WAY PROBLEMS

Right of way presents another perplexing problem. The irregularity of these lines due to small individual parcels of land involved, as well as certain construction features, will not permit much latitude by traverse or plus and offset methods. The coordinate method is once more the answer to this problem. Points are set on the property corners or right of way line to the degree of accuracy necessary, depending upon their permanency and their use. The important feature is that small sections of right of way may be staked with accuracy, confidence and speed.

A question which may have occurred to the reader is: "If a theoretical straight line has been projected on a diagonal through a number of city blocks, would there not be a slight angle at each intersecting street?"

The answer is, "Yes."

When the right of way has been cleared of all obstructions a transit line would show that the intersection points set by ties from the nearest intersection would not necessarily check by a small amount, depending upon the distance between them. It then becomes obvious upon further examination that these slight angles do not materially change the design of construction nor do they disturb the description of the right of way lines.

From this line of reasoning it is evident that the project has been divided into individual sections between intersecting streets and the whole tied together by coordinate control. It is further reasoned that the right of way lies between individual parcels of land on either side; therefore if the individual parcels bounding the right of way are defined, then the right of way consists of the remainder. Should the problem be considered from the usual method, that is, the right of way established from ties to the base, layout or center line, there would be a greater chance of encroachment onto private property, with the added danger of damage.

BOUNDARY LINE CASES

Another question might be: "How are the boundary lines of the individuals' parcels determined?" In most cases it is rather simple inasmuch as most of the land in the west has been divided up by subdivisions, and therefore the individual parcels are proratable within the blocks, with certain rare exceptions. These exceptions occur when lines of possession defined on the ground do not agree with the recorded subdivision. Should it prove upon analysis that lines of possession will hold, then the error is considered to have been made in the original survey. Upon completion of the analysis, coordinates are computed and shown on the right of way maps. At some later date should the position of these points which define the right of way line be challenged, it would be a rather simple matter to check. If an error exists, adjustments would be made to the satisfaction of the injured party or parties. This plan has been given careful consideration and weighed against other methods. It was found that the savings in survey and office work by the plan outlined justify the slight cost and inconvenience that may occur when errors are found.

The coordinate method of base control has been in actual use both in the office and on construction and has definitely proven its value.

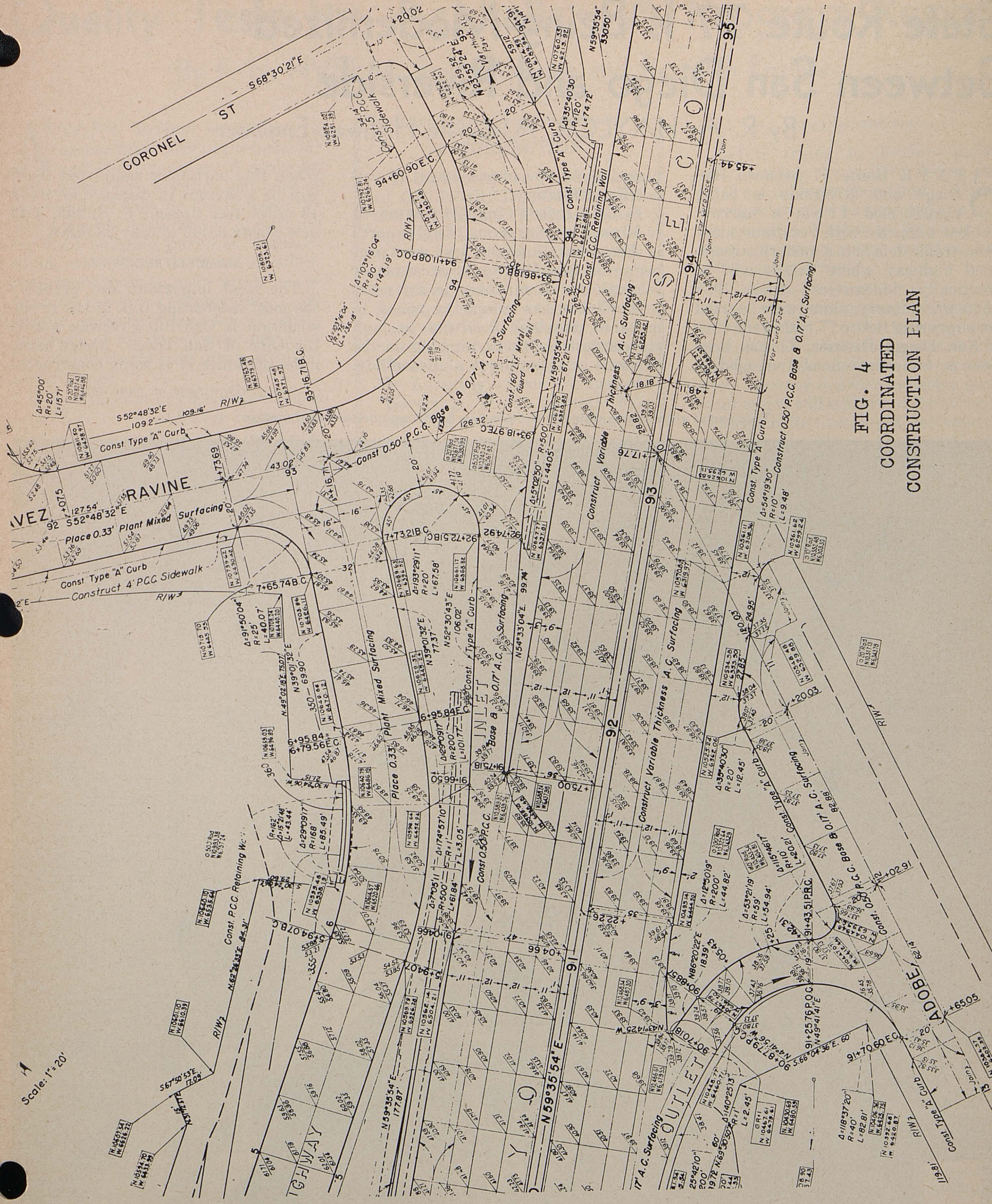


FIG. 4
COORDINATED
CONSTRUCTION PLAN

State Route 77 Is Being Modernized Between San Diego and Riverside

By R. A. HAYLOR, Associate Highway Engineer

STATE Route 77 between San Diego and Riverside is being transformed from a narrow, crooked highway with resultant numerous traffic delays to a modern streamlined highway where delays will be practically nonexistent. Since 1938 when preliminary plans were started for improving Route 77 within the City of San Diego, District XI has been more or less continuously engaged in planning for the improvement of this north-south artery.

In 1941, Prison Camp 38 was moved to Moosa Canyon, about 14 miles north of Escondido, and the first work was begun on San Diego's greatest major relocation in recent times. In five years prison labor has completed about 16 miles of two-lane roadway to high standards and is now working on the five-mile gap just north of Escondido. When this portion is completed there will be a savings in distance of about 13 miles over present U. S. 395, with new construction of only 23 miles.

CABRILLO FREEWAY

The most important and probably the most interesting link in the reconstruction is Cabrillo Freeway within the City of San Diego. About seven miles of Route 77 is being constructed

(Continued on page 42)

This aerial view shows Cabrillo Freeway in San Diego under construction

Quality Tests for Asphalts—A Progress Report

By F. N. HVEEM, Staff Materials and Research Engineer

ANYONE having more than a casual knowledge of the behavior and characteristics of asphaltic paving materials is aware that most of the standard tests do not indicate the actual quality or suitability of asphalts for road building purposes. Asphalts which meet all of the usual specification requirements may prove to be more or less unsatisfactory and, conversely, cases have been known where materials which do not meet orthodox test requirements have given excellent performance.

A vast amount of research work has been done in an endeavor to improve this situation and numerous test methods and procedures have been tried in search of an answer to the problem of establishing *quality tests* for asphalt.

Perhaps at this point it will be helpful to trace briefly something of the history of established test procedures. To a large degree these are either a rationalization of preconceived ideas with mechanically improved means for standardizing rule-of-thumb methods, or are developments of analytical procedures typical of general laboratory practice.

In the days when the design of asphalt paving mixtures rested largely in the hands of construction superintendents or "hot stuff" foremen, i. e., the type of individuals usually designated as "practical men" it required considerable experience and the exercise of some ingenuity in order to detect differences in character of materials. Asphalts were, undoubtedly, subject to at least as many variables 40 years ago as at present, and a paving man would often shape a small piece of paving asphalt and stretch it by hand in order to determine if the material was "short." From observing this practice Dow developed the ductility machine making it possible to stretch a sample of asphalt under controlled conditions. (At the present time, however, it appears to be very difficult to establish any simple relationship between the results of such ductility tests and performance.)

TEST METHODS

Many "old timers" could make a very good estimate of consistency by chewing a sample of asphalt and then someone employed a needle to test the softness. (It is reported that in former days a No. 2 sewing machine needle was specified.) This expedient was, of course, a forerunner of the present penetrometer.

A second group of test methods has grown out of standard laboratory practices, such as fractionation by distillation and by determining the so-called solubility in certain solvents.

The majority of engineers have rather taken it for granted that all of these tests rest upon well-founded and proven bases. It would be illogical and unfair to be critical of the pioneers who devised our present standard laboratory procedures; they deserve every credit, but progress usually involves casualties in time-honored methods and viewpoints and we need not assume that the existing standards are sacred. Familiar things are usually taken at their face value without too much questioning or probing beneath the surface to understand the true significance or meaning. This tendency may account for the lack of realistic quality tests for asphalts. The real properties of materials and causes of certain phenomena are not always immediately evident and the investigator can take nothing for granted in trying to find "what causes a good asphalt pavement."

A CORRECTION

In the September-October issue of CALIFORNIA HIGHWAYS AND PUBLIC WORKS there appeared an article, "Results Obtained and Experiments Made in Asphalt Subsealing," authored jointly by H. L. Cooper, Assistant Maintenance Engineer, and W. R. Lovering, Associate Physical Testing Engineer. Through a typographical error, Mr. Lovering's name was spelled "Sovering" in the authors' byline. The article by Mr. Cooper and Mr. Lovering has attracted considerable attention in engineering circles.

SOME QUESTIONS

Before trying to develop quality tests it might be well to decide just what qualities *are* important. In other words, what must be expected of a paving asphalt? What is its function and what properties are essential and which unimportant?

To the chemist, asphalt is a mixture of hydrocarbons mutually dissolved and dispersed. To the highway engineer, asphalt is something used to stick particles of sand, gravel or crushed stone together in order to form a pavement which will withstand the abrasion of automobile tires, resist deformation under the weight of the vehicle, and withstand the deteriorating effects of rain and sun.

It was once thought that the stability of a pavement depended on the hardness of the asphalt, but as it has been widely demonstrated that stable surfaces can be constructed with practically any grade ranging from 20 penetration to an SC-2 road oil, and as all grades of asphalt have been found adequate to resist ravelling or abrasive action (provided proper proportions are used), it appears that *any adhesive semiliquid material which can be made sufficiently fluid to permit mixing with the aggregate, which will adhere well to the stone in the presence of water, and which will not become brittle with age, will make a suitable binder for a road surface;* and it does not matter whether it be asphalt, rubber, tar, or molasses, if it has these properties and is cheap enough.

Thus we can conclude that only four primary properties need be determined by testing, all others are irrelevant or comparatively unimportant. These properties are consistency, durability, rate of curing, and resistance to water action.

Consistency

The engineer must have some means for classifying bituminous materials of varying fluidity or hardness and for this purpose standard test methods are reasonably adequate. Undoubtedly, they can and will be improved. It would be desirable if all asphaltic materials could be compared on the same numerical scale and it would be nice if we could deal in fundamental units and express viscosity in poises or centipoises. Nevertheless, this is a refinement and the problem of determining consistency is not clamoring for immediate solution.

It should be recognized, however, that consistency measurements may serve two purposes. First, the viscosity of the product must be taken into account in considering the type of construction operation. Road mixing, for example, is only feasible with the more liquid grades and is ordinarily impracticable with anything heavier than Grade 4 products of either slow, medium, or rapid curing types. In the plant mixing process consistency can be altered at will through the application of heat.

MATTER OF CONSISTENCY

Secondly, choice of a certain consistency depends upon conditions after construction. The character of the aggregate gradation may influence the designer in selecting consistency. For example, a Grade 2 liquid asphalt would not ordinarily be suitable for macadam aggregate and hard paving asphalts have many drawbacks when mixed with very fine materials. (The surface area of the aggregate should be taken into account when selecting the most appropriate grade of asphaltic binder.) A third consideration involves the permanence of the construction. For example, it is often desired that the bituminous surfacing be susceptible to reworking or reshaping at intervals and obviously only the more liquid asphalts should be used in such cases.

It may then be concluded that the consistency of asphaltic products is important under two quite distinct conditions and, therefore, under two different temperature ranges. It appears that serious attention should be given to the desirability of reporting consistency of all asphaltic materials at a temperature appropriate for mixing and construction operations and at a temperature typical of service conditions. It is recognized, of course, that actual working temperatures vary considerably. Nevertheless, it would be enlightening, for example, to indicate not only the consistency at a temperature between 70° F. and 100° F. but also at another point between 200° F. and 300° F.

Admitting that it is possible to distinguish between the various degrees of fluidity by using available testing equipment the next problem to be considered is whether or not the asphaltic material will retain its original properties and it is the ability of an asphalt to remain unchanged which determines the degree of durability.

Durability

Before discussing the durability of asphalts, it must be emphasized that all failures of bituminous pavements can not be charged to the asphaltic binder. There is a definite tendency for many engineers to blame any troubles on the asphalt or else to some vaguely inferred "chemical action." But before seeking to cure the ills of bituminous pavements by adjusting the properties of the asphalt, we must identify those troubles *for which the asphalt alone is responsible.*

A careful study of the types of distress which can be shown to occur with one asphalt and not with another of the same grade indicates that the most frequent and consistent difference to be observed is in cracking of the pavement, and/or dusting and disintegrating of the surface from abrasion. Failures and deterioration of this type can be pretty broadly covered by recognizing that the asphaltic binder has become too hard or too brittle and has lost the properties of plasticity, ductility or malleability. Test procedures aimed at measuring durability have been of two general types. One group we may designate as typical of the chemist's approach while the other group represent physical tests which may require the use of mechanical devices.

LABORATORY OPERATIONS

Laboratory operations which involve the analytical procedures typical of the chemist's profession are the various solubility tests. For example, the solubility in CCl_4 and CS_2 undoubtedly have the general purpose of detecting asphalts which had been damaged by overheating in the process of manufacture and perhaps these tests are useful for the purpose.

In California experience, however, after testing many thousands of samples we have no record of a sample of commercial asphalt which failed to pass, but, nevertheless, we have received unsatisfactory asphalts. Furthermore, any sample which contains a percentage of mineral matter as in the case of most natural bitumens would not meet the standard requirements for solubility but a small amount of inert mineral matter can hardly be considered detrimental as filler dust is deliberately added as a component of most dense paving mixtures. These tests cannot be considered, then, as reliable indications of quality. (It is also obvious that the engineer should not be too greatly concerned with refining practices provided that the ultimate product is suitable for the purpose intended.)

SOLUBILITY RELATIONSHIPS

The solubility in petroleum ether and the various modifications of the Oliensis Spot Test are also attempts to classify asphalts by their so-called "solubility relationships." Whether or not this group of tests indicates the presence of asphaltenes or "heterogeneity" or whether they simply indicate something of the equilibrium of a colloidal system in the presence of organic fractions depends largely on the viewpoint and the background of the individual.

The second group of tests deals with the vapor pressure relationships and includes the flash test, the loss on heating, distillation, and the retention of consistency after a sample has been heated. All of these methods or analytical procedures have shown some correlation with performance and undoubtedly there are a number of measurable differences between a group of "good" asphalts and "poor" asphalts.

There is, however, one fatal weakness in virtually all these tests which is undoubtedly the principal reason for the lack of correlation which is known to exist. This is due to the incontrovertible fact that all of the test methods are performed on samples which are maintained in a fairly large bulk with a very limited area of exposed surface and for the most part evaporation and hardening tests are conducted at elevated temperatures. In contrast, asphalts in the pavement exist largely as films representing a vast surface area compared to the volume of asphalt and rarely are heated above 140° F. There is ample evidence to prove that hardening and changes in asphalt are largely a surface phenomena and marked differences have been reported due to variations in temperature and agitation in the presence or absence of oxygen.

There is no question that analytical methods have their value. Undoubtedly, they will continue to be used but the consumers and users of asphalts are desperately in need of means which will detect durable asphalts from nondurable, irrespective of the reasons for the difference. As nondurable asphalts fail through becoming brittle and chalky and by losing their ability to resist pounding and abrasion it seems an obvious conclusion that durability tests should establish the existence or absence of these properties after the asphalt has been subjected to conditions typical of its service life. Such a durability test will be described later in this paper.

Rate of Curing

A third property of asphalt which is of concern to the consumer is the rate of curing of the more liquid products. These road oils and cutbacks have been logically classified as slow curing, medium curing, or rapid curing, and there are times and places where one or the other of these is most appropriate and definitely superior to the other alternates. Nevertheless, there is a considerable variation at times in products purchased under one of these designations. Materials have been delivered which met all of the test requirements for a slow-curing product and yet which were found to set up so rapidly that road mixing became difficult if not impossible.

On the other hand, rapid curing cutbacks have been specified and purchased under standard specifications but which were found to set up or cure no more rapidly than the medium-curing grades. It is clearly evident that existing specifications which undertake to control rate of curing by limitation of the distillation test are not adequate for the purpose and it seems reasonable to assume that failure to correlate is due to the marked difference between test conditions and temperature and those of service.

Again, in order to simulate service conditions, the asphalt must be spread in thin films and subjected to moderate temperatures and as curing obviously involves increasing viscosity or hardening of the asphalt, all that is necessary is to measure this change under appropriate conditions. A procedure for accomplishing this will be described later under the section devoted to recommended or proposed tests.

Resistance to Water Action

A fourth property of asphalts which will be of some concern to the user is the ability to adhere well to mineral aggregates and to resist stripping or separation by the action of water. It is not believed that asphalts ordinarily differ widely in this respect. It is generally known that the greatest variable exists in the mineral aggregates. Nevertheless, the user would like to know that an asphalt has at least the average capacity to stick in the presence of water.

The foregoing completes the summary and discussion of the essential properties of asphaltic materials so far as the user is concerned. Beyond a doubt the producer of asphalts may consider many other factors and conditions in manufacturing an asphalt which will meet quality tests. If tests can be established which deal only with essential properties, the purchaser and user of asphalts need not concern themselves with source, method of manufacture, or composition of the substance. In other words, if the material has the properties to make a good durable pavement, the consumer should not care who makes it or how or from what ingredients.

Research dealing with the above problems has been under way for some time in the California laboratory and is by no means completed and no implication is made that it is entirely original. If we have made any progress, we must acknowledge a considerable debt to all other effective workers in the field. The following will describe such progress and conclusions as have been made in answer to the four problems just outlined.

Consistency

Only a limited amount of work has been done on new methods of measuring viscosity or consistency. As previously mentioned, it is felt that this is the least acute and it is possible to get along quite well by the use of existing methods. It is believed that this phase of testing ultimately will be clarified by the adoption of true viscosity measurements applied to all grades ranging from 40 penetration to grade "O" liquid asphalt.

Interesting results have been secured by use of the Brookfield Synchro-lectric Viscosimeter. This apparatus is particularly attractive because of the possibility of measuring viscosity at a number of temperatures in a comparatively short time by a simple apparatus. However, the equipment should be modified and could doubtless be improved for routine work.

We are aware of the work by other laboratories using a modified Ostwald type of Viscosimeter(1) but the method appears too complex and time-consuming to be the ideal answer for a large consumer laboratory.

Durability Tests

The matter of durability has seemed to be the most pressing. A considerable amount of work has been carried out. Satisfying the conditions set forth in the previous discussion of the durability problem we have made numerous attempts to measure the behavior of asphalt in thin films. Two methods suggest themselves.

First, to spread the asphalt in a thin film over a plane surface, such as a glass or metal. Benson(5) developed a technique for spreading small smears on microscope slides and the success reported by Benson in classifying the films by microscopic examination after exposure to radiant energy tends to confirm the soundness of the belief that thin films are essential. We followed Benson's lead for some time and reached the conclusion that while informative and vastly interesting it, nevertheless, does not lend itself well to specification purposes. The patterns developed represented a too wide variety for easy classification.

Adopting the mechanical approach, similar smears were made on strips of thin sheet metal which after exposure to heat and light were subjected to abrupt bending and observed for cracking.

SECOND ALTERNATE

A second alternate was the use of thin films on circular tinned metal discs, such as lids of three-ounce ointment tins. After weathering, the film was subjected to sudden impact through the dropping of a steel ball on the reverse side of the tin. This produced a raised, rounded bump under the asphalt causing cracks in a brittle film and by making a series of these tests after a number of weathering cycles, it was possible to determine the effect of weathering in producing hardening. The primary difficulty was in establishing films of uniformly even thicknesses and it was quickly demonstrated that the resistance to shatter or cracking varied markedly depending on the thickness of the film. We were unable to devise any means for spreading these films with absolute accuracy and uniformity over the entire surface. The method has definite possibilities if this difficulty can be overcome.

Another approach is to utilize a standard aggregate and this thought immediately brings to mind Ottawa sand. At this point in our investigation, the work reported by Lang and Thomas **(3)** came to hand and we immediately tried out certain of the methods described in this report. Three test procedures on Ottawa sand-asphalt specimens were reported by Lang. One, an elongation test, requires the manufacture of a special briquette which is pulled apart in a stretching device. The prospect of manufacturing these specimens as a routine operation was definitely unattractive; therefore, this operation was rejected.

LANG METHOD

A second method used by Lang with which we also experimented involves the manufacture of a briquette of Ottawa sand and asphalt which is destroyed by the impact of a hammer. This procedure has two definite weaknesses. One, the difficulty of detecting precisely when the first evidence of fracture has occurred. Second, the impossibility of gauging the weight of the blow. This means that a number of specimens must be tested involving a considerable amount of work, time and material.

The abrasion method however, has none of these limitations and as Lang's report seemed to indicate that the correlation by the abrasion method was at least as good as by any other, work was undertaken using the Deval machine as indicated by Lang. This was soon dropped in favor of a special tumbling device designed for the particular purpose. Many trials were made with generally gratifying results. It was clearly evident that very high losses were developed in specimens known to contain poor asphalts while relatively small losses were found with known good materials. Attempts were made to standardize and improve the reproductibility of results. However, while the test results were generally in the right order, it was found impossible to reproduce values on identical specimens as closely as could be desired.

Studying the problem further, the thought occurred that specimens could be subjected to abrasion by a stream of sand falling freely from a prescribed height. Simple trials were made and the method immediately indicated marked differences between briquettes manufactured from cracked asphalts as compared to good grades of steam-refined products. The difficulty in uniformly compacting a briquette one inch in depth and two inches in diameter lead to the adoption of a relatively thin specimen. The study has resolved itself to the method now in use.

This consists of preparing a mixture of Ottawa sand with 2 percent of the asphalt under test using a mixing temperature of 230° F. For the lower penetration grades, the lowest possible mixing temperature (above 230° F.) is used. (Mixing temperatures can, of course, be established as desired. For example, it may be most logical to use temperatures typical of paving plant practice for the particular asphalt.) Sufficient mix is prepared to make a number of 30 gram specimens which are compacted immediately in the form of small plaques using the lids of three-ounce ointment tins for the purpose. **(Figures 1A, 4 and 5)** These lids will hold approximately 30 grams of mixture when compacted level full. The samples are spread out in a flat pan and cured in a special weathering machine which employs an atmospheric temperature of 140° F. during which samples are exposed to the direct rays of standard drying lamps which emit the bulk of their energy in the infra-red band. A circulation of air is maintained. One complete cycle in this machine requires about five hours. The essential elements of this weathering operation could be produced very cheaply in a simple device built along the lines of the Weatherometer using radiant energy in the infra-red and a circulation of air.

TESTING APPARATUS

Two samples are tested immediately and others are removed from the curing ovens at intervals of three cycles and tested for abrasion loss under the impact of a stream of 10-14 mesh steel shot. The testing apparatus is so constructed that the specimen is rotated under a stream of shot falling freely through a tube 2½ cm. in diameter and 1 meter in length **(Figures 2 and 3)**. These dimensions are arbitrarily selected and are not necessarily the most ideal. Steel shot is allowed to fall at the rate of 1,800 grams per minute and the wear on the test specimen is expressed in grams lost per 1,000 grams of abrasive. A 10-14 mesh steel shot has been used because of its ready availability and east with which it may be reclaimed after being mixed with the asphalt coated particles which are eroded from the specimen.

ABRASION TESTS NOT NEW

The use of this technique has proved to be the most satisfactory thus far considered and has the advantage of utilizing comparatively small quantities of materials for the test, specimens are easily prepared, large numbers can be handled in a weathering device of reasonable size, the tests are quickly made. Reproductibility is excellent and marked differentiation is shown between samples of known good and bad performance. Questions remaining to be finally settled are the appropriate temperatures for most significant results and the type and the development of a variable temperature laboratory mixer which will approximate the mixing conditions found in the field.

Abrasion tests or sand blast tests are not new. We have reports of a sand blast method used in Germany a number of years back and Rhodes of the Koppers Company **(6)** has reported favorably on the use of a sand blast device for measuring the durability of tar-sand specimens.

In adopting our present procedure it was felt that utilizing a gravitational fall would be much more simple and more easily controlled than the use of an air blast with the sand. In all cases we are strongly influenced by the consideration that to become a satisfactory routine method a test procedure should be as simple as possible, should preferably involve no expensive apparatus and be capable of being made in large numbers.

DEGREE OF WEATHERING

The principal drawback to this method is that a period of several days is involved as tests must be made after six or nine cycles of weathering in order to establish clear differences. The most satisfactory and significant degree of weathering is yet to be definitely fixed upon.

Figure 6 indicates the range of values developed by a series of asphalts ranging from good to poor based on service performance.

Figure 7 is a chart representing the durability rating of a series of asphalts which represent straight run steam refined, cracked, also cracked and blown.

Figure 1 represents three plaques or test specimens of compacted Ottawa sand-asphalt mixtures weighing approximately 30 grams, compressed under 1,000 lbs. per square inch using the lid of a standard three-ounce gil ointment tin to hold the specimen.

Specimen A represents the specimen appearance as initially compacted showing no loss under sand abrasion. Specimen B is a specimen showing moderate loss. Specimen C indicates a considerable loss typical of an asphalt lacking in durability.

Figure 2 is a schematic diagram of the durability test apparatus for subjecting specimens (illustrated in Figure 1) to the abrasive action of sand falling through a tube one meter in length. Test specimen is rotated and entire system subject to temperature control.

Figure 3 is a photograph of the apparatus diagrammed in Figure 2.

Figure 4 shows the units used in preparing the durability test specimens.

Specimen A is the plunger or follower as commonly used in the Hubbard-Field Test, dia. 1.994 inches. Specimen B is a cylindrical steel mold 2 inches inside diameter. Specimen C is a lid of a standard three-ounce ointment tin, diameter 2-3/16 inches. Specimen D is a base plate with grooved recess to hold the tin lid. Specimen E is the funnel for introducing Ottawa sand-asphalt mixture.

Figure 5 is the same as Figure 4, showing apparatus assembled, ready for applying compression load of 3,500 pounds total (i. e. 1,000 lbs. per square inch).

A B C

Figure 1

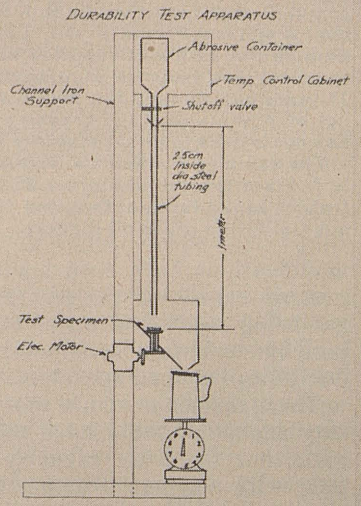


Figure 2

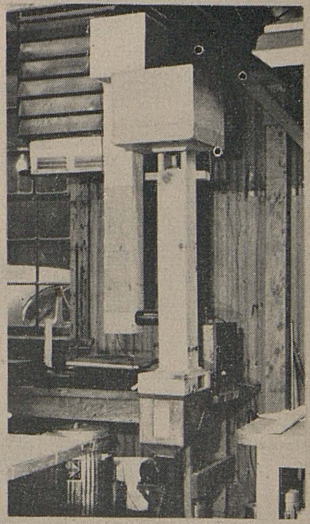
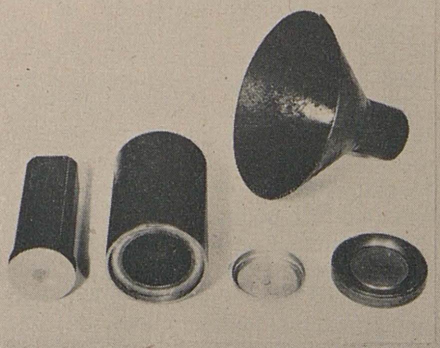


Figure 3



E

A B C D

Figure 4

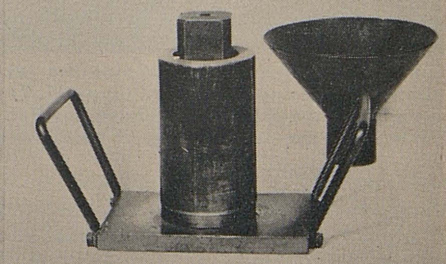


Figure 5

Table I gives detail of other test data. While no service record is available it is believed, however, that the data are significant as the durability test shows all steam refined asphalts to have low loss and, hence, good durability, while cracked asphalts show an increased susceptibility to abrasion loss and cracking plus blowing is apparently even more detrimental. It will also be noted that the Mid Continent crudes may not be adversely affected by a certain degree of cracking if not carried too far.

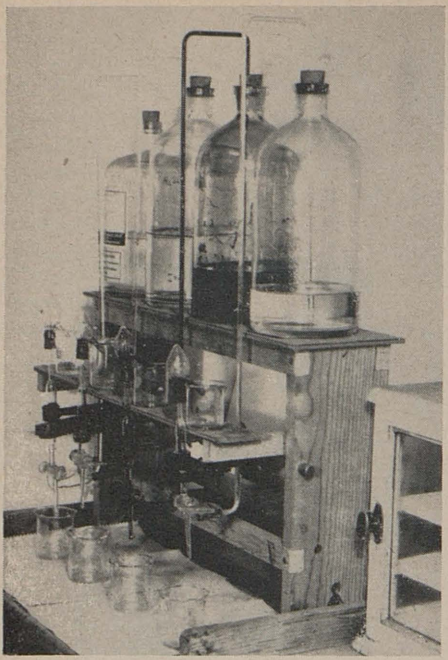
MECHANISM OF HARDENING

Figure 9 represents durability results on seven samples of SC oils from the State of Wisconsin all of which met Standard Specification requirements according to Mr. Zapata. He advises that No. 1 and No. 7 have given poor service. **Figure 9** indicates the poor quality of No. 7 while **Figure 21** seems to account for No. 1.

A test of this type does not carry any particular implication or produce direct evidence as to the mechanism of hardening. It has been variously maintained that the hardening of asphalts is due primarily to the loss of volatiles **(2)**. Others contend that oxidation is a primary factor. Polymerization and thixotropy have been mentioned and no one can question that all of these mechanisms may play a part. Oxidation tests such as the Kansas City Testing Laboratory Oxidation **(11)**, as well as those reported by Nicholson **(7)** and Skidmore **(8)**, Raaschig and Doyle **(9)**, Anderson, Stross and Ellings **(10)**, all have shown a considerable degree of correlation with performance.

Even though hardening may develop through several types of mechanism, there seems to be good reason for finding out something about the capacity of an asphalt to take up oxygen and it appears unquestioned that if an asphalt will combine with any appreciable quantity of oxygen, its physical characteristics will be changed.

Working in the California Laboratory, Mr. A. R. Ebberts devised a technique for quantitative measurement of the relative oxidation of asphalt in thin films **(4)**. Details of this method have been previously reported but



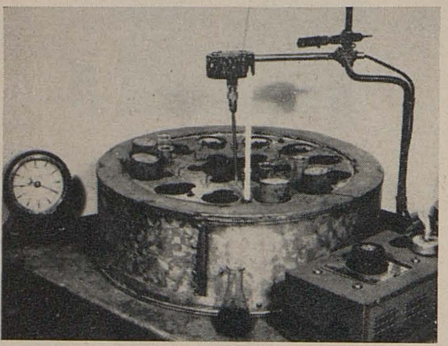


Figure 10. An automatic pipe the layout for dispensing re-agents. Figure 11. The water bath maintained at 140 degrees Fahrenheit for the conditioning of specimens.

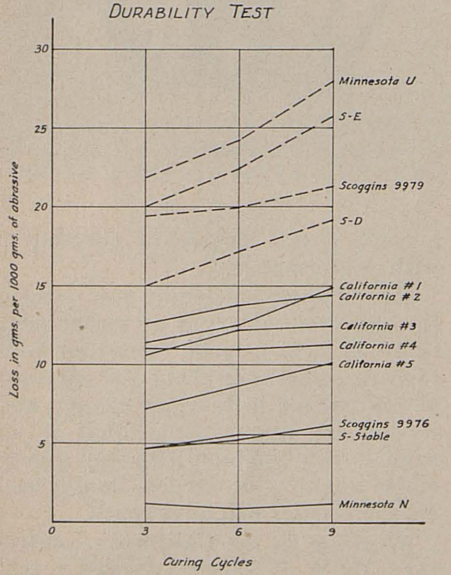


Figure 6 is a chart showing abrasion loss on 13 samples of asphaltic materials which have given previous indications of quality either in service or by extensive laboratory investigations. Samples N and U, furnished by the Minnesota Department of Highways, were previously reported by Lang and Thomas.[3] Samples marked S-stable, S-D and S-E furnished by Mr. V. A. Endersby of the Shell Development Company, were classified as follows:

S-stable, carefully refined asphalt found to be durable on field experiments; Samples S-D and S-E were cracked to varying degrees; and S-E was found to be very unstable and ravelled badly on the street under moderate traffic. Samples Nos. 9976 and 9979 were furnished by B. I. Scoggin of the Anderson-Prichard Oil Corporation. Sample No. 9976 was reported as showing excellent performance in pavements over 11 years old. Sample No. 9979 was a product of a Winkler Koch cracking unit and has not proved to be satisfactory in service.

The samples marked California No. 1, 2, 3, 4, 5 are typical California 85-100 penetration asphalts manufactured from various California crude oil sources.

modifications have been made and at present details of the test procedure are being studied in order to make it possible to obtain satisfactory reproducibility between operators.

There is some evidence that satisfactory asphalts should have neither too great nor too little capacity to combine with oxygen. Furthermore, the oxygen demand evidently varies with

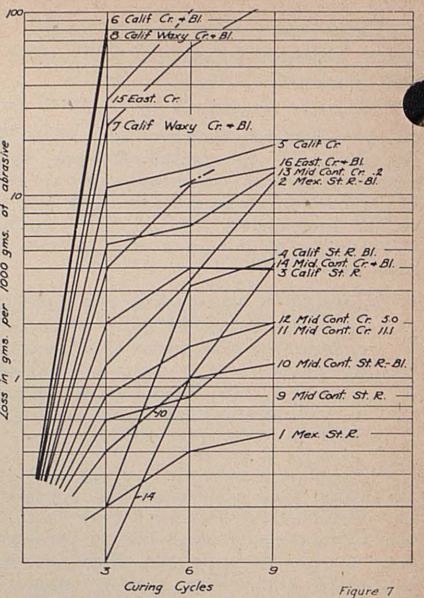


Figure 7

the different grades and a consistent increase may be traced from the heavier paving grades to the most liquid materials. For example, it appears that satisfactory asphalts of 50 penetration should consume not less than 0.9 ml. nor more than 1.2 ml. of $KMnO_4$

TABLE I

A	B	C	D	E	F	G	H	I	J	K
Sample No.	Source of Crude	Str. Run	Cracked	Blown	A.P.I.	Pen.	Sft. Pt. Ring & Ball	Suscept. Index	Ebberts Oxid.	Abrasion
1	Mexican	x	------	------	------	103	119.5	2	4	1
2	"	x	------	x	------	100	144	1	8	9
3	Calif. Lube	x	------	------	------	97	110	15	5	7
4	"	x	------	x	------	94	112	10	3	8
5	"	------	x	------	------	108	108	16	9	12
6	"	------	x	x	------	107	110	9	15-16	15
7	Calif. Waxy	------	x	x	------	92	112.5	8	14	13
8	"	------	x	x	------	100	113	5	15-16	16
9	Mid-Cont.	x	------	------	------	103	112	7	1	2
10	"	x	------	x	------	84	118	3	2	3
11	"	------	x	------	11.1	108	109.5	12	6	4
12	"	------	x	------	5.3	92	112	13	7	5
13	"	------	x	------	—.2	96	111	12-13	10	
14	"	------	x	x	5.3	92	116	4	10	6
15	Eastern	------	x	------	------	105	110	11	12-13	14
16	"	------	x	x	------	86	115.5	6	11	11

The above table lists certain data on 16 samples of asphalts representing different crude sources and different methods of treatment in the refinery. Column B indicates source of crude, Columns C, D, and E indicate the refinery process, and columns F, G, H, and I indicate A.P.I. Gravity, Penetration, Softening Point, and Susceptibility Index (according to Piper and Van Doormal). Column J indicates the relative order of quality as indicated by the Ebberts Oxidation Test. Column K indicates the relative order of quality indicated by the Durability test at 6 cycles as shown on Figure 7.

in 60 minutes at a temperature of 140° F. under the conditions described; whereas, an asphalt of 200 penetration should range between 1.0

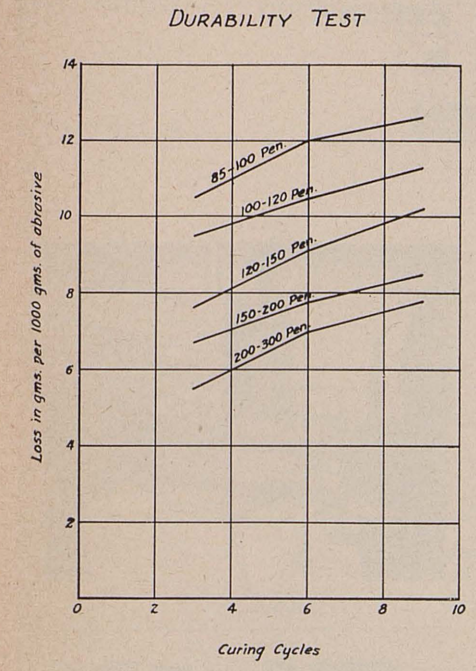


Figure 8 is a chart showing the differences in abrasion losses between five grades of California paving asphalts all refined from the same crude oil source.

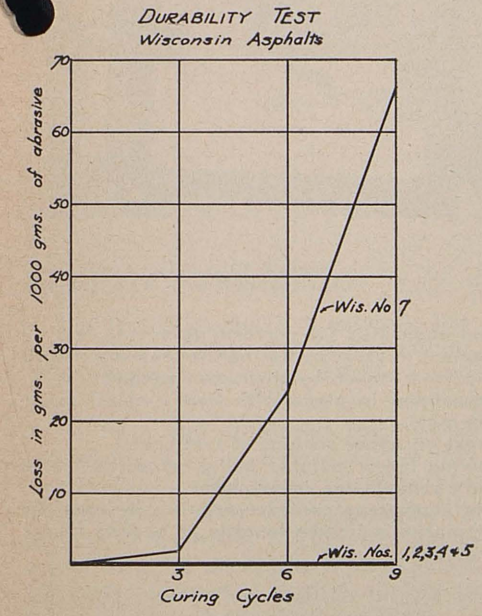


Figure 9 is a chart of abrasion losses displayed by seven samples of slow-curing oil furnished by Mr. Joseph Zapata of the Wisconsin Highway Department. Mr. Zapata reports that all samples have met standard specification requirements, however, samples No. 1 and No. 7 were found to be unsatisfactory in service. Figure 9 seems to indicate the reasons for the failure of sample No. 7. The deficiencies of sample No. 1 are at least partially indicated by Figure 20.

ml. and 1.7 ml. In a similar manner tentative limits have been established based on the existing data which involves tests performed on some 40 or 50 samples in each of several grades. Data thus far available establish a tentative rate of change relationship between the paving grades and the SC products. Sufficient study has not been completed on the MC and RC types.

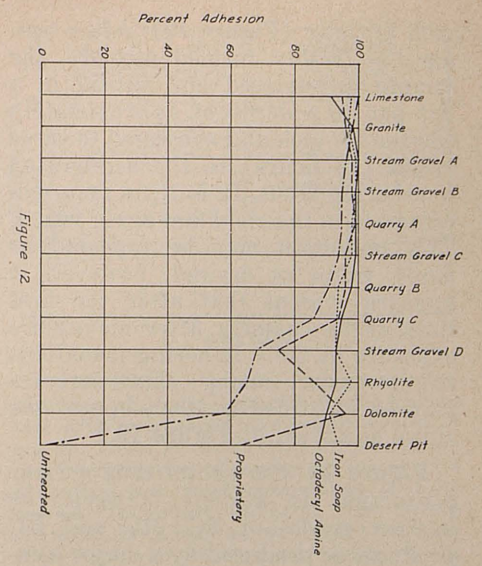
It does not necessarily follow that this particular test will show 100 percent correlation with road performance but it offers attractive possibilities for the immediate and rapid classification of asphalts as the method will produce an answer within a few hours after the sample is received and requires relatively simple and inexpensive equipment.

As previously reported, there is a consistent and considerable difference between the oxidation capacity of SC-1 and SC-6 and it seems inescapable that the presence of the more volatile fractions permits a greater consumption of oxygen. Whether it is the volatiles which take up the oxygen or merely facilitate its consumption is not at present known. Probably two factors in the asphalt composition bear on the susceptibility to oxidation. These are the size and the nature of the molecules. The capacity to consume oxygen increases with the percentage of the more volatile fractions and there is no doubt that it also varies with the percentages of aromatic and paraffinic types of molecules. The total values in the oxidation test, then represent some sort of compromise between molecular size and type making it necessary to set up a standard for each liquid grade or penetration range.

At the present time this oxidation test appears to have considerable degree of significance, although not necessarily capable of detecting every potentially poor asphalt. The fact that it is quantitative, comparatively simple and capable of producing rapid results seems to justify further work in the hope of developing a satisfactory technique for routine operation.

Tests for Determining Rate of Curing

Rate of curing becomes important when dealing with Grades 1, 2, 3 and 4. Serious damage can result if an alleged SC product sets too rapidly or an RC cutback fails to set up as expected. Existing distillation tests, while generally indicating the difference, nevertheless, permit too much variation and, furthermore, are conducted at elevated temperatures far beyond the range of service conditions.



The effect of various wetting agents as assessed by the dye adsorption technique is shown graphically in Figure 12. An adhesion of about eighty-five per cent (85%) is necessary to assure satisfactory service life. These agents seem to be most effective when the aggregate is damp at the time of mixing. The mixtures were all made with SC-3 oil.

A method developed in the California laboratory seems to need little further improvement to supply an adequate answer to this problem. The test is performed as follows: 2 percent by weight of liquid asphalt is mixed with Ottawa sand in the same manner as prescribed for the durability test. The test requires some 160 grams of mixture. Immediately after mixing, this coated sand is pressed by hand trowel into a small metal mold in the form of a trough, having a semicircular cross-section with a radius of .687 inch and a length of 9 inches. This mold is then placed in a specially designed apparatus housed in a cabinet permitting accurate temperature control **(Figure 13)**. The beam of asphalt is pushed or extruded from the mold in a horizontal position **(Figures 14 and 15)**. The unsupported overhanging end of the small beam will bend and break off under its own weight as soon as a sufficient length has been extruded **(Figures 16 and 17)**. The mold travels at a uniform speed of six inches per minute with temperature of all metal parts and enclosed atmosphere maintained at 100° F.

These breaks will occur at intervals varying in length depending on the consistency of the asphalt. For example, a freshly mixed SC-2 will produce breaks at intervals of about .3 inch **(Figure 18)**, whereas, MC and RC products may range from .6 inch to .9

inch initially (**Figure 19**). After testing the freshly formed mixture, the sample is retrieved and spread in a flat pan to a depth of approximately one-fourth inch and subjected to three cycles (16 hours) in the accelerated weathering oven. It is then removed, reformed in the mold and again tested. This operation may be repeated as many times as desired, however, it appears evident that after the first three cycles (namely, after one night's exposure in the weathering machine), the essential curing characteristics may be identified by the slope of the curve as shown in **Figure 19**.

Figure 19 also shows that a clear distinction is evident between the various grades of SC, MC and RC products as produced by a major company, which so far as field experience is concerned appear to act in the manner expected. However, samples have been made available representing products which were reported to fail completely in setting up properly in service and these samples have unmistakably shown this tendency by the virtually unchanging length of break developed in the machine, regardless of the number of curing cycles (**Figure 20**). The instrument has been devised to be self-recording so that the length of break is unmistakably marked on a paper strip permitting the averages to be determined (**Figures 17 and 18**).

Surprising uniformity has been secured, although occasional increments may run out of line. It should be possible to prevent these occasional discrepancies, however, they are not serious as the large number of breaks makes it possible to virtually eliminate errors by averaging the individual lengths. To all intents and purposes this particular machine produces from six to 20 test results on each specimen in the short space of a few minutes (**Figure 18**).

As in all studies for significant qualities of asphalts, material with a known record of poor performance are difficult to secure and proof of the significance of the tests must of necessity rest on a rather limited number of samples. California practice makes occasional use of RC cutbacks to supply cohesion in fine sands of low internal friction. This expedient has been quite useful when stable aggregates are not readily available.

On a recent project, however, the material failed to harden or set up as had been expected in previous cases. A careful recheck of the cutback indicated that it was well within specification requirements in all respects. When subjected to this curing test, however, it was found to perform definitely below the general run of such material; in fact, it gave almost the same indications as an MC product. Results of the test were in excellent agreement with observed performance. **Figure 21** shows several samples which fail to cure at the normal rate.

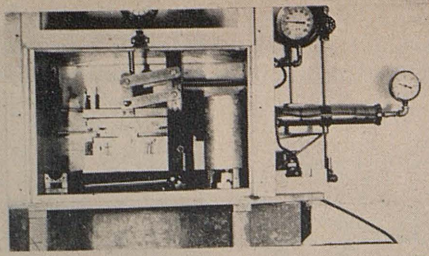


Figure 13

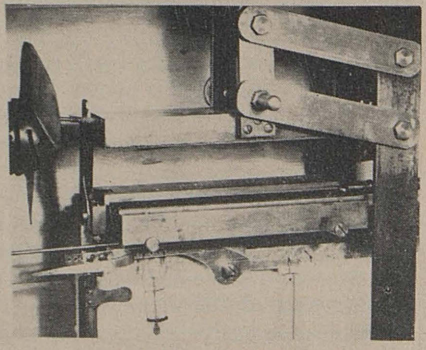


Figure 14

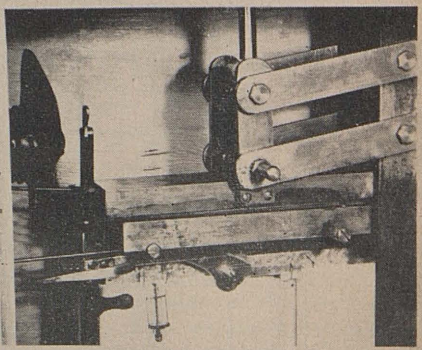


Figure 15

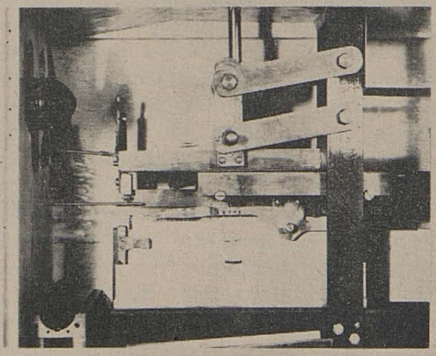


Figure 16

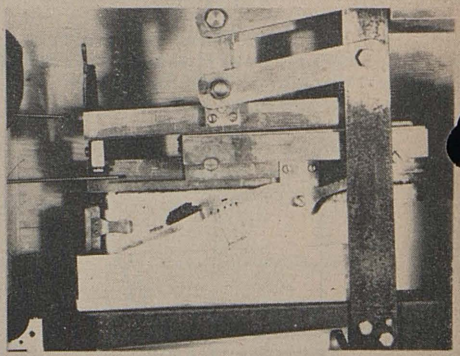


Figure 17

Figure 13 is a general view of cabinet and apparatus for performing curing test by extruding a beam of compacted Ottawa sand-asphalt mixture by noting the tensile strength as evidenced by the lengths of increments which are broken by their own weight.

Figure 14 is a close-up view showing specimen in place with heavy metal cover suspended to permit insertion of semi-circular mold.

Figure 15 shows metal cover lowered to rest on upper surface of test beam.

Figure 16 represents test under way showing lower member being retracted to the right. End of asphalt beam may be seen drooping beneath the cover plate.

Figure 17 shows increment broken off and depressing recorder arm which inscribes a mark on paper strip. The distance between marks indicates lengths of broken increments. (See Figure 18 for facsimile of record strip.)

This particular procedure appears to be in little need of further modification or drastic improvement and can be strongly recommended in its present form. Several changes in the mechanical equipment could be made without altering the principle. For example, the slide should be actuated by a synchronous motor operating through a reduction gear to produce

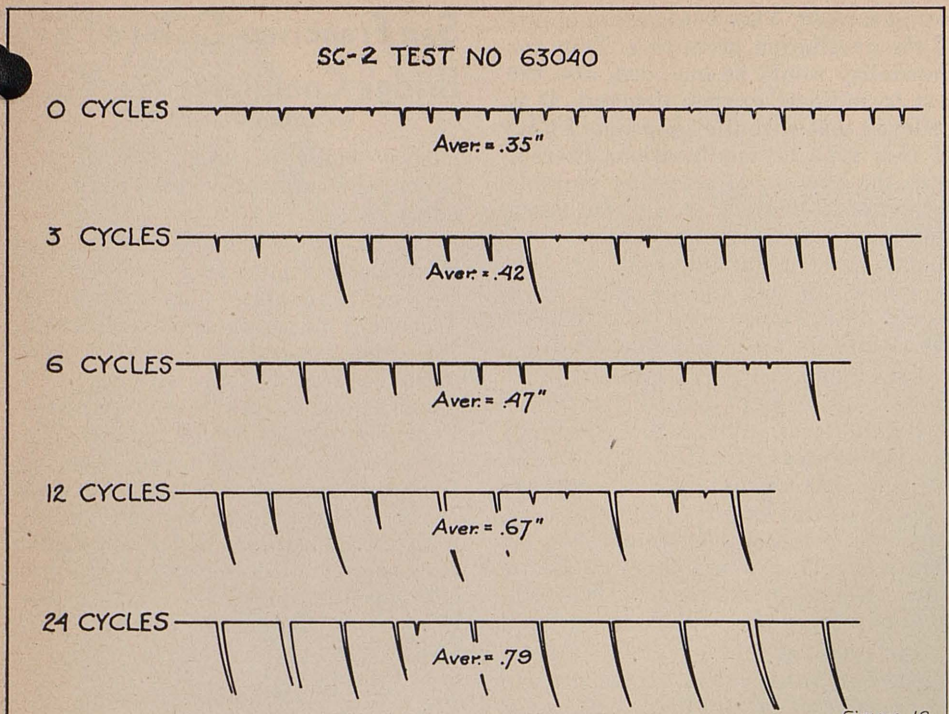


Figure 18

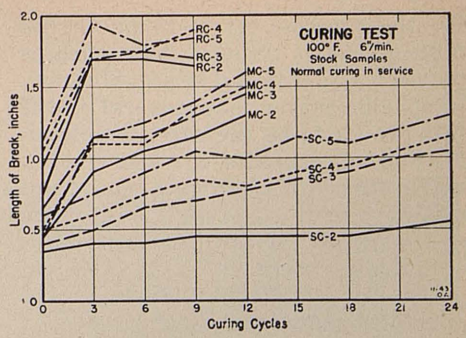


Figure 19 is a chart showing relative behavior of liquid asphalts in the curing test after a varying number of cycles of curing. These products have all given normal performance in service so far as rate of curing and final consistency is concerned. The chart indicates that curing characteristics may be identified after only three cycles of accelerated curing. While minor discrepancies exist, the pattern of behavior for slow curing, medium curing, and rapid curing are distinctive and the several grades fall approximately in normal sequence.

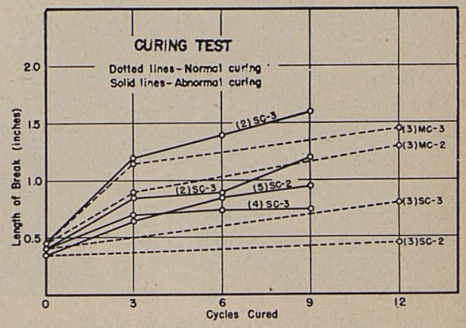


Figure 20. A chart showing several oils wherein the curing characteristics are at marked variance with the normal for the grade. The dotted lines indicate normal curing behavior for the grades indicated. The solid lines show the rate of curing of certain products which have been observed to perform in an erratic manner during construction operations. These test data seem to be in good agreement with observed performance.

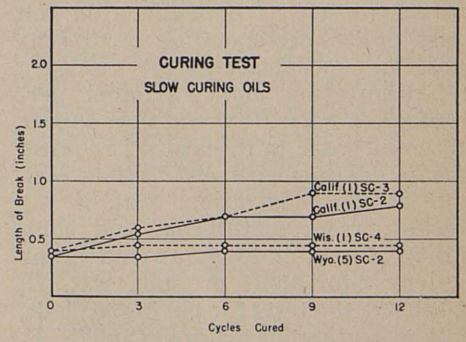


Figure 21. This chart illustrates the difference in test results between slow curing and non-curing samples. Wisconsin No. 1 and Wyoming No. 5 were reported as failing to set up or harden on the road. Two California oils which have shown normal curing are included for comparison.

the desired speed. While a hydraulic cylinder was used in the original machine to permit ready variation of speed, this type of drive will not be satisfactory for routine control after a standard speed has been agreed upon.

Thus we have two methods, both dealing with the asphalt spread in films over the surfaces of aggregate particles and subjected to the hardening influences of radiant energy and oxygen. The methods are simple and direct.

Resistance to Water Action

The fourth property of asphalts concerns the resistance to water action. While tests for this type of failure have been in use since 1929 in the form of swell tests and stripping tests, there is still much to be desired in the way of correlation with actual performance. While these tests so far have generally been used to classify the mineral aggregates there is no doubt that asphalts also vary somewhat in their ability to adhere in the presence of moisture.

Work has been under way in the California laboratory for some time seeking to develop a quantitative measure of stripping. This work is based on the known fact that most surfaces will adsorb dyes of various types and by selecting a suitable dye it was hoped that the amount of stripped surface could be accurately measured. The procedure followed consists of, first, determining the dye adsorption of the untreated aggregate. For this purpose the entire material is used ranging from four-mesh to and including the dust. This constitutes a definite improvement over the standard stripping test as the smaller sizes are generally the most important due to the large surface area represented. The aggregate is then coated with a standard grade of asphalt and after curing over night it is subjected to the stripping test. Dye is then added and the adsorption again determined.

PERCENTAGE OF STRIPPED AREA

By comparing the amount of dye adsorbed after the stripping test has been performed to the amount taken up by the entire aggregate before being coated with asphalt, it is possible to determine the percentage of stripped area. This type of determination has shown good reproducibility but requires the attention and time of an operator who is well-trained in the techniques employed. The method cannot be recommended or advocated in its present state as a routine operation but does provide a means for obtaining comparative data on adhesion phenomena.

If a dependable method can be devised which will show good correlation with field performance, it might then be possible to classify asphalts by using some standard aggregate for the purpose. It is to be feared that adhesion tension relationships between asphalts and aggregates may be specific rather than general and if this proves to be the case, the classification of asphalts by means of a single standard aggregate would not be very useful. At present, it appears necessary to use several aggregates of varying composition in order to get a fairly reliable picture of the ability of asphalt to stick.

A complete solution to this entire problem may readily appear from another source. There are now many methods of treatment being advocated or in process of development which should improve the capacity of any asphalt to stick to virtually all aggregates under the most adverse conditions. When an agent is commercially available which can be added to the asphalt at the refinery, this entire problem may largely disappear, although it is likely that accurate test methods will always be needed in order to compare the effectiveness of competing forms of treatment and to assure ourselves that the wetting agent is actually present in specified quantities in the delivered material.

At the present time, three experimental projects are being constructed at selected points in Districts II, VIII and XI, in order to observe the effectiveness of several additives under actual roadway conditions. However, final conclusions cannot be drawn for some time.

RECOMMENDATIONS

With perfection and further corroboration of the results indicated in the foregoing, the next step would be the inclusion of such quality tests in all Standard Specifications. It is suggested that a typical specification would consist of limitations on the flash point corresponding to present practice, specifications for viscosity or penetration and maximum percentage of water. It would then appear to be in order to discard all requirements dealing with distillation, residue of 100 penetration, tests on the residue from distillation and solubility of CCl_3 and CS_2, as well as the xylene equivalent or spot test. In addition, the tests for paving asphalt, loss on heating for five hours at 325° F. and penetration after loss on heating could also be dropped.

In lieu of these requirements, limits of performance under the curing test would indicate a maximum and minimum rate of change for all grades of liquid asphalt. This would serve in lieu of the distillation procedure. Tests for durability would be included, also the test to indicate oxygen demand. It is believed that with the adoption of tests of this type or modifications thereof that the process of selecting suitable bituminous binders would be much simplified and would be in some respects less restrictive than present specifications, but on the other hand would be far more positive in rejecting definitely unsuitable materials.

Evidence thus far available indicates that when judged by these determinations all cracked products are not necessarily objectionable. It appears that a great deal depends on the degree and extent of the cracking and a moderate amount may even be beneficial. This would seem to be in line with reported experience, particularly from the Middle West.

The point should again be emphasized that properly coordinated tests will permit the acceptance of all materials which are capable of producing satisfactory construction and would eliminate all which are unsuitable for the purpose and that having such test procedures the purchaser need not be concerned with either source of material or method of manufacture. The problem of manufacturing a binder or cementing agent which will meet these requirements is up to the producer.

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San Francisco-Oakland Bay Bridge Completes Ten Year[illegible]

(Continued from page 6)

output would necessarily have been curtailed—all at the expense of the war effort.

On its tenth anniversary the San Francisco-Oakland Bay Bridge is experiencing a traffic volume rapidly approaching maximum capacity. Studies for a new crossing are now being made under the general supervision of Director of Public Works Purcell and Chief Engineer of the San Francisco-Oakland Bridge, with F. W. Panhorst, Bridge Engineer of the California Division of Highways, in direct charge.

In "Engineering Facts," a study for the California Legislature, by the staff of the Collier Joint Fact-Finding Committee on Highways, Streets and Bridges, we read:

> "When the San Francisco-Oakland Bay Bridge was opened to traffic on November 12, 1936, it was hailed as an engineering wonder of the age, the solution of transbay transportation problems for years to come. Today, only 10 years later, its traffic is so heavy that anoth[illegible] bay crossing is under consideratio[illegible] to meet present and future needs."

This road when completed will carry to market millions of board feet of sorely needed lumber

Mosquito Ridge National Forest Road Will Relieve Lumber Shortage

IN MAY of this year the Mosquito Ridge Forest Highway, Route 96, was approved as an addition to the California Forest Highway System following joint recommendation to that effect by the Regional Forester, State Highway Engineer, and Division Engineer of Public Roads Administration. The route extends from Forest Hill, a small lumbering settlement 20 miles east of Auburn, easterly for 19.2 miles to a point on Mosquito Ridge about 20 air-line miles westerly from Lake Tahoe.

For some years the U. S. Forest Service has planned ultimate development of the extensive stands of Government-owned merchantable timber in the Mosquito Ridge and adjacent Ralston Divide areas of Tahoe and Eldorado National Forests, and early in 1945 the regional forester requested that Public Roads Administration make surveys of both the Mosquito Ridge Road and the connecting Ralston Divide Route.

The acute shortage of lumber for needed housing at the war's end made it necessary that plans for development of timber be accelerated. Accordingly, early in 1946 studies of available timber in the Mosquito Ridge and Ralston Divide areas were completed by the Forest Service. These studies indicated that sufficient timber to support a continuous extensive lumbering operation can be obtained from the areas. Since one of the chief functions of forest highways is development of National Forests it was recommended immediately that the Mosquito Ridge Route be added to the Forest Highway System and that funds made available for forest highway construction by the Federal Highway Act of 1944 be programmed for construction. No cutting of timber in the Ralston Divide area is planned for a number of years and, therefore, construction of that road will be deferred.

Completed design for the Mosquito Ridge Route provides a 22-foot roadbed for the first 9.5 miles with a single lane road 12 feet wide with intervisible turnouts on the remainder. There are only two major structures on the entire length, a reinforced concrete arch cul-

(Continued on Page 37)

Traffic Engineer Looks at the Current Traffic Accident Problem

By J. W. VICKREY, Traffic Engineer

ACCORDING to the reports of the National Safety Council, California's traffic fatality record for the first nine months of 1946 shows 10.4 fatalities per 100,000,000 miles of motor vehicle travel.

Compared with the 1945 record of 15.3, this report shows considerable improvement and it offers encouragement and support to the hope of everyone whose daily life is affected by motor transport that we may be able to squeeze through the year with a much smaller toll of life than was predicted during the late spring and early summer.

The record for the portion of the State Highway System outside of incorporated cities for the first nine months of the year, compared with a like period in 1945, shows that fatalities have increased 29 percent while motor vehicle traffic has gone up 46 percent. Making a comparison with the first nine months of 1941, fatalities and traffic have increased 13 and 24 percent respectively.

While it is a cold fact that there have been more persons killed in motor vehicle traffic accidents thus far during 1946 than for a like period in any recent year, we have reason to be encouraged that at least the rate or trend line for 1946 shows some improvement.

The bringing about of improvement in the traffic accident problem is a difficult and complex undertaking. Even maintaining reduced fatality rates already achieved, requires constantly increasing effort because the conditions which cause traffic accidents are more widespread and more frequent with expanding motor transport. General recognition and acceptance of this fact is apparent from the widespread interest manifest in the President's Safety Conference and the conferences called by the Governor of California and the action of Interim Legislative Committees.

In order to take proper measure of the magnitude and importance of the traffic accident problem, it is necessary to turn to accurately compiled motor traffic data.

These data, through traffic and traffic accident analysis, provide not only the one sound basis by which the traffic accident problem may be measured but they also, and of equal if not greater importance, supply the only basis by which proper remedial action may be formulated.

Adequate traffic accident reports analyzed by competent and experienced analysts, of which there are all too few, form the single basis from which remedial measures that have any hope of success may be planned and put into action. It is regrettable that the whole traffic accident problem is made more complex, and its improvement more difficult and further away, by the suggestion of so many panaceas and palliatives that have no base or foundation that can be supported by an analysis of factual data.

Traffic accident reports competently analyzed and interpreted, bring out concentrations of locations and types that point the way to remedial action. Eighty-six percent of the traffic accidents reported on the State Highway System outside of incorporated cities occur on 38 percent of the mileage or on about 4,700 miles.

This same 4,700 miles carries 81 percent of rural state highway traffic and it comprises the portion of the system which carries 1,500 or more vehicles per day. About 12 percent of the system, or some 1,600 miles, carries an average daily traffic of 4,000 and over vehicles. This small portion of the mileage accounts for almost 60 percent of the traffic accidents. This is substantially the mileage that should be expanded to more than two lanes in order to safely accommodate the present vehicle load.

It is very evident from these figures that insofar as rural highways are concerned the traffic accident problem is actually concentrated on a very small portion of the system. A large portion of the mileage, some 7,500 miles, does not show any concentration of accidents in general pattern. There is ample reason to believe that this same concentration of the majority of traffic accidents on a reasonably small mileage prevails on the entire road and street system of the State.

An analysis of all the traffic accidents that were reported as occurring on the rural State Highway System during the year 1945 in which persons were killed, shows that in about 50 percent of these situations some type of highway improvement is indicated as a remedy for preventing that particular type of accident. At the same time this same study shows that HBD (had been drinking) was a factor in 27 percent of the accidents.

All fair and impartial analyses of traffic accidents show up drinking as one of the principal contributing factors. HBD drivers and HBD pedestrians take an all too important part in the traffic accident problem. This is the outstanding contributing cause to traffic accidents, with which society should deal with quick and decisive results. It is a job for society at large.

There is little that enforcement can do with this particular part of the problem but compile the accident reports, and there is little that the engineer can do but point out the facts. The fact cannot be denied that in the failure to recognize and solve this particular accident problem is reflected the true attitude of the general public toward traffic accidents.

On the other hand, the 50 percent of fatal accident reports that indicate some type of highway improvement as a remedy, reflect a part of the problem that can be to large extent solved by improved highway facilities and to a considerable degree minimized by selective enforcement. It all costs money—but it will cost more to continue with the present conditions than it will cost to improve them.

There is ample reason to support the belief that through the application of techniques already known the fatality rate of 10.4 per 100,000,000 miles of motor vehicle travel can be reduced by at least one half. A program to put such procedure into effect will cost large sums of money but it will be worth it.

RURAL STATE HIGHWAY ACCIDENTS

				Percentage Change 1946 over 1941		Percentage Change 1946 over 1945	
January	1941	1945	1946	Accidents	Traffic	Accidents	Traffic
Fatal	75	61	100	33.3	---	63.9	---
Non-Fatal	643	494	909	41.4	---	84.0	---
P. D. O.	478	307	657	37.4	---	114.0	---
Total	1,196	862	1,666	39.3	38.6	93.3	45.8
February							
Fatal	68	61	109	60.3	---	78.7	---
Non-Fatal	647	407	833	28.7	---	104.7	---
P. D. O.	495	271	621	25.5	---	129.2	---
Total	1,210	739	1,563	29.2	36.7	111.5	52.0
March							
Fatal	69	81	109	58.0	---	34.6	---
Non-Fatal	610	422	875	43.4	---	107.3	---
P. D. O.	489	352	704	44.0	---	100.0	---
Total	1,168	855	1,688	44.5	24.8	97.4	48.7
April							
Fatal	87	62	86	1.1	---	38.7	---
Non-Fatal	619	434	770	24.4	---	77.4	---
P. D. O.	494	308	592	19.8	---	92.2	---
Total	1,200	804	1,448	20.7	28.1	80.0	54.8
May							
Fatal	80	52	81	1.3	---	55.8	---
Non-Fatal	735	463	819	11.4	---	76.9	---
P. D. O.	589	320	637	8.2	---	99.1	---
Total	1,404	835	1,537	9.5	24.2	84.1	51.7
June							
Fatal	88	77	84	4.5	---	9.1	---
Non-Fatal	741	490	781	5.3	---	59.4	---
P. D. O.	478	380	663	38.7	---	74.5	---
Total	1,307	947	1,528	16.9	21.2	61.4	59.2
July							
Fatal	100	77	93	7.0	---	20.8	---
Non-Fatal	888	601	887	0.1	---	47.6	---
P. D. O.	664	408	652	1.8	---	59.8	---
Total	1,652	1,086	1,632	1.2	22.1	50.3	50.0
August							
Fatal	99	102	97	2.0	---	4.9	---
Non-Fatal	903	801	931	3.1	---	16.2	---
P. D. O.	728	542	726	0.3	---	33.9	---
Total	1,730	1,445	1,754	1.4	14.1	21.4	49.3
September							
Fatal	93	96	101	8.6	---	5.2	---
Non-Fatal	813	913	881	8.4	---	3.5	---
P. D. O.	647	647	810	25.2	---	25.2	---
Total	1,553	1,656	1,792	15.4	19.2	8.2	16.7
January through September, 1946							
Fatal	759	669	860	13.3	---	28.6	---
Non-Fatal	6,599	5,025	7,686	16.5	---	53.0	---
P. D. O.	5,062	3,535	6,062	19.8	---	71.5	---
Total	12,420	9,229	14,608	17.6	24.4	58.3	46.1

New Fresno Freeway Does Away With Congested Section of U. S. Highway 99

By R. S. PERCIVAL, Associate Highway Engineer

WITH the opening to traffic of the Fresno Freeway in October, a seriously congested section of US 99 at the southerly approach to the City of Fresno has been eliminated. The improvement is on new alignment and is, in general, about 600 feet westerly of the original highway between the Calwa Overpass and the south city limit of Fresno at Church Avenue.

The average daily traffic on this two-mile section, based on the July, 1946 counts, is 19,000 vehicles at the southerly end and 22,000 vehicles at the northerly end. Because of the extensive commercial development along Railroad Avenue, which was the former State Highway, it was determined that it would be more economical to relocate the highway than to widen the existing one. A further advantage of the relocation is that a wide right of way could be acquired at a reasonable cost, which would provide ample room for road connections with wide flares for good turning radii, and traffic islands and speed change lanes for the better protection of traffic. The former route was not susceptible to these advantages because of the very short distance between the edge of pavement and the railroad tracks.

Plans for this project were completed in 1943 and funds were allocated for construction; however, because of the critical shortage of materials and manpower, the work was deferred for the duration of the war. With the cessation of hostilities, this project was advertised for construction. Work was begun in January, 1946, and is scheduled to be completed the later part of November.

The work as completed is the first stage in making this section of State Highway Route 4 (U. S. 99), in and adjacent to Fresno, a freeway. Present construction provides a four-lane, divided highway on 200 feet of right of way with grade crossings at the existing county roads, but with no direct access to the freeway allowed to abutting property owners. The distance between the northbound and southbound pavements is thirty-two feet. The final stage of the work, to be completed when traffic demands require it, will involve the construction of grade separation structures at some of the intersecting roads and the closing of others, with outer highways being provided where needed to connect intersecting roads. In its ultimate stage, the freeway will have no crossings at grade but will be provided with on-and-off ramps adjacent to grade separation structures.

The pavement consists of two lanes of Portland cement concrete eight inches thick and twenty-three feet wide, with plant-mixed surfacing borders and bituminous treated shoulders. The more important intersections have been channelized with traffic islands and speed change lanes.

The concrete pavement was constructed without expansion joints and with weakened plane joints at fifteen-foot intervals. The weakened plane joints were cut with a diamond saw the day after pouring the concrete. The cutting machine used for this purpose is a device having rotary cutters faced with diamond chips. It is mounted on a two-axle, six-tired-wheel, frame, which can be steered longitudinally along the pavement slab. The cutting beam is mounted transversely and holds six cutting discs. These are spaced twenty-four inches apart and thus can cut a slab twelve feet in width to a depth of 1¼ inches with a two-foot movement of the cutting beam. The machine is operated by one man from a platform above the cutting beam which he controls hydraulically. The time required to cut each joint is about two minutes and each disc will cut about 1600 linear feet of concrete to the depth required for weakened plane joints. Tie bolts at thirty-inch centers were used in the longitudinal joint between the 11-foot and 12-foot slabs and in transverse construction joints. Adjacent slabs were also keyed to each other by attaching a key strip to the metal side form of the first slab to be poured in each pavement.

The concrete slab was laid on a three-inch bituminous treated base. This material consisted of imported borrow mixed with RC-3 at a central mixing plant and was spread with a Lakewood Finisher after the subgrade had been cut with a Lewis Subgrader and compacted.

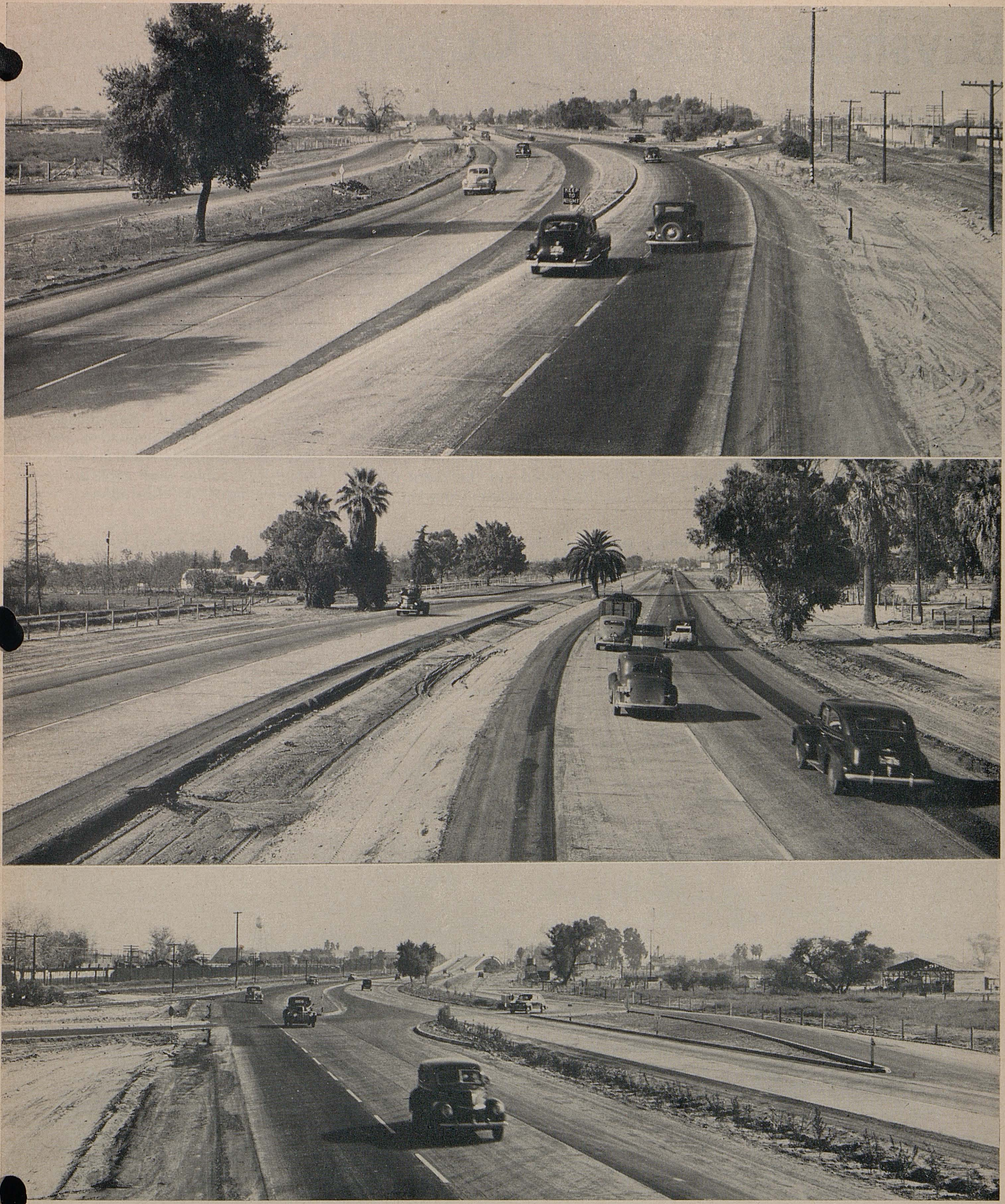
Approximately 2,000 linear feet of concrete-lined irrigation canal were relocated to eliminate the necessity for constructing two long siphons under the freeway.

The project will be completely landscaped in keeping with the semi-arid climate of this region. Rows of oleanders will be planted along each side of the right of way with a third row in the center dividing strip. Cork oak trees will be planted at 100-foot intervals in the outer rows of oleanders. At intersections and in curbed traffic islands, low growing myrtles will be used. The various shrubs and trees have been selected with consideration for their adaptability to the local climate as well as from the standpoint of maintenance and their usefulness as traffic barriers and headlight screens.

The work was contracted by Marshall S. Hanrahan at a bid price of approximately $338,000. S. T. Ball is Project Superintendent for the Contractor, and C. F. Oliphant is Resident Engineer for the State.

CHINA HAS HIGHWAY PROGRAM

Construction of 118,430 miles of new highways is the goal of the Chinese national government's new five-year roadbuilding program. Main roads will be under the control of central government; secondary roads will be administered by the provinces.



Upper—Looking northerly towards Cedar Avenue intersection. Old highway on upper right. Center—Looking north. Palm tree in center at Orange Avenue intersection. Lower—Looking southerly. Channelization at Cedar Avenue intersection. Calwa Overpass in distance

Bayshore Freeway Construction

By W. G. REMINGTON, Associate Highway Engineer

THE Bayshore Freeway is, to many thousands of motorists entering and leaving San Francisco from and to the south, becoming a near reality with the letting of several road and structure contracts for work between San Mateo and South San Francisco.

Particularly noticeable to users of the present overcrowded Bayshore Highway is construction on a contract for 2.2 miles of freeway between Broadway in Burlingame and State Street in San Mateo which was awarded to the Guy F. Atkinson Company at a cost of approximately $630,000. This project utilizes the present traveled way for three lanes of a six-lane freeway with an outer highway and miscellaneous ramps and connections. Additional right of way to accommodate this project provides a minimum width of 153 feet expanding to greater widths as necessary at points of interchange and along tideland areas.

ACCESS RIGHTS ELIMINATED

All access rights from abutting properties have been eliminated from the freeway except at points where interchange structures provide this service.

The present four-lane Bayshore Highway was completed in 1931 and consists of a high standard Portland cement concrete surface 40 feet in width. This route is the main artery serving San Francisco from the south and accommodates a large percentage of the commuter traffic to and from the rapidly expanding residential area in San Mateo and Santa Clara Counties.

Traffic on this route has increased rapidly in the past 15 years until over 25,000 cars per day are now carried over the section included in this project. Hourly peaks of over 3,000 cars have recently been observed. A large percentage of the traffic is composed of heavy trucks and the accident rate on this section of the Bayshore Highway is one of the highest in the State. These conditions dictated that the present highway be reconstructed along full freeway standards with all direct access, left turns and crossing movements completely eliminated.

Looking north on Bayshore project, showing construction of fill for northbound freeway section. Traffic is on present traveled way

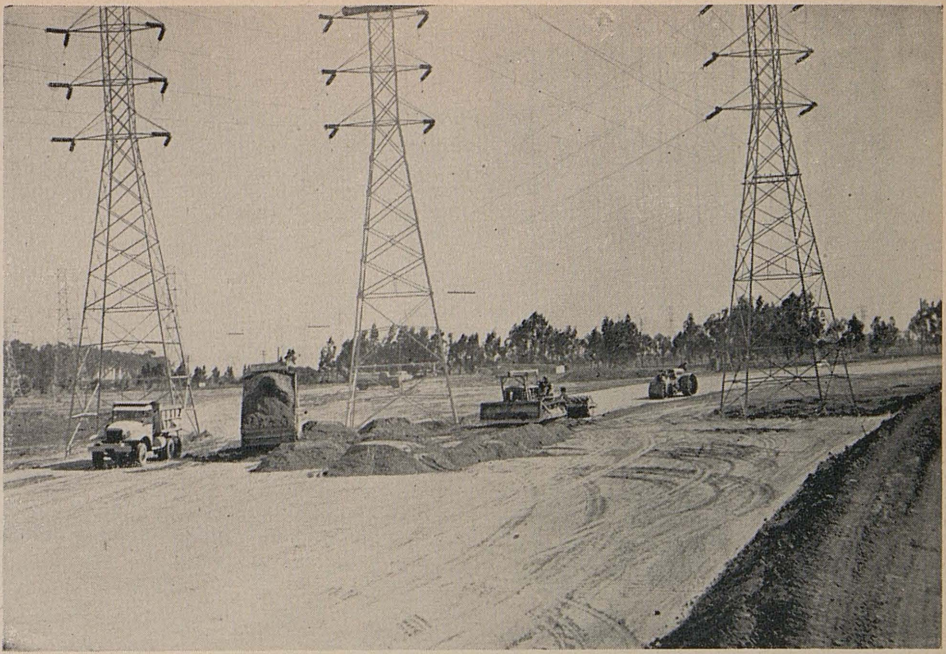
SIX-LANE FREEWAY

Development of the six-lane freeway section is being accomplished, first by utilizing the existing pavement for the southbound traffic. The present 40-foot traveled way will be reduced to 36 feet by placing a "Class C Fine" seal coat on the outer four feet of the existing pavement as well as on four feet of the existing shoulder on that side, thus providing three 12-foot lanes for traveled way and an eight-foot shoulder on the outside. The existing shoulder will be utilized on the inside for a width of eight feet.

Northbound freeway traffic will be routed over a new section being constructed on the east or bay side of the existing pavement. This new section will consist of a Portland cement concrete slab of a uniform eight-inch thickness placed on a half inch sand cushion over four inches of crusher run base. The outside shoulder will consist of two inches of plant mixed surfacing eight feet wide placed over a three-foot crusher run base border of variable depth adjacent to the pavement while the inside shoulder will be two feet wide and placed on crusher run base. Adjacent edges of the northbound and southbound traveled ways are 36 feet apart.

Design of the freeway section provides sufficient width for the construction of two additional lanes within the center division strip and still allows a minimum separation of 12 feet.

An outer highway is being provided on the west side of the freeway to serve the existing highway frontage and the numerous city streets which intersect the present Bayshore Highway. This outer highway will consist of a 23-foot, two-lane traveled way constructed of three inches of asphalt concrete placed on six inches of crusher run base. On the east or freeway side a Portland cement concrete curb and one-foot gutter are being constructed. On the right an eight-foot Portland cement concrete curbed parking strip six inches thick will be placed directly on select imported borrow. Provision for a sidewalk area with a nominal width of 10 feet between the face of the outside curb and the right of way line has been made.



Looking south, showing construction of freeway fill and fill for overhead around existing Pacific Gas and Electric power poles

The parkway between the freeway and outer highway will be a minimum of 11 feet from the edge of the freeway shoulder to the inside curb of the outer highway. A chain link fence along this parkway will provide a physical barrier.

An overhead grade separation at Peninsular Avenue is being constructed simultaneously with the road work under a contract awarded to the Macco Construction Company at a cost of approximately $282,000. T. E. Ferneau is Resident Engineer for the Bridge Department on the structure. Ramps and connection to this structure are being built under the road contract and will be surfaced with three inches of asphalt concrete placed on six inches of crusher run base.

At either end of the project transition sections are planned to taper into the existing roadway. Surfacing for the transition at the south end of the project will be four inches of alphalt concrete placed on eight inches of crusher run base. It is anticipated that this connection will be in service for several years.

The northerly transition will have three inches of plant mixed surfacing on eight inches of crusher run base.

Looking south showing construction of final subgrade

This latter connection will be more temporary and will be removed to connect the freeway with the 5.1 miles of freeway around the San Francisco Airport, now under construction under a contract recently awarded to the Macco Construction Company and Morrison-Knudsen Company, Inc., at a cost of approximately $2,900,000.

240,000 TONS OF MATERIAL

It has been necessary to use imported borrow to construct a majority of the fills and ramp connections due to the small amount of excavation and the lack of any other suitable material within the limits of the job. This item amounting to approximately 240,000 tons is, therefore, one of the major items of the contract.

A small area of marshy ground with a mud depth varying to a maximum of 12 feet was encountered at the beginning of the project under both the freeway and the outer highway and extending from Broadway for a distance of approximately 1,000 feet south. The lower two feet of the fills in this area, the heights of which average about six feet, has been made of imported borrow of a rocky nature that will not break or soften in the presence of water.

A surcharge has been placed on this fill by building it approximately one foot above the final pavement grade. Settlement measuring platforms were constructed in these fills and a record of the settlement has been made both during construction of the fill and after placement of the surcharge was complete. The surcharge will not be removed until settlement has either ceased or is satisfactorily stabilized.

The new freeway section is immediately adjacent and subject to action of the bay for a length of about 1,600 feet. A heavy riprap wall two and one-half feet thick and on a $1\frac{1}{2}$:1 slope is provided on the bay side slope of the fill in this area.

There are no major structures on the project except for the overhead at Peninsular Avenue which was previously mentioned. Drainage is cared for in the main by extending and modifying existing facilities to the requirements of the new freeway. This includes extension of one triple 10′ x 8′ reinforced concrete box culvert, extension of numerous small pipe culverts and the construction of necessary inlets.

The initial stage of landscaping is provided for by scarifying and placing top soil on the center division strip, the parkway between the freeway and outer highway and the easterly slope of the freeway except in area where riprap wall is being placed. Western rye grass will be seeded in these areas.

This project should be completed and opened to public traffic early in the spring of 1947.

W. G. Remington is Resident Engineer in direct charge of the project which is under the general supervision of Jno. H. Skeggs, District Engineer, and R. P. Duffy, District Construction Engineer.

Looking north along riprap wall and adjacent fill

Old "Diggins" Scene of Road Work

(Continued from page 8)

separation structures will be completed early in 1947 and before the completion of the grading and paving contract.

The new road will be an integral portion of U. S. Route 40 and will carry interstate as well as local traffic. The estimated present average daily traffic is 7,000. The section of road now being constructed will replace the existing route of the highway through the streets of Auburn now inadequate to care for the increased traffic on U. S. Route 40 and the augmented local travel.

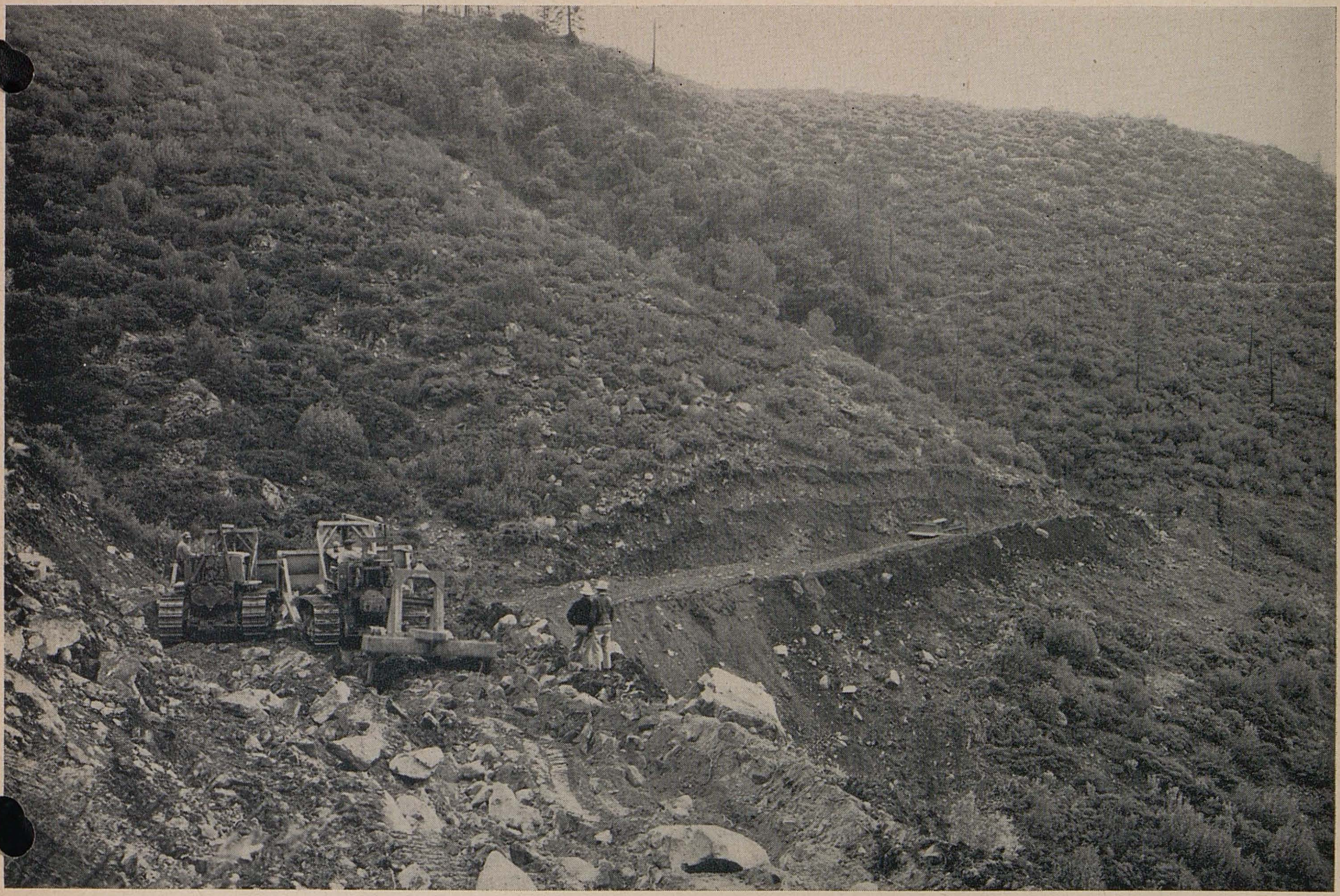
The work through Auburn required the relocation and adjustment of many sanitary sewer and water service lines, and such work is being done under the contract. It was also necessary to place 560 lineal feet of 48-inch reinforced concrete pipe to carry the Boardman Canal, a Pacific Gas and Electric Company facility, under the new roadway.

The major portion of the grading work has been completed. Heavy power scrapers were employed on most of this work, with a two-yard shovel excavating cuts on the easterly end of the project where rock was encountered. A large air compressor is employed in the drilling of the rock formations.

The Portland cement concrete paving will not be placed until next spring. Three inches of the four inches of imported subgrade material placed under the pavement will be bituminous treated. The subgrade material will be obtained from an abandoned railroad fill of disintegrated granite near Newcastle.

The connecting ramps to the separation structures at East, Walsh and Elm Streets will be constructed of crusher run base five inches thick with a wearing surface of three inches of plant-mixed material.

The contract for this work was awarded on June 24, 1946, to Fredrickson and Watson Construction Company. The total amount of the contract is $614,492.50. The same company was also awarded a contract September 16, 1946 in the amount of $194,103.12 for the construction of 1.7 miles of highway between Auburn and the Wise Canal on the Auburn-Grass Valley highway. A channelized connection will be made with the new construction on U. S. Route 40 in Auburn in the vicinity of the East Street separation structure. The Resident Engineer on both contracts is E. L. Miller, and the work is under the supervision of C. H. Whitmore, District Engineer.



Public Roads Administration engineers overcoming obstacles presented by rugged terrain

Mosquito Ridge Road Will Relieve Lumber Shortage

(Continued from page 29)

vert at Volcano Creek which handles waste from hydraulic mining operations and a 500-foot steel deck truss bridge across the North Fork of the Middle Fork of the American River.

Prior to designation of the road as a forest highway, Public Roads Administration was requested to prepare plans and supervise contract construction of the North Fork of the American River Bridge using forest development road funds furnished by the Forest Service. This construction is now under way with delivery of fabricated structural steel expected about mid-1947. Principal feature of interest on the bridge is the planned construction on a 260-foot radius curve. Total cost of the bridge is estimated at $215,000. Fred D. Kyle of Pasadena is the superstructure contractor and John B. Kiely resident engineer for Public Roads Administration.

Forest highway funds have been programmed for grading and surfacing the entire route at an estimated total cost of about $1,500,000.

Contracts for two sections have been awarded and construction is under way. The initial seven-mile section from Forest Hill passes through numerous gold mining claims and old mine workings. Because of the possibility of grading operations uncovering veins or pockets of gold, right-of-way agreements provide in certain cases that construction operations be halted temporarily, if values are exposed, so that owners may remove the ore. The construction contract stipulates accordingly. Total cost of the seven-mile section is estimated at $500,000. W. C. Thompson, Inc., of San Francisco is the contractor and the public roads resident engineer is R. W. Schmidt.

A contract for an additional 4.8 miles from the North Fork Bridge easterly has been awarded recently to Leo G. Lynch of Danville. This portion, which requires construction of a temporary river crossing for access, is characterized by very steep side slopes. Since embankments cannot be constructed generally approximately 239,000 of the 320,000 cubic yards of excavation involved is "waste." Total estimated cost of this section is $400,000. J. E. Wood is resident engineer for Public Roads.

While the road is being developed primarily to make available additional commercial timber, it also will provide access to hunting, fishing, and other recreational areas in the High Sierra region west of Lake Tahoe, which in the past have been served only by a narrow, steep and dangerous road from Soda Springs on U. S. 40, and will aid in forest fire control and in general administration of the National Forest.

Johnson finishing machine at work on newly laid Portland cement concrete

STOCKTON-LODI FREEWAY WELL UNDER WAY

(Continued from page 7)

tiates the basis of heavy design for these two new pavement lanes.

In brief, the design calls for the removal of roadway excavation to a point two and one-half feet below the top of pavement grade, and 90 percent compaction of the excavated portions and the original ground for a minimum depth of six inches additional. Upon this compacted ground there is placed 18 inches of compacted imported subbase material, a four-inch thickness of cement treated base, and an eight-inch uniform thickness of five-sack Portland cement concrete pavement without expansion joints. The outside traffic lane is 11 feet in width and the passing lane 12 feet in width tied together with tie bolts to prevent spreading of the slabs. The shoulders are eight feet in width on the outside, consisting of three feet of untreated rock border six inches in thickness with an armor coat adjacent to the pavement edge, and a penetration oil treatment for the remaining width. The shoulder on the inside is five feet in width with a two foot width rock border of six inch thickness finished in a manner similar to the outside shoulder.

BRIDGE CONSTRUCTION

There are three bridge structures on this project 27 feet in width between curbs with a four-foot width sidewalk located on the outside. A bridge at Mosher Slough 82 feet in length has no skew, whereas a bridge 91 feet in length at Bear Creek and another 60 feet in length at Live Oak Slough are each constructed with a 45-degree angle skew. These bridges are tied directly to the existing bridge structures on the present pavement so as to provide a continuous channel under the divided highway. The present project includes the construction of a four-foot sidewalk on the outside of the existing structures also so as to provide a walk on each side of the freeway.

This project is located on almost straight alignment throughout. The former right of way was 100 feet in width with the existing two lanes located in the center of this right of way. The acquisition of rights of way therefore involved obtaining access rights on both sides, and the taking of a 60 foot strip on the easterly side, throughout, in order to provide a 36 foot width of center division strip between ultimate inside pavement edges and a symmetrical geometrical design. This involved acquisition for a total of 158 right of way cases, 155 of which were acquired through negotiation, and three of which were settled in court. Seventy of these cases involved the moving and relocation of improvements. On 48 of these the improvements were moved and rehabilitated by the owners under their individual right

Showing position of new lane in relation to the existing lane. Material between steel headers is cement treated base with curing seal applied

of way contracts with the State. These improvements consisted of eight residences, three service stations, one commercial garage, three stores, one cafe, and numerous smaller buildings such as private garages, storage sheds, auto cabins, miscellaneous fences, irrigation facilities, etc.

Twenty-two properties were involved wherein the State was responsible for the moving and relocation of improvements. This involved 18 residences, three service stations, one commercial garage, one store, one cafe, and some 17 other miscellaneous buildings. Five contracts were awarded for this work upon a competitive bid basis, three going to Fred Kaus of Stockton, one to Louis Biasotti & Son of Stockton and one to J. E. Fitzsimmons of Lodi. Most excellent cooperation by the property owners, the moving contractors and the general contractor on the highway project assisted greatly in getting this important project under way.

The main contract involves some 44,000 cubic yards of roadway excavation, — 200,000 square yards of ground compaction,—111,000 cubic yards of imported borrow and 124,000 cubic yards of imported subgrade material. It calls for 100,000 square yards of cement treated base which requires some 3,300 barrels of Portland cement. The pavement involves 24,000 cubic yards of concrete, and there are approximately 2,000 cubic yards of concrete and 270,000 pounds of reinforced steel in the structures cited above. The general contractor on this project is Fredrickson and Watson Construction Company of Oakland whose contract work with the State is estimated to total $830,000.

The five building removal contracts approximate $100,000 and the building removal work by owners was about $82,000 included in a total estimated right of way cost of $361,000. Although final costs will not be exactly known until this contract is completed it is estimated that the right of way, construction and construction engineering involved for this 8.2 mile section will approximate $1,275,000. The present project under present progress should be completed in the spring of 1947. A. M. Lund is Resident Engineer.

Stockton, which is located in the heart of the San Joaquin Valley, one of the most fertile in the world, has been designated as one of the metropolitan areas of the State. Nearby Lodi is the home of the Tokay grape and is located in one of the most intensive grape and wine producing sections of the world. This highway, although not full freeway design, traversing a rich agricultural area and considered as a rural section, is indicative of the cost of providing limited access freeways.

This project will connect directly to another postwar project extending southerly through the Stockton metropolitan area on a revised location which contemplates many full freeway characteristics. Rights of way have been acquired upon this other project and the start of its construction is contemplated for the year 1947. Upon completion of these two projects some of the most troublesome traffic problems of U. S. 99 and U. S. 50 in the Stockton metropolitan area will be solved.

Highway Bids and Contract Awards for October and November, 1946

October, 1946

CONTRA COSTA COUNTY—Between Fourth St. and First St. in Rodeo, about 0.3 mile, to be widened and paved with asphalt concrete on crusher run base. District IV, Route 14, Section B. J. R. Armstrong, El Cerrito, $17,156. Contract awarded to Lee J. Emmel, San Pablo, $17,150.

FRESNO COUNTY—Between one-quarter mile south of Fowler and Calwa overpass, about 6.5 miles, to be graded and paved with plant-mixed surfacing on cement treated base. District VI, Route 4, Section A, Fow.,B. Basich Bros. Construction Co. & Basich Bros., Alhambra, $836,755; Peter Kiewit Sons' Co., Arcadia, $896,229. Contract awarded to Gunner Corp. & J. E. Haddock, Ltd., Pasadena, $778,949.

HUMBOLDT COUNTY—Between Arcata and Ryans Slough Bridge, about 8 miles, a graded roadbed to be constructed, and plant-mixed surfacing to be placed on imported base material and on existing surfacing. District I, Route 501. W. C. Railing, Redwood City, $215,592. Contract awarded to Mercer-Fraser Co., Eureka, $185,557.

HUMBOLDT COUNTY—At Dyerville, pile and heavy stone riprap bank protection to be constructed. District I, Route 1, Section D. Evans Construction Co. and Barton & Anderson, Berkeley, $48,660. Contract awarded to Mercer-Fraser Co., Eureka, $39,392.

HUMBOLDT COUNTY—Between Redwood Summit and one mile east of Redwood Creek, portions, a net distance of about 4.7 miles, imported base material to be furnished and placed. District I, Route 20, Sections B,C. Mercer-Fraser Co., Eureka, $71,052; Johnson, Drake & Piper, Inc., Oakland, $90,450. Contract awarded to W. C. Railing, Redwood City, $59,744.

IMPERIAL COUNTY—About 9 miles and 15.5 miles northwest of Westmorland, at Lone Tree Wash and San Felipe Creek, two bridges and approaches thereto to be constructed. District XI, Route 26, Sections B,C. United Concrete Pipe Corp. & Ralph A. Bell, Baldwin Park, $284,066. Contract awarded to Bent Construction Co., Los Angeles, $245,709.

KERN COUNTY—At Bakersfield between Brundage Lane and 21st Street, traffic signals and illuminating devices to be furnished and installed. District VI, Route 4, Section C, Bkd. Econolite Corp., Los Angeles, $39,400. Contract awarded to Oilfield Electric Co., Ventura, $37,562.

KERN COUNTY—Between Cawelo and Famoso Underpass, about 6.7 miles to be graded and paved with Portland cement concrete, plant-mixed surfacing to be placed on the shoulders and a reinforced concrete bridge to be constructed across Poso Creek Overflow. District VI, Route 4, Section E. N. M. Ball Sons, Los Angeles, $527,012; J. E. Haddock, Ltd., Pasadena, $595,860; Bowen & McLaughlin & L. G. Lynch, Danville, $627,068; M. J. B. Construction Co., Stockton, $636,634. Contract awarded to Griffith Co., Los Angeles, $515,503.

KERN COUNTY—Between Route 4 and five miles north, about 5.1 miles to be graded and surfaced with road-mixed surfacing on imported borrow and on crusher run base. District VI, Route 129, Section A. Rand Construction Co., Bakersfield, $188,898; M. J. Ruddy & Son, Modesto, $196,486; Griffith Co., Los Angeles, $198,345; Rexroth & Rexroth, Bakersfield, $206,684; Vinnel Co., Alhambra, $212,038; George von KleinSmid, Bakersfield, $214,913; W. C. Railing, Redwood City, $218,504; Brown-Doko, Pismo Beach, $252,619. Contract awarded to George E. France, Visalia, $166,504.

LOS ANGELES COUNTY—In the City of Los Angeles, adjacent to Hollywood Parkway, between Diamond Street and Sunset Boulevard, storm drains and sanitary sewer construction appurtenant to four level grade separation structure to be constructed. District VII, Route 2, Section L.A. Mike Radich & Co., Burbank, $228,102; Artukovich Bros., Hynes, $324,089; J. E. Haddock Ltd., Pasadena, $389,307. Contract awarded to Chas. T. Brown Co., San Fernando, $182,543.

LOS ANGELES COUNTY—Between Route 77 and Pomona, about 0.7 mile to be graded and widened with Portland cement concrete, and existing pavement to be surfaced with plant-mixed surfacing on a portion. District VII, Route 19, Section B,Pom. Cox Bros. Construction Co., Stanton, $71,169; United Concrete Pipe Corp., Baldwin Park, $88,237. Contract awarded to Matich Bros., Colton, $70,325.

LOS ANGELES COUNTY—Between Latigo Canyon and Malibu Creek, about 4.5 miles to be graded and paved with Portland cement concrete. District VII, Route 60, Section A. H. Earl Parker & N. M. Ball Sons, Los Angeles, $1,561,101; Guy F. Atkinson Co., Long Beach, $1,591,308; Bressi & Bevanda Constructors, Los Angeles, $1,627,667; Bowen & McLaughlin & L. G. Lynch, Danville, $1,808,201; United Concrete Pipe Corp., Ralph A. Bell, Vinnell Co., Baldwin Park, $1,859,533; Matich Bros. & L. A. & R. S. Crow, Colton, $1,893,329. Contract awarded to Peter Kiewit Sons Co., Arcadia, $1,543,233.

LOS ANGELES COUNTY—Between Sproul Street and Anaheim-Telegraph Road, about 1.5 miles, to be resurfaced with plant-mixed surfacing and bituminous surface treatment to be applied to shoulders. District VII, Route 170, Section A. Cox Bros. Construction Co., Stanton, $23,205. Contract awarded to Griffith Co., Los Angeles, $22,372.

MENDOCINO COUNTY—Between Northwestern Pacific R.R. grade crossing and Northwestern Pacific R.R. underpass, about 0.8 mile, to be graded and surfaced with cement treated base and plant-mixed surfacing. District I, Route 1, Section E. Louis Biasotti & Son, Stockton, $170,027; N. M. Ball Sons, Berkeley, $171,376; Guy F. Atkinson Co., South San Francisco, $189,441. Contract awarded to A. R. McEwen & C. M. Syar, Willits, $136,870.

MENDOCINO COUNTY—Between Red Mountain Creek and Piercy, about 4.6 miles, to be graded and paved with plant-mixed surfacing on cement treated base. District I, Route 1, Section K. Parish Bros., Benicia, $748,549; A. Teichert & Son, Inc., Sacramento, $796,040; H. Earl Parker & Clements & Co., Marysville, $824,581; N. M. Ball Sons, Berkeley, $841,107; Guy F. Atkinson Co., South San Francisco, $932,660; Piombo Construction Co., San Francisco, $981,915; Chas. L. Harney, San Francisco, $1,159,583. Contract awarded to Oilfields Trucking Co. & Phoenix Construction Co., Bakersfield, $718,234.

MENDOCINO COUNTY—Between Bromley Creek and Fort Bragg, about 3.8 miles to be graded, surfaced with plant-mixed surfacing on imported base material; and structures to be constructed at Mitchell Creek and Hare Creek and foundations at Noyo River. District I, Route 56, Section E. United Concrete Pipe Corp. & Ralph A. Bell, Baldwin Park, $1,568,257; Stolte Inc. & E. B. Bishop, Oakland, $1,673,445; J. H. Pomeroy & Co. Inc., San Francisco, $1,769,698; Haddock Engineers, Ltd., Oceanside, $1,909,521. Amended contract awarded to Guy F. Atkinson Co., South San Francisco, $874,215.

MONTEREY AND SAN BENITO COUNTIES—Between 0.8 mile north of Crazy Horse Summit and Chittenden Road, about 6.7 miles to be graded, crusher run base and plant-mixed surfacing to be placed and seal coat to be applied. District V, Route 2, Sections J,B. H. Earl Parker & N. M. Ball Sons, Berkeley, $877,428; E. W. Elliott Construction Co., San Francisco, $880,971; Fredrickson & Watson Construction Co., Oakland, $941,899; Parish Bros., Benicia, $983,830. Contract awarded to A. Teichert & Son, Inc., Sacramento, $723,658.

SACRAMENTO COUNTY—Across Bear Slough, 4.5 miles west of Galt, a reinforced concrete slab bridge to be constructed. District III, Route 900. Republic Construction Co., Lodi, $82,347; Dan Caputo, San Jose, $85,660; Bent Construction Co., Los Angeles, $100,291; Johnson Western Co., Alameda, $117,515. Contract awarded to M. A. Jenkins, Sacramento, $74,295.

SACRAMENTO COUNTY—Across Laguna Creek, about 0.8 mile north of Elk Grove, a reinforced concrete slab bridge to be constructed. District III, Route 933. Lew Jones Construction Co., San Jose, $36,394; Wm. E. Thomas, Sacramento, $37,714; A. Teichert & Son, Inc., Sacramento, $43,442; A. L. Miller, Sacramento, $46,331; S. C. Giles and Co., Stockton, $46,704; Republic Construction Co., Lodi, $48,537; Dan Caputo & Ed Keeble, San Jose, $50,991; Wheeler Construction Co., Oakland, $53,085. Contract awarded to Bati Rocca, Stockton, $34,074.

SAN BERNARDINO COUNTY — Between 8.6 miles and 11.7 miles north of San Bernardino, about 0.4 mile, to be widened and surfaced with plant-mixed surfacing. District VIII, Route 43, Section A. Cox Bros. Construction Co., Stanton, $63,384. Contract awarded to Geo. Herz & Co., San Bernardino, $39,323.

SAN FRANCISCO COUNTY—In the City of San Francisco, the existing steel bridge over Presidio of San Francisco to be cleaned and painted. District IV, Route 2. D. E. Burgess Co., San Francisco, $36,600; Pacific Bridge Painting Co., San Francisco, $51,278. Contract awarded to R. W. Reade & Co., Berkeley, $33,174.

SAN JOAQUIN COUNTY—Painting portion of steel bridge over Mokelumne River about one mile north of Clements. District X, Route 97, Section B. D. E. Burgess Co., San Francisco, $1,175; F. Kaus, Stockton, $1,975; R. W. Reade & Co., Berkeley, $868; James B. Haynie, Stockton, $1,185. Contract awarded to Fred T. Judd Co., Berkeley, $692.

SAN MATEO COUNTY—Bay Shore Freeway from Colma Creek in South San Francisco to Broadway Ave. in Burlingame, about 5.1 miles to be graded and paved with asphalt concrete on crusher run base. District IV, Route 68, Sections S.Sf.,F, Burl. Guy F. Atkinson Co., South San Francisco, $3,365,440; Chas. L. Harney, San Francisco, $4,128,363; Eaton & Smith, San Francisco, $4,656,694. Contract awarded to Macco Corp. & Morrison-Knudsen Co. Inc., San Bruno, $2,993,138.

SANTA BARBARA COUNTY—Between ¼ mile east of Las Varas Creek and ¼ mile east of El Capitan Creek, about 2.9 miles to be graded and surfaced with plant-mixed surfacing on imported borrow. District V, Route 2, Section G. Winston Bros. Company, Los Angeles, $486,189; J. E. Haddock, Ltd., Pasadena, $493,931; Basich Brothers Construction Co. & Basich Bros., Alhambra, $502,544; Dimmitt & Taylor, Los Angeles, $547,720; Ralph A. Bell & A. F. Heinze, Monrovia, $555,764; E. W. Elliott Construction Co., San Francisco, $599,835. Contract awarded to N. M. Ball Sons, Los Angeles, $418,948.

SANTA BARBARA COUNTY—At Santa Barbara between Ashley Street and De La Vina Street, buildings to be demolished. District V, Route 2. Joseph D. Ballinger & Co., Oakland, $4,175; Santa Barbara Crane Service, Santa Barbara, $4,512; Emsco Concrete Cutting Co., Los Angeles, $6,284; Brown & Doko, Pismo Beach, $8,550; Cleveland Wrecking Co. of Cincinnati, Los Angeles, $7,900. Contract awarded to Mead House Wrecking Co., Pasadena, $3,385.

November, 1946

FRESNO COUNTY — Between Shields Avenue and Herndon Avenue, about four miles to be graded and paved with asphalt concrete on crusher run base. District VI, Route 125, Section C. J. E. Haddock, Ltd., Pasadena, $323,923; Granite Construction Co., Watsonville, $336,999; Frederickson & Watson Construction Co., Oakland, $343,455; N. M. Ball Sons, Berkeley, $344,406; Griffith Company, Los Angeles, $345,380; Piazza & Huntley, San Jose, $359,928; M. J. B. Construction Co., Stockton, $359,113. Contract awarded to Basich Brothers Construction Co. & Basich Bros., Alhambra, $316,444.

FRESNO COUNTY—On Fresno-Coalinga Road, between Mt. Whitney Avenue and State Highway Route 10, about 8.6 miles to be graded, surfaced, with imported surfacing material and bituminous surface treatment applied. District VI, Route 809. John M. Ferry, Glendale, $164,404; Ted F. Baun, Fresno, $165,730; S. Edmondson & Sons, Los Angeles, $188,420; Oilfields Trucking Co. & Phoenix Construction Co., Bakersfield, $196,472; Volpa Brothers, Fresno, $203,707; Griffith Company, Los Angeles, $212,400; J. E. Haddock, Ltd., Pasadena, $213,033; W. C. Railing, Redwood City, $214,813; N. M. Ball Sons, Berkeley, $217,500; Clyde W. Wood, Inc., North Hollywood, $218,835; Brown-Doko, Pismo Beach, $248,420; Owl Trucking & Construction Co., Compton, $245,634. Contract awarded to Louis Biasotti & Son, Stockton, $156,420.

LOS ANGELES COUNTY — Hollywood Parkway, at Silver Lake Boulevard in the city of Los Angeles, a reinforced concrete undercrossing to be constructed. District VII, Route 2. E. B. Bishop, Orland, $492,319; J. E. Haddock Co., Pasadena, $523,104; Oberg Bros., Inglewood, $523,898; E. W. Elliott Construction Co., San Francisco, $529,738; Winston Bros. Co., Los Angeles, $547,394; United Concrete Pipe Corp., Baldwin Park, $547,942; Johnson Western Co., San Pedro, $561,586; Contracting Engineers Co., Los Angeles, $571,776. Contract awarded to Guy F. Atkinson Co., Long Beach, $441,766.

LOS ANGELES COUNTY—At 16 intersections on Valley Boulevard between Westminster Avenue and Del Mar Avenue in the cities of Alhambra and San Gabriel, traffic signal systems to be furnished and installed. District VII, Route 77. Econolite Corp., Los Angeles, $56,840. Contract awarded to C. D. Draucker Co., Los Angeles, $55,504.

RIVERSIDE COUNTY—Across Coachella Canal, 5 miles east of Indio, a reinforced concrete slab bridge to be constructed. District XI, Route 64, Section H. E. H. Thomas Co., Los Angeles, $38,334; O'Brien & Bell Construction Co., Santa Ana, $39,868; Bent Construction Co., Los Angeles, $46,432; Cox Bros. Construction Co., Stanton, $59,839. Contract awarded to F. Fredenburg, Temple City, $35,544.

SAN DIEGO COUNTY — Across Santa Ysabel Creek, about 8.7 miles east of Escondido, a bridge to be constructed, a cattle pass to be extended, and about 0.3 mile of approaches to be graded and bituminous surface treatment applied. District XI, Route 197, Sections A, B. United Concrete Pipe Corp., Baldwin Park, $219,282; N. M. Ball [illegible], Los Angeles, $220,953; Carroll & Foster, San Diego, $234,411; Walter H. Barber, La Mesa, $238,974; Johnson Western Co., San Pedro, $248,899. Contract awarded to Spencer Webb, Inglewood, $218,957.

Federal Secondary Roads

By H. B. La FORGE, Engineer, Federal Secondary Roads

IN THE July-August, 1945, issue of this publication there appeared an article outlining the Federal-aid Secondary Program as it applied to California. This article is intended to summarize its status for those interested in the development of the program.

The "Federal-aid Highway Act of 1944" required the State in cooperation with the counties and the Public Roads Administration to select an initial system of principal roads which were not on the Federal-aid System but which were intergrated with that system. All details in connection with that selection were completed in February, 1946. As of November 1, 1946, Commissioner of Public Roads has approved an initial Federal-aid Secondary System consisting of 8,882 miles of which 5,184 miles are county roads and 3,698 miles are state highways.

The "County Highway Aid Act of 1945" stipulated that 87½ percent of the federal-aid secondary funds apportioned to the State should be expended on the county road portion of the Federal-aid Secondary System. In August of 1945 the counties were requested to select construction programs.

San Francisco City and County has no FAS routes. All other counties have submitted construction programs having a total estimated cost of $20,537,000. The proposed projects are distributed in the three following categories:

1. **Ninety-one road projects, length 620 miles, cost $11,650,000.**
2. **Sixty-four bridge projects, cost $6,002,000.**
3. **Twenty-four road and bridge projects, length 76 miles, cost $2,885,000.**

At this time 13 contracts have been awarded having a total estimated cost of $2,989,000. The work under way includes nine road and four bridge contracts. The following contracts are under way:

Alameda, FAS route 1030, San Lorenzo Creek to Proctor Road, length 2.7 miles, cost $170,000.

Fresno County, FAS Route 809, about five miles Northeast of Oil King School on Fresno-Coalinga Road, length 8.6 miles, cost $171,000.

Humboldt, FAS Route 505, Ryan's Slough to Arcata, length 8.0 miles, cost $215,000.

Modoc, FAS Route 513, Eagleville to four miles north of Lake City, length 29.5 miles, cost $452,000.

Plumas, FAS Route 523, Big Meadows Dam to Lassen County line, length 9.9 miles, cost $405,000; bridge across Hamilton Branch of Feather River, cost $79,000.

Sacramento, FAS Route 900, bridge across Bear Slough four miles west of Galt, cost $82,000.

Sacramento, FAS Route 933, bridge across Laguna Creek about 0.8 miles north of Elk Grove, cost $34,000.

San Mateo, FAS Route 1052, Redwood City to Canada Road, length 2.9 miles, cost $220,000.

Santa Clara, FAS Route 992, Gilroy to State highway 32, length 4.5 miles, cost $187,000.

Siskiyou, FAS Route 753, Cal-Ore to four miles west of Hatfield, length 15.6 miles, cost $577,000.

Shasta, FAS Route 1072, Anderson to Cottonwood, length 10.8 miles, cost $257,000.

Sonoma, FAS Route 786, bridge across Russian River at Hacinda, cost $140,000.

Alameda, San Mateo, Humboldt, Sonoma and Fresno Counties are supplying their own resident engineers. State resident engineers are assigned to the above contracts in the other counties. It is the policy of the Division of Highways to encourage the counties to provide construction engineering personnel.

In addition to the above 13 contracts bids are being invited for three projects at an estimated cost of $500,000.

It is anticipated that about 19 contracts totaling $4,000,000 will be awarded this calendar year.

In addition to contracts under way or advertised, the counties have submitted plans, specifications and estimates for projects having a total estimated cost of approximately $3,000,000. It is expected that contracts for most of these projects will be awarded during 1947.

(Continued on page 44)

State Route 77 Is Being Modernized Between San Diego and Riverside

(Continued from page 18)

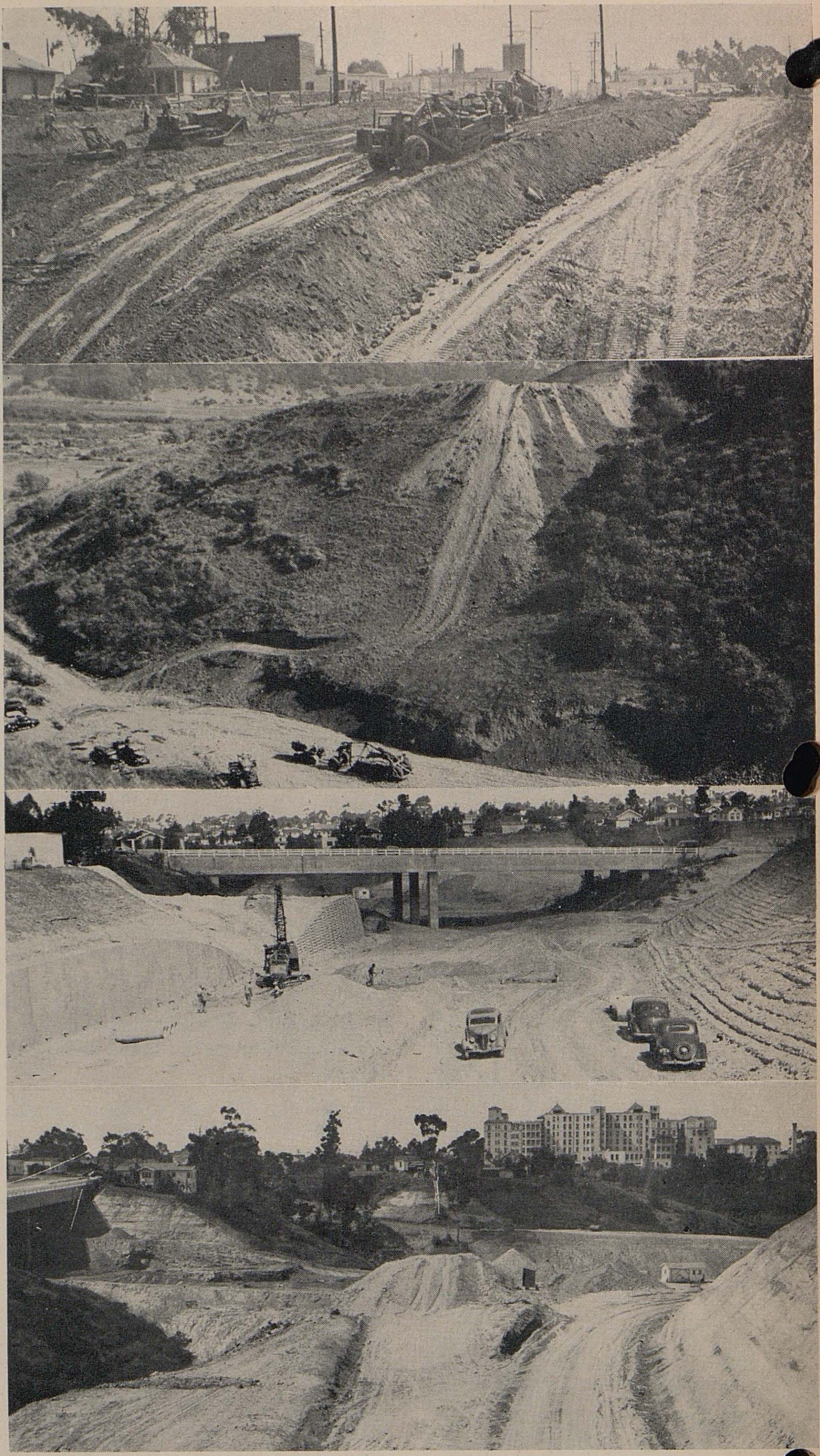
at a cost of about $4,000,000 on freeway standards. The portion within beautiful Balboa Park is being planted and improved as a parkway.

As long ago as March, 1941, the people of San Diego voted eight to one to set aside a 200-foot width of right of way through Balboa Park for highway purposes. With this fine start, plans were rapidly taking shape when the beginning of the war put a temporary stop to this work. From 1942 to 1944 the project was at various times considered as a possible access road, connecting military establishments in the vicinity of San Diego, but was finally set aside for other access roads which were considered more urgent. In 1944 the freeway was included as Postwar Project No. 116 in the State's postwar program of construction. Plans were completed in 1945 and at the close of the war preparations were made for advertising various units of this freeway at an early date. All units of the freeway except the landscaping are now being built under ten separate contracts through the cooperation of five different contractors.

TWO ROADWORK CONTRACTS

The roadwork, costing about $2,700,000 is divided into two contracts which include all grading, paving and drainage structures. The southerly three miles which follows the Eleventh Avenue Canyon through Balboa Park for almost two miles, will be extensively planted to provide a suitable blending with Balboa Park.

The northerly four miles of the freeway includes the grading and paving of approach ramps for a traffic interchange at Mission Valley Road, and is based on the latest modern design in grade separation structures. By means of two bridges carrying Mission Valley Road over the freeway, and direct on and off turning ramps, traffic can proceed with a minimum of delay and interference. This type of separation structure greatly reduces the distance traveled by left turn traffic as compared to the standard cloverleaf design.



Grading operations on Mitty Bros. Freeway contract just north of University Avenue—Grading operations on Basich Bros. contract, first big cut north of San Diego River—Looking north toward Washington Street Bridge—Looking west from Pascoe Street ramp toward Freeway.

SEPARATION STRUCTURES

Grade separation structures and bridges are provided at 11 locations, in addition to two bridges previously constructed by the State for the City of San Diego on Streets of Major Importance. The following streets and roads are to be taken under or over the freeway: Date Street, Quince Street, Upas Street, Richmond Street, University Avenue, Pascoe Street, Sixth Street Extension, Mission Valley Road (two structures), San Diego River and Friar's Road.

The typical section on the freeway consists of two 24-foot x 8-inch Portland cement concrete pavements laid on 12 inches of selected material or imported borrow, of which the top four-inch or six-inch layer has been cement treated. The concrete pavements are separated by an island, varying in width from six feet to fifty-four feet. Bituminous surface treated shoulders eight feet wide are provided throughout.

BALBOA PARK PROJECT

Through Balboa Park, a complete sprinkler system using more than 24,000 feet of pipe was provided to aid in the landscaping and roadside treatment which was designed to help blend the roadway with the natural park surroundings.

As most of the freeway follows natural drainage courses, a storm drain system with pipes ranging in size from 24 inches to 60 inches in diameter was provided throughout portions of the project.

Over 1,650,000 cubic yards of dirt with cuts as deep as 150 feet and fills as high as 60 feet, and more than 30,000,000 station yards of overhaul are involved in this seven miles of roadway. One cut contains approximately 300,000 cubic yards in less than one-fourth mile of length. Heavy road-building equipment up to thirty cubic yard capacity is being utilized to move this tremendous yardage.

NORTH-SOUTH ARTERY

The completed freeway will provide San Diego with an adequate north-south artery connecting the business district with the residential sections in the north and east parts of the city and Linda Vista Housing Project. Connecting ramps are provided at the more important separation structures. A braided intersection is developed at Washington Street, which connects with an extension of Washington Street to U.S. 80 (El Cajon Blvd.) to the east. A project for improvement of this portion of Washington Street is scheduled for construction in 1947 from funds for city streets of major importance.

The traffic interchange at Mission Valley Road provides a connection to one of San Diego's most important east-west by-passes. The section of Mission Valley Road west of the freeway connecting to U.S. 101 (Pacific Highway) and the beaches was recently built to high standards as a military access road. The section of Mission Valley Road to the east connects by way of Fairmount Avenue or Alvarado Canyon to U.S. 80 and the communities of La Mesa and El Cajon. This section is badly in need of improvement and is planned for reconstruction by the City and County authorities at an early date.

FUTURE CONSTRUCTION

Extension of the relocation northerly from the freeway to connect with the prison labor work from Escondido to the Riverside County line is planned as future construction. The 12 miles between Miramar and Lake Hodges is planned as Postwar Project No. 117, but is being delayed pending decisions as to the disposition of the Navy's Camp Miramar, and the proposed raising of Lake Hodges.

When all this construction is completed, the modernized Route 77 will be about 17 miles shorter than the old road. Literally hundreds of sharp curves will have been eliminated and a wider roadbed with greater safety and less delay to traffic will be the result.

Work is under the general direction of E. E. Wallace, District Engineer, District XI; Ed Rawson is Superintendent of the prison labor work; J. Frank Jorgensen and Howard F. Caton are Resident Engineers on the Freeway roadwork; H. R. Hineman and H. R. Lendecke are representing the Bridge Department as Resident Engineers on the freeway structures.

All Maintenance Men Are Very Much Alike

DISTRICT COURT OF APPEAL
Third District
Sacramento, California

Paul Peek
Associate Justice

Charles H. Purcell,
Director of Public Works,
Public Works Building,
Sacramento, California.

Dear Charlie: This is in the nature of a fan letter relative to an employee of your department, Mr. Lee Harvey, who works out of the Sonora Junction Maintenance Station.

Approximately a month ago, while Mrs. Peek's mother and a guest were on their way home to Pasadena after vacationing at Lake Tahoe, her automobile stalled due to serious mechanical trouble near where Mr. Harvey lives at the maintenance station. He very graciously helped them by placing flares about their car, saw to the arrangements for having it towed to a garage in Bridgeport, and then took them to his home where his wife prepared a wonderful trout dinner which they are still talking about.

Of course I do not advocate that every person stalled on the highway should be succored by a member of your department and treated in a comparable fashion, but certainly such thoughtfulness on the part of state employees goes a long way in establishing the good will of the people toward their public servants.

With kindest regards,
Sincerely,
(Signed) Paul Peek

California's Highway Builders

(Continued from page 2)

developing law relating to the acquisition of access rights will be fully discussed at the Los Angeles meeting.

By T. H. DENNIS
Maintenance Engineer

MAINTENANCE engineers, during the past several years, have been conducting intensive studies on methods to be employed in prolonging the service life and efficiency of various highway facilities. Hand in hand with these investigations are those involving the efficient use of men and equipment. It is expected that the results of these studies will be elaborated upon in the committee meetings which are to be held during the convention.

The exchange of ideas and personal experiences at these meetings goes far beyond the information which could be presented in a general report on these subjects. In these days of rising costs and heavy traffic, it is felt that we in California will be particularly benefited in this personal contact with the acknowledged experts who will be present at this meeting.

By A. M. NASH
Surveys and Plans

THE REAL purpose and justification for such conventions is of special significance to the particular Department of the California Division of Highways over which I preside.

We are charged with the review and approval of all designs and I believe I am safe in saying that no aspect of highway engineering has seen such great changes take place in methods of procedure or in basic concepts of approach as this phase of our profession during the last few years as we embark upon a great program of expressway design. Many of these changes are still in a state of flux as we strive to analyze and isolate the laws of traffic behavior and translate this knowledge into rules of design to the end that better and safer highways will be the result of our efforts.

Because of this fact, it is particularly important that all of the individuals who are striving toward this goal meet together as often as possible to mutually consult and evaluate their experiences and ideas as they strive to separate the true from the false.

In the open committee forums of the convention, free and honest debate and deliberation have always acted to stimulate the thinking of all the participants and have served the cause of scientific knowledge well.

There is every reason to hope that our Los Angeles meeting will be particularly fruitful in this regard, and it is with keen anticipation that I look forward to meeting with my colleagues so that I may learn both from their successes as well as their failures and thus improve my knowledge and understanding to the important end that better designed highways will result here in California.

By F. W. PANHORST
Bridge Engineer

THE Los Angeles Convention will have two full-day meetings packed with important subjects and projects. On Monday, December 16th, there will be an all day preconvention meeting to discuss proposed changes in the Specifications for Highway Bridges, which meeting is open to members and associates only. On Wednesday, December 18th, the regular group meeting, open to all, will be held at 9.30 a.m., at which time Prof. J. S. Worley, of the University of Michigan, will speak about "Design Loads for the Interstate Highway System." At this time there also will be a discussion of clearance required for navigation at bridges over navigable streams.

In the afternoon, R. Robinson Rowe, of the California Bridge Department, will speak on "Culvert Design." There also will be a discussion of requirements for protection of highway traffic on bridges with movable spans. Our bridge specifications are used by all of the states and many foreign countries. They are not perfect and much is yet to be done. With the large amount of bridge work ahead of us, it is important that necessary changes be made in the specifications.

This meeting of A. A. S. H. O. is called a convention and there will be many interesting trips and breathtaking entertainment features, but of much more significance is the fact that there is important business to be transacted.

Federal Secondary Roads

(Continued from page 41)

All of the projects under contract or for which plans have been received represent forthcoming improvements vital to the economic needs of the respective counties. When completed traffic upon these roads will be relatively high both as to volume and weight and the standards of construction have been selected accordingly. Because of their nature and location the projects will benefit very large county areas and will prove prideful improvements to the county road system.

Increasing progress in plan preparation is reported by county engineers and it is hoped that during 1947 the program will be in full swing with about $10,000,000 of additional projects placed under construction.

Burnt Ranch, Calif.
November 5, 1946

Mr. G. F. Hellesoe, Acting District Manager
Division of Highways
546 W. Wabash Avenue
Eureka, California

Dear Mr. Hellesoe: On September 2d, I wrote the State Highway Commission at Sacramento in re the dangerous condition of the point on U. S. Highway 299 where our county road intersects said highway. I wrote this letter as unofficial spokesman for our various neighbors here who were affected by this dangerous intersection.

Now, on behalf of myself and my neighbors I wish to thank you for the promptness and efficiency with which you handled our plea for a correction of the condition complained of.

Your workmen have placed our road in such condition that there would be no possible excuse for an accident at that particular point now. We feel that the hazard has been entirely removed and everyone seems well pleased with the result of your efforts in our behalf.

Respectfully,
(Mrs.) Ellarena M. Stetter

State of California

EARL WARREN, Governor

Department of Public Works

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

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