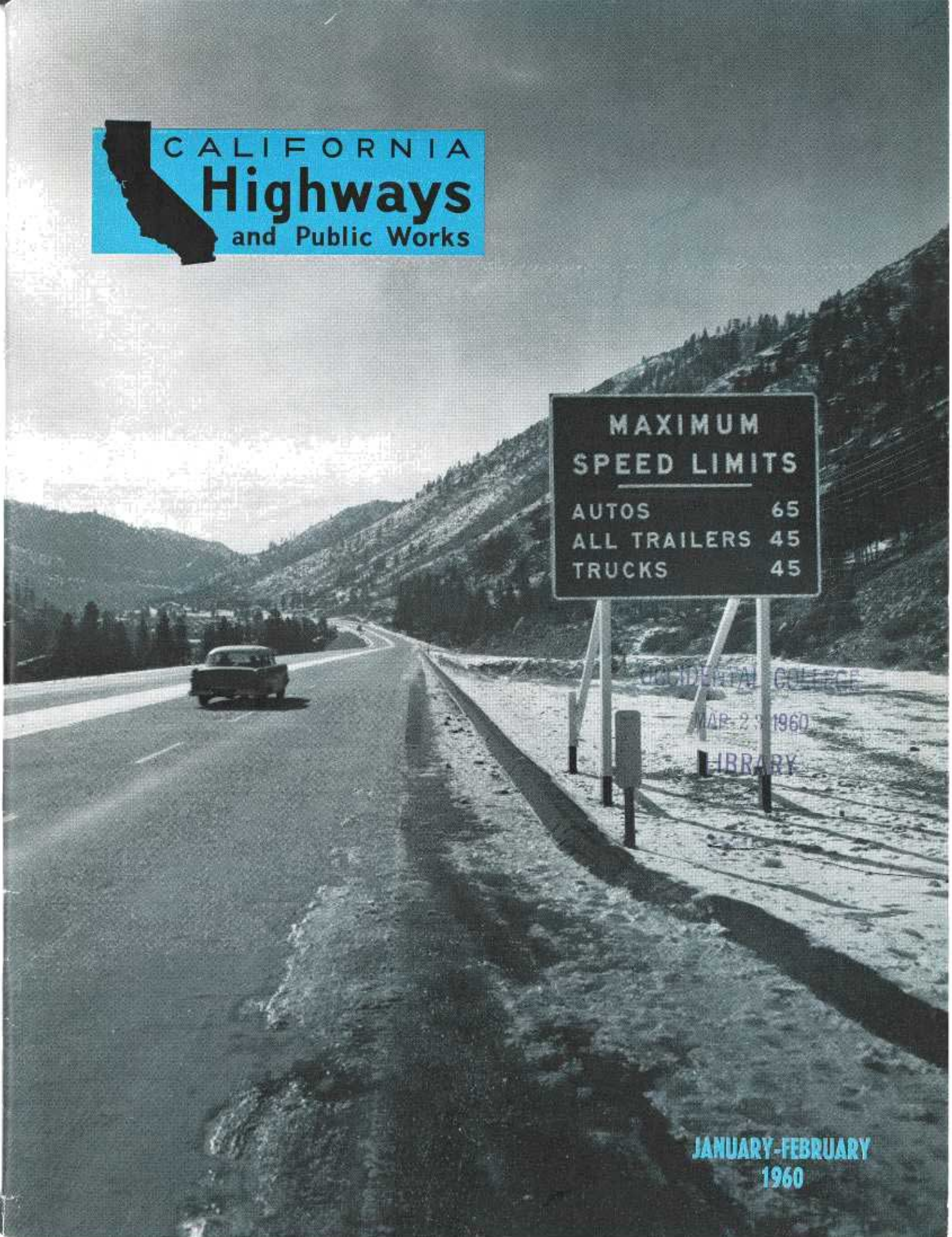

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JANUARY-FEBRUARY
1960

In Memoriam

J. W. Vickrey

1892-1959

J. W. Vickrey, California's State Highway Engineer, died on December 4 following a short illness.

Vickrey was appointed on October 1 to succeed G. T. McCoy as the chief of the State Division of Highways. He had been with the Division of Highways for 42 years. For the past 12 years he had been closely identified with the California freeway program as the division's chief planner.

On learning of Vickrey's death Governor Edmund G. Brown said:

"The death of State Highway Engineer J. W. Vickrey has deprived the people of California of one of its most brilliant and valuable civil servants.

"Mr. Vickrey devoted practically all of his professional career to this State. He has been more closely identified than any other person with the long-range planning of California's modern highway system, which is universally acknowledged to be the most advanced in the nation.

"Mr. Vickrey contributed to the growth and development of our State not only his engineering knowledge and ability, but also bold vision and a practical understanding of the legal and legislative aspects of the highway program.

"We had all looked forward to his guidance as we start to carry out the statewide master plan of freeways and expressways which he was a key man in shaping.

"His loss will be most keenly felt, even though he has trained some able assistants to carry on his work."

Vickrey was born in Hendricks County, Indiana, in 1892. He studied engineering at Danville, Indiana, and later at the Los Angeles Polytechnic Institute.

After some engineering work with the Southern Pacific Railroad and the Los Angeles County Surveyor's office, Vickrey went to work for the Division of Highways at Willits (Mendocino County) in 1917 as a transitman. For the next eight years he worked as a construction engineer and on survey parties in various parts of the State.

In 1925 he was appointed assistant engineer in charge of location and construction for District III, at that time with offices in Sacramento, and three years later was appointed District Maintenance Engineer.

In 1932 he was transferred to District IX at Bishop as Acting District Engineer and the following year was appointed District Engineer of District I at Eureka. He remained there until his promotion to Traffic and Safety Engineer for the Division of Highways in 1938, and has been in the Sacramento Headquarters office ever since.

In 1947, when California began its intensive highway modernization program under the Collier-Burns Act, Vickrey was appointed Assistant State Highway Engineer in charge of planning. He was promoted to Deputy State Highway Engineer in 1955, and has since been responsible for all the various engineering phases of the California highway program.

Vickrey, whose home was at 1371 46th Street in Sacramento, is survived by his wife, Katie; by two sons, John W. Vickrey, Jr., of Alamo (Contra Costa County), and William T. Vickrey of Los Angeles, and five grandchildren.

Mr. Vickrey's professional affiliations included membership in the American Society of Civil Engineers and the American Association of State Highways Officials. He was recently elected to the executive committee of the latter.

He was a member of Golden Empire Lodge, F. and A.M., of the Scottish Rite Bodies and the Ben Ali Shrine, and was a past patron of Rainbow Chapter No. 385, Order of the Eastern Star.

California Highways and Public Works

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

Vol. 39 January-February Nos. 1-2

New Signs, Rezoning For 65 M.P.H. Limit

The State Division of Highways is completing a major program of establishing and revising speed zones as a result of the new 65-mile-an-hour maximum speed limit which became effective January 1, 1960.

From a traffic engineering standpoint and safety requirements, the new speed limit involved more than the posting of "Maximum Speed Limit 65 Miles" signs. Signs were posted where appropriate, but in addition a number of speed zones had to be established. About 200 miles of highway were affected by new and revised speed zones.

FRONT COVER — On January 1, new signs, such as this one on U.S. 40 near the Nevada state line, appeared on California highways to inform motorists of the new speed limit now in effect.

—Photo by Jack Meyerpeter

New zones in a large measure were extensions of existing zones adjacent to communities in areas which are partially built up, have closely spaced intersections or a considerable amount of crosstraffic. Some highway locations where 55 miles an hour is appropriate are now signed "Speed Limit 55" whereas the old 55-mile prima facie limit made signs unnecessary.

At all highway entrances to California, large signs warn that the maximum speed limit for autos is 65 miles an hour, all trailers 45 miles an hour and trucks 45 miles an hour.

"Maximum Speed Limit 65 Miles" signs have been placed at entrance points to interstate highways and elsewhere as appropriate.

The signs advising motorists entering the State are extra large, 9 by 7 feet, and mounted 7 feet above the ground.

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LESTER S. KORITZ, *Editor*
STEWART MITCHELL, *Associate Editor*
HELEN HALSTED, *Assistant Editor* JOHN C. ROBINSON, *Assistant Editor*
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Editors are invited to use information contained herein and to request prints of any black and white photographs.

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SACRAMENTO 7, CALIFORNIA

Appointments

Four Engineers Named To Top Highway Posts

J. C. Womack has been named State Highway Engineer and Chief of the Division of Highways.

Womack, a 30-year employee of the division, was Deputy State Highway Engineer under J. W. Vickrey, who died on December 4.

Other appointments in the division included the promotion of J. P. Murphy to Deputy State Highway Engineer (Planning), succeeding Womack; the promotion of Lyman R. Gillis to Assistant State Highway Engineer (Administration), succeeding Murphy; and the promotion of George A. Hill to District Engineer (Planning) for District VII in Los Angeles, succeeding Gillis.

Regarding Womack's promotion to State Highway Engineer, Director of Public Works Robert B. Bradford,

J. C. Womack

J. P. Murphy

who announced the appointment, said: "With California on the threshold of a long-range freeway development program, the people of this State are fortunate in having a highway planner of proved ability in charge of our state highway work. Mr. Womack has been closely associated with Mr. G. T. McCoy, who retired recently as State Highway Engineer, and particularly with Mr. Vickrey, whose premature death shocked us all. He can be counted on to continue their tradition of efficiency and sound planning."

Womack's advancement to the post of State Highway Engineer climaxes a highway engineering career which began in Oregon and Washington in 1922 on location and construction work for the U. S. Bureau of Public Roads. A native of Emmett, Idaho, he was educated in Seattle and attended the University of Washington. He served as a second lieutenant of field artillery in World War I.

Joining the Division of Highways in 1929, he first served as District Location Engineer and as a resident engineer on construction projects in District III (Sacramento-Marysville). From 1935 to 1942 he supervised location surveys and planning development for the district, and was promoted to District Maintenance Engineer in 1942. In succeeding years he served as Engineer of Surveys and Plans and as District Construction Engineer.

He was promoted to Assistant District Engineer in District III in 1948, but later the same year he moved to Headquarters Office in Sacramento for the Division. He held this post for the next seven years, with responsibility for processing all highway improvement projects through Headquarters Office from their inception to the detailed design stage, including route adoption, freeway agreements, planning programs and budgets.

In 1955 Womack was promoted to Assistant State Highway Engineer—Planning, with supervision over six staff departments. In October 1959, he was advanced to Deputy State Highway Engineer—Engineering, succeeding Mr. Vickrey in that post upon

L. R. Gillis

the latter's appointment as State Highway Engineer.

Womack is a member of the American Society of Civil Engineers, the American Association of State Highway Officials (currently chairman of the A. A. S. H. O. Committee on De-

. . . Continued on page 67

Freeways in District VII

By E. T. TELFORD
Assistant State Highway Engineer

WITHIN the three counties of Los Angeles, Orange and Ventura (including 92 incorporated cities) which comprise District VII, are about 6,800,000 people operating nearly 3,500,000 motor vehicles. By 1980 this number of people and of motor vehicles probably will have doubled. To serve these people the Legislature has provided in Senate Bill No. 480 about 1,500 miles of the California freeway system in District VII. About 700 miles of the routes in the system within this district have been adopted by the California Highway Commission.


E. T. TELFORD

As of June 30, 1959, we had obligated a total of slightly over $800 million in freeways since the start of the freeway program. This has given District VII 181 miles of freeways and 103 miles of expressways, with 43 miles of freeways under construction at a construction cost of $84 million. We also have right-of-way acquired equal to somewhat more than two years' requirements beyond current construction. Completion of the system will require about $4 billion after the 1959-60 fiscal year.

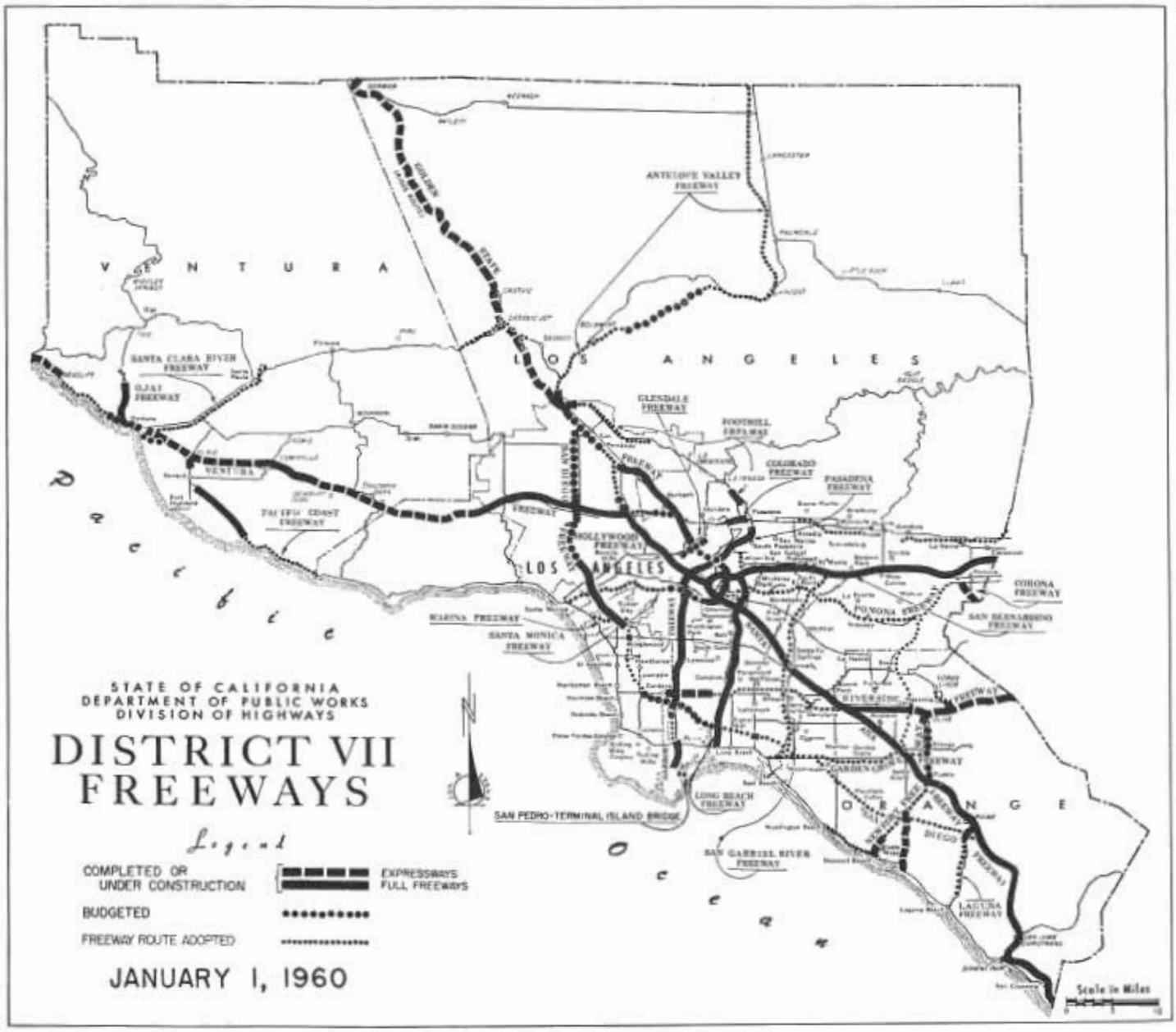
During the fiscal year July 1, 1958, to June 30, 1959 we opened to traffic 31.9 miles of freeways—16 miles in Los Angeles County, 10.2 miles in Orange, and 5.7 miles in Ventura. Since July 1 some additional mileage has been opened and more will be opened in the next few months. Some of the important sections soon to be opened are:

Ventura Freeway—Two sections, totaling 8.1 miles—to be opened April 1960. This will complete the Ventura Freeway from Hollywood Freeway to west city limits of Los Angeles.


Looking northward along the Hollywood Freeway extension from Lankershim Boulevard (foreground). The Ventura Freeway interchange is in the background.

Harbor Freeway—190th Street to 124th Street, 4.5 miles—to be opened August 1960.

San Diego Freeway—In San Clemente, Orange County, 7.8 miles—to be opened December 1960. In West Los Angeles, Jef-



ferson to Venice, 2.3 miles—to be opened June 1960.

Golden State Freeway—In East Los Angeles, 4.3 miles, Sixth Street to Pasadena Avenue—to be opened February 1960.

This section connects to the East Los Angeles Interchange now under construction, to the San Bernardino Freeway, and on the north to a section of the Golden State Freeway budgeted but not as yet under construction.

In view of the difficulties we have had in the financial field, due to drastic cutback of federal aid on interstate system highways, it will be simpler to combine the budget figures for the two fiscal years 1959-60 and 1960-61 as they now stand.

Right-of-way	$128,016,500
Construction	207,723,000
Two-year total	$335,739,500
Freeway construction only	$192,475,000

If we add to freeway construction the probable right-of-way acquisition for freeways, we have a figure of about $300,000,000 representing planned two-year investment in freeways. The two-year goal anticipates 68 new miles of freeway and 17 miles widened (six to eight, and four to six lanes). Most of this widening is scheduled on the San Bernardino Freeway. In addition there is provided a total of 16 miles of grading to be followed by later contracts for completion. For the 1959-60 fiscal year, we have under contract 13.8 miles of freeway representing a construction cost of $26 million.

Some specific items of major interest in the two fiscal years are:

San Diego Freeway—in Los Angeles County—Construction, 16 miles (in addition, Burbank Blvd. to Golden State Freeway, 8.5 miles—grading only)	$45,392,000
Golden State Freeway—Construction, 11.5 miles	44,375,000
Santa Monica Freeway—Construction, 5.6 miles	47,700,000
San Bernardino Freeway—Added lanes, 17 miles	5,750,000

Antelope Valley Freeway—Grading and structures, 7.6 miles	8,000,000
San Diego Freeway—in Orange County, 7.8 miles	6,500,000
Newport Freeway—in Orange County, 8.4 miles	8,800,000
U.S. Route 101 Freeway—City of Ventura, 7.5 miles	15,825,000

For planting of freeway roadsides for erosion control and landscaping, we have available $3,500,000 in the two fiscal years.

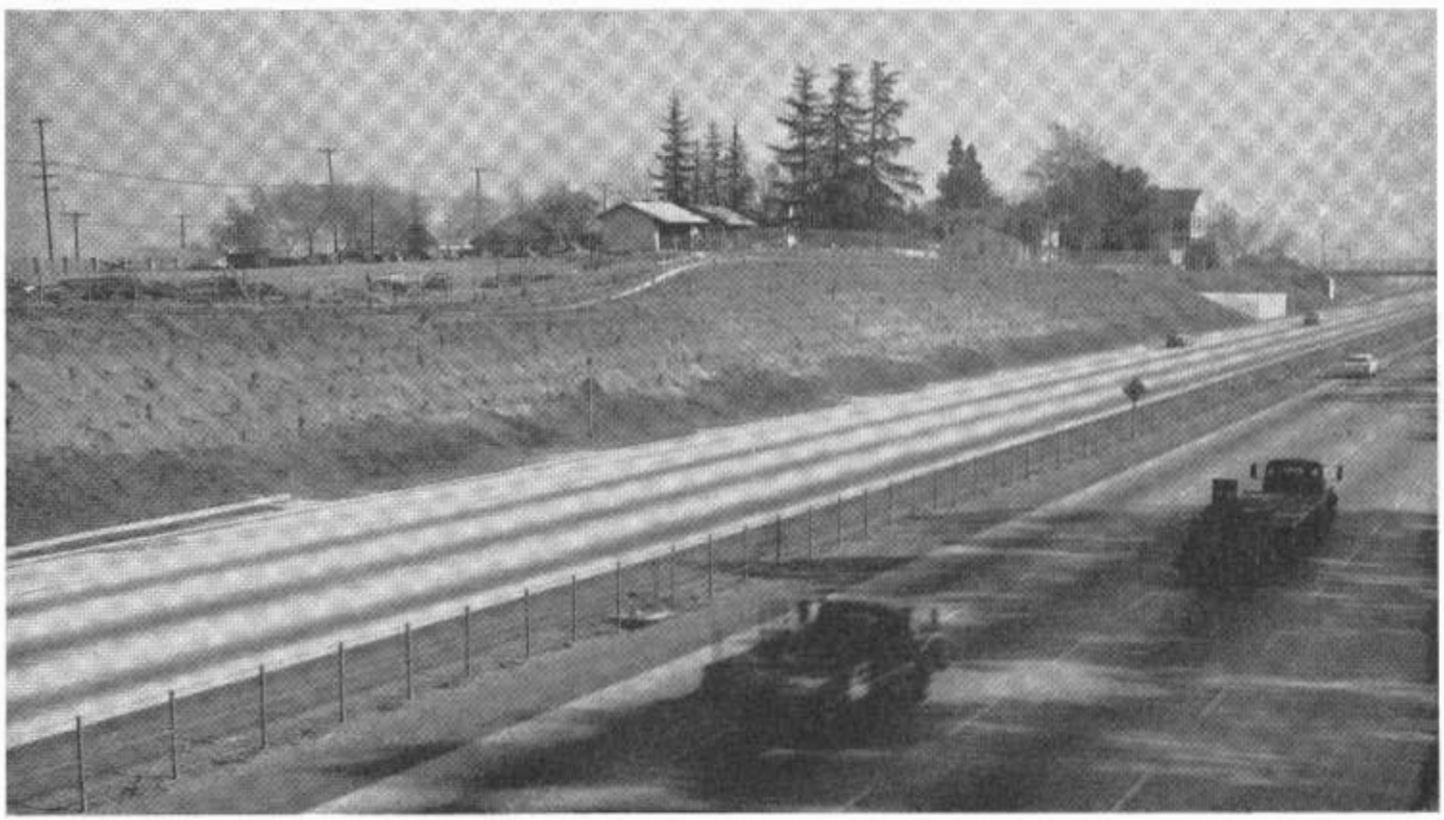
By the end of 1960 we will have in operation 90 miles of freeway on US 101 between the San Diego-Orange county line and the west city limits of Los Angeles. The rate at which projects can go to contract is controlled by the anticipated rate of cash flow from all sources of revenue including reimbursement from the federal government. We hope that in the future this flow will follow a consistent pattern and thus permit efficient planning and predictable accomplishment.

Common to all freeways is the problem of the proper treatment that should be given to central dividing or median strips to the end that cross-median accidents may be reduced both in number and severity.

Median Barriers

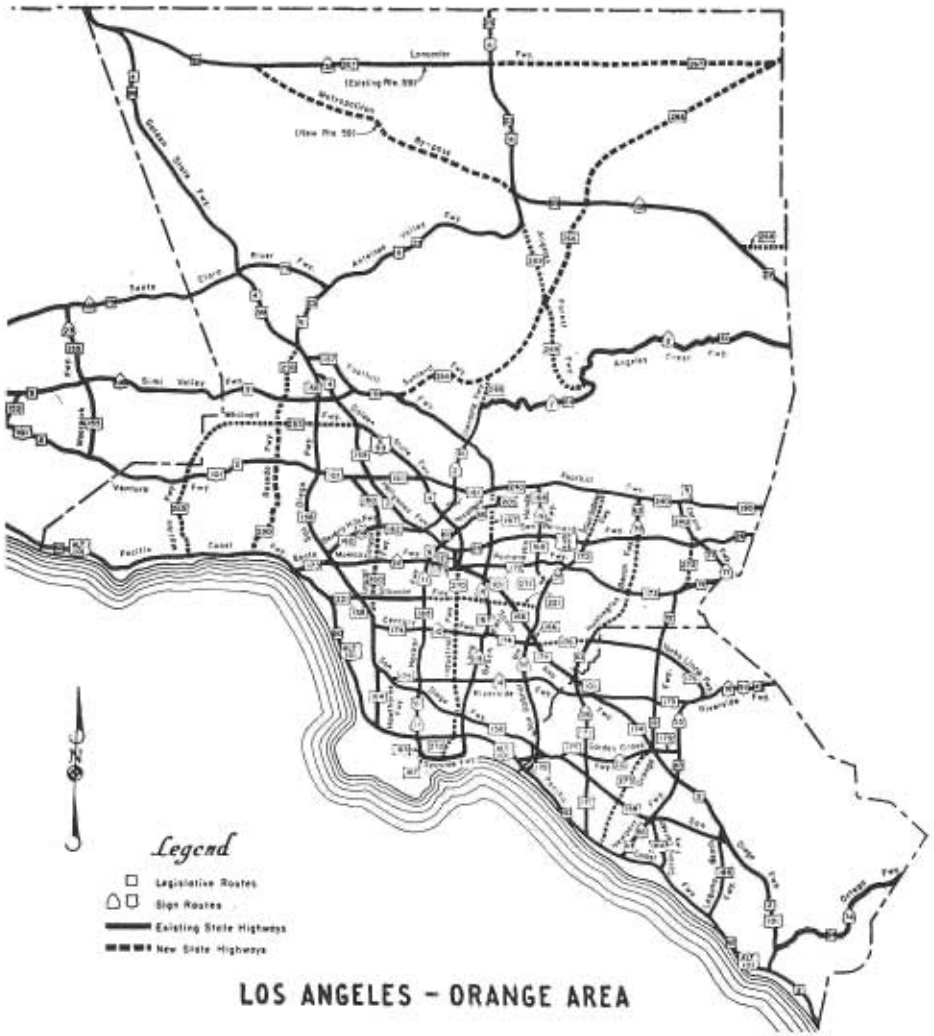
Exhaustive scientific studies and tests by Headquarters Materials and Research Laboratory in Sacramento relative to the problem of cross-median accidents on freeways and effectiveness of median barriers during the last three years led to important developments during 1959. It was found that there were two types of barriers that were the best and most effective of the 15 types that were tested. These are the combination cable-chain link barrier, and the blocked out metal beam barrier. The first installation was on the Ventura Freeway, west of the San Diego Freeway, made as a part of a $192,500 landscaping contract to Valley Crest Landscape Nurseries, Inc. This contractor placed 12,500 lineal feet of the combination cable-chain link barrier in the 22-foot median area. A second median barrier contract—suspended in September 1959 because of the steel strike—was awarded to Milleman and Sooy for $343,900 and provides for construction of 17,000 lineal feet of cable-chain link barrier and 30,000 lineal feet of blocked out beam barrier on the Hollywood and Santa Ana Freeways at various locations between Benton Way and Lakewood Boulevard, a distance of 14.1 miles. The 1960-61 budget also has a $300,000 allocation for median barrier construction on portions of the Harbor Freeway and Pasadena Freeways. (See articles Median Study, by George M. Webb, Traffic Engineer, and "Impact Tests," by John L. Beaton and Robert N. Field, Jr., in *California Highways and Public Works*, July-August 1959.)

There are in District VII 30 freeways totaling about 700 miles upon which the California Highway Commission has taken official action in adopting as freeway routes. Below, in alphabetical order, there is reported basic information concerning these freeways.



A new type median barrier fence was recently installed along the Ventura Freeway. This view eastward is taken from Louise Avenue. The home of Edward Everett Horton, motion picture and television star, can be seen in the background.

FREEWAY AND EXPRESSWAY SYSTEM IN DISTRICT VII



LOS ANGELES – ORANGE AREA

Antelope Valley Freeway

The 54 miles of freeway location in Los Angeles County on US Highway 6 from the Golden State Freeway north of San Fernando to the Kern county line were adopted by the California Highway Commission in three separate units during 1955, 1956 and 1957. The preliminary estimate of right-of-way acquisition and construction for this freeway is $60,000,000.

The first construction, expected to start late in 1960, is for grading and drainage structures on approximately eight miles between the community of Lang and Escondido Canyon Road. Financing of this construction, which does not provide for the paving that will have to come later, is from the item of $8,000,000 in the 1960-1961 Budget as adopted by the California Highway Commission in October 1959. Satisfactory progress has been made in right-of-way acquisition so that this construction can go forward without delay. Under future budget allocations this initial grading and construction of drainage structures can be extended and pavement provided so that a usable section 16 miles long between the community of Solamint and the Red Rover Mine Road can be completed and opened to traffic. Engineering studies and preparation of contract plans are in progress over the entire 54 miles of the Antelope Valley Freeway.

Artesia Freeway

As a result of a public hearing held in Los Angeles on November 12, 1958, for the portion of the Artesia Freeway between Alameda Street and Palo Verde Avenue traversing portions of the Cities of Compton, Long Beach, Bellflower and Dairy Valley, the California Highway Commission adopted this unit as a freeway on February 18, 1959.

Preliminary engineering studies are now in progress and negotiations have been started, with the various cities involved, looking toward the execution of freeway agreements.

Five miles of the Artesia Freeway near the westerly end from Normandie Avenue to 0.2 mile east of Alameda Street, were completed to expressway and divided highway standards during previous years.

Designing and preparation of contract plans are now under way to convert this section to full freeway standards. Design is also in progress for the section from the San Gabriel River to the Santa Ana Freeway. A right-of-way acquisition program is currently under way.

Colorado Freeway

Development of State Sign Route 134 as the Colorado Freeway will eventually extend from the Golden State Freeway on the west to the junction with the Foothill Freeway in Pasadena on the east. At present, only 2.3 miles of this route has been constructed as a full freeway. This completed portion extends from Eagle Vista Drive in Eagle Rock to Holly Street in Pasadena. This freeway, including the large arch bridge structure over the Arroyo Seco which was completed June 18, 1954, and dedicated as "Pasadena Pioneers Bridge," cost a total of $8,669,000.

Preliminary engineering studies have been carried out on several possible locations for extending this freeway westerly from Eagle Rock to the Golden State Freeway, and on October 8, 1959, a public meeting was held in the Glendale High School relative to the various alternate routings that were under study. There was a great deal of public interest in this meeting and the attendance exceeded 2,500 persons. Information which was presented at the meeting, together with subsequent information received, is being reviewed so that a report with recommendations may be made by the State

Highway Engineer to the California Highway Commission.

Two public hearings relative to the location studies for the portion of this freeway within Pasadena have previously been held (in conjunction with discussions of the Foothill Freeway).

From the latest 1959 traffic counts, the average daily traffic on the Colorado Freeway near Linda Vista Avenue is 23,000 vehicles.

Corona Freeway

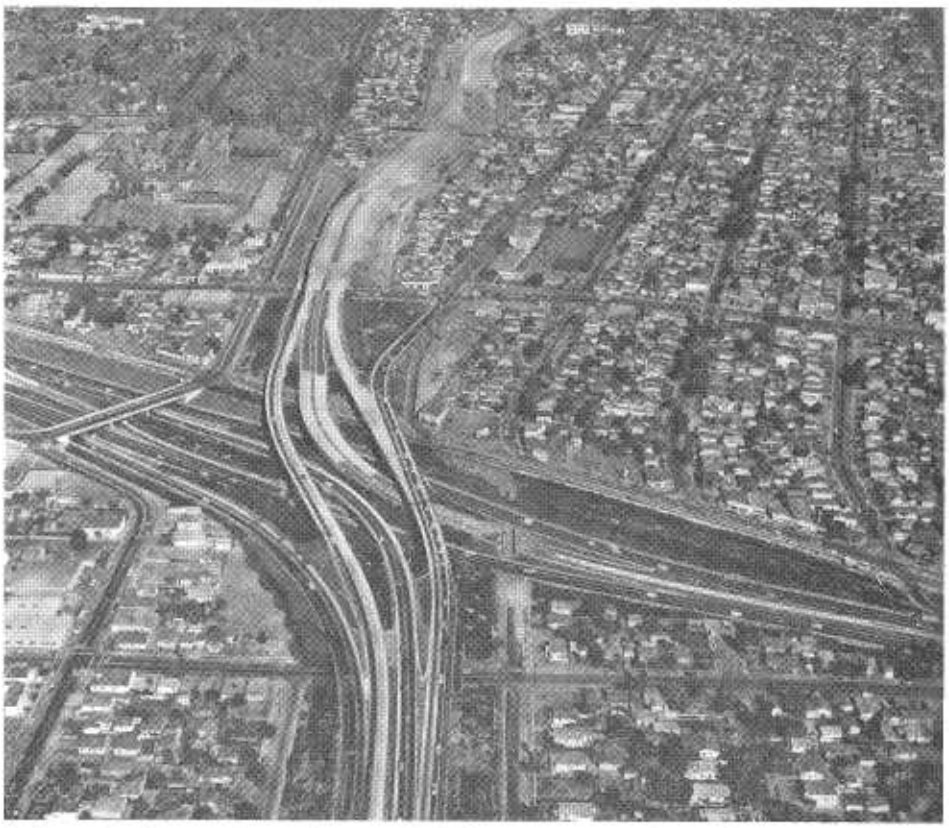
This freeway, formerly known as the Temescal Freeway, for 3.2 miles between Fifth Street in Pomona and a point one mile south of Riverside Drive in San Bernardino County, was completed to four-lane expressway standards in June 1958 at a cost of $800,000.

Plan work has been completed to convert this expressway to full freeway standards for its entire length of 4.4 miles from the San Bernardino Freeway to the San Bernardino county line. The estimated cost of this reconstruction is $2,500,000. It will require grade separation bridges and interchange facilities at Holt Avenue, Valley Boulevard and Fifth Avenue. Widening of the existing bridges over the Southern Pacific Railroad and Union Pacific Railroad will also be carried out. The start of reconstruction to obtain a full freeway depends upon future financing.

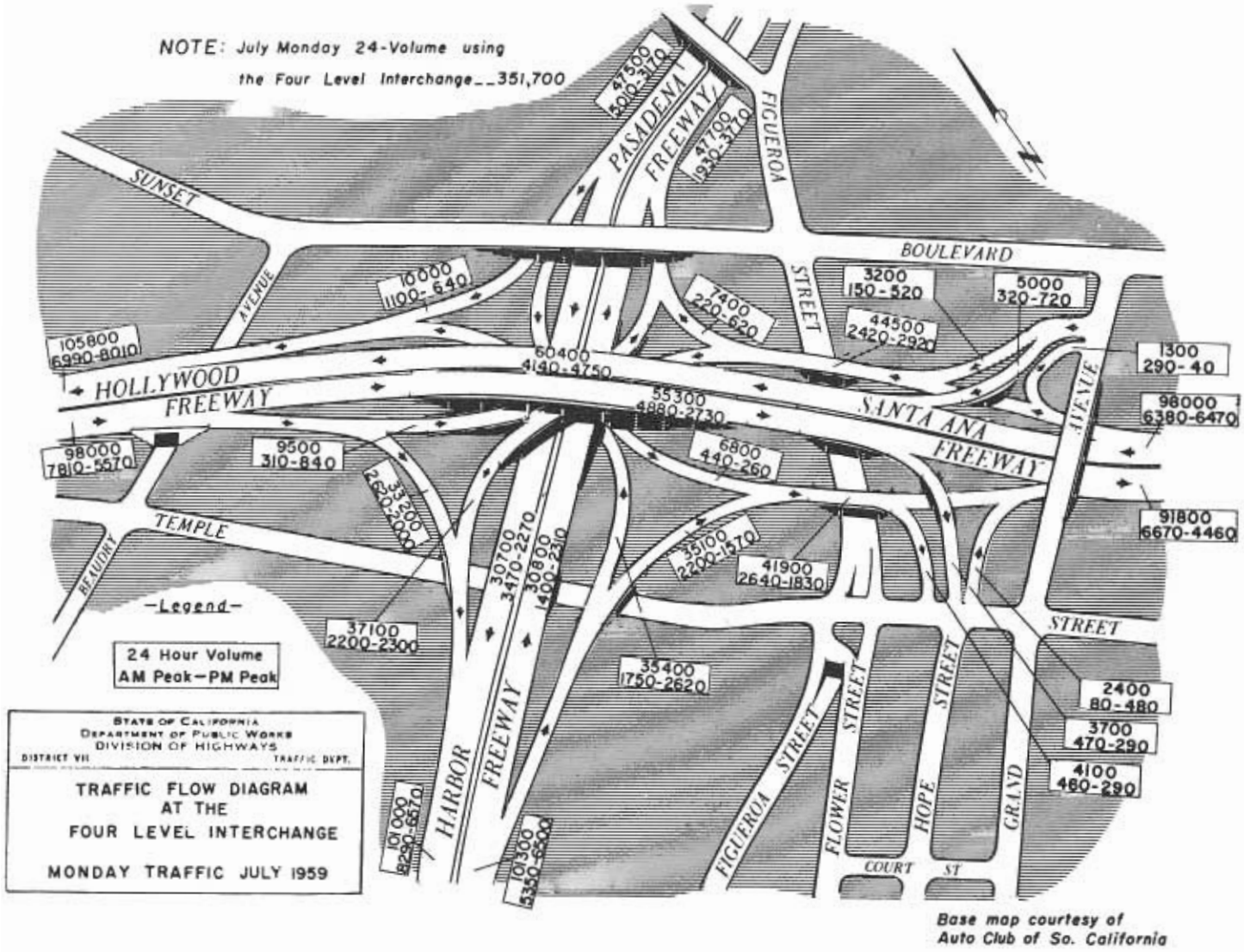
Corona Del Mar Freeway

State Highway Route 184 in Orange County from Coast Highway, US 101 Alternate, to Newport Freeway, State Highway Route 43, was adopted by the California Highway Commission as a freeway January 26, 1940. Of the total length of 6.3 miles, 2.3 miles at the southerly end adjoining US 101 Alternate were completed in 1942 as a four-lane divided highway. During the same year and under the same contract four miles were completed as a two-lane highway. This construction contract was carried out by Mittry Brothers at a total cost of $215,000. Further construction on this freeway route is not proposed in the immediate future. Some reconstruction will be necessary in connection with the future development of the San Diego Freeway in this vicinity.

Construction on the Long Beach Freeway extension. This northward view was taken from above Olympic Boulevard.



Another view of construction on the Long Beach Freeway extension showing the interchange with the Santa Ana Freeway in the foreground.



Base map courtesy of Auto Club of So. California

Foothill Freeway

The Foothill Freeway, the major portion being State Highway Route 9, is on the U.S. Interstate system. It extends from junction with the Golden State Freeway north of San Fernando southeasterly and easterly to the San Bernardino county line near Claremont. The California Highway Commission has adopted four freeway location units on the Foothill Freeway. These are as follows:

From Filbert Street to Foothill Place—9.7 miles, adopted March 26, 1958.

From Grand Avenue to San Bernardino county line—6.8 miles, adopted April 29, 1959.

From Michillinda Street to Bradbourne Avenue—5.9 miles, adopted May 20, 1959.

From Glendora Avenue to Grand Avenue—4.7 miles, adopted November 18, 1959.

To date the only construction on this freeway is a section 1.8 miles long in the Altadena-Flintridge area from Hampton Road to Montana Street. The cost of this construction, which was completed October 28, 1955, was $2,098,000.

Covering the section of the Foothill Freeway from Bradbourne Avenue at the west city limits of Irwindale through Azusa to Glendora Avenue, the California Highway Commission on November 20, 1959, held a public hearing in Los Angeles. At the time of this writing, the California Highway Commission had not taken official action in adopting the location for this section.

Remaining sections of the proposed Foothill Freeway through Pasadena, Altadena, La Canada and La Crescenta are under preliminary engineering study. Two public meetings relative to freeway location studies in Pasadena have previously been held.

Garden Grove Freeway

This freeway extends for 17.9 miles from US 101 Alternate to the Newport Freeway near the City of Orange. Resolutions of the California Highway Commission between 1954 and 1957 adopted this route as a freeway, and the commission on October 22, 1957, officially named it the Garden Grove Freeway. Contractors Cox Brothers Construction Company and J. E. Haddock, Ltd. on July 15, 1959, completed reconstruction of 5.4 miles of this route between Los Cerritos Channel and Knott Avenue. The cost of this work was $1,473,000.

This job has been designated as an "interim project," providing a four-

lane divided highway now, until full freeway construction can go forward at a later date. An unusual feature of this contract was that 2.1 miles of this construction along the Los Alamitos Naval Ordnance Area will at some future time become a part of the San Diego Freeway as well as the Garden Grove Freeway.

Design work is under way on the Garden Grove Freeway from Bolsa Chica Road easterly to the Newport Freeway.

Glendale Freeway

A total of 3.2 miles of the Glendale Freeway has been adopted by the California Highway Commission, of which 1.1 miles between the Los Angeles River and Avenue 36 near Eagle Rock Boulevard was completed November 3, 1958, to full freeway standards at a cost of $2,832,000.

Just southerly of the completed section, in connection with construction on the Golden State Freeway between Arnold Avenue and Glendale Boulevard, the interchange between these two freeways will be constructed as well as a new bridge across the Los Angeles River. This will be financed from the item of $14,845,000 in the 1959-1960 Budget. It is anticipated that this section will be ready to advertise early in 1960.

In the 1960-61 fiscal budget, there is an item of $2,700,000 for extending the Glendale Freeway from the Golden State Freeway southerly to a connection with Glendale Boulevard. It is anticipated that this construction will be ready to advertise for contract in mid-1960.

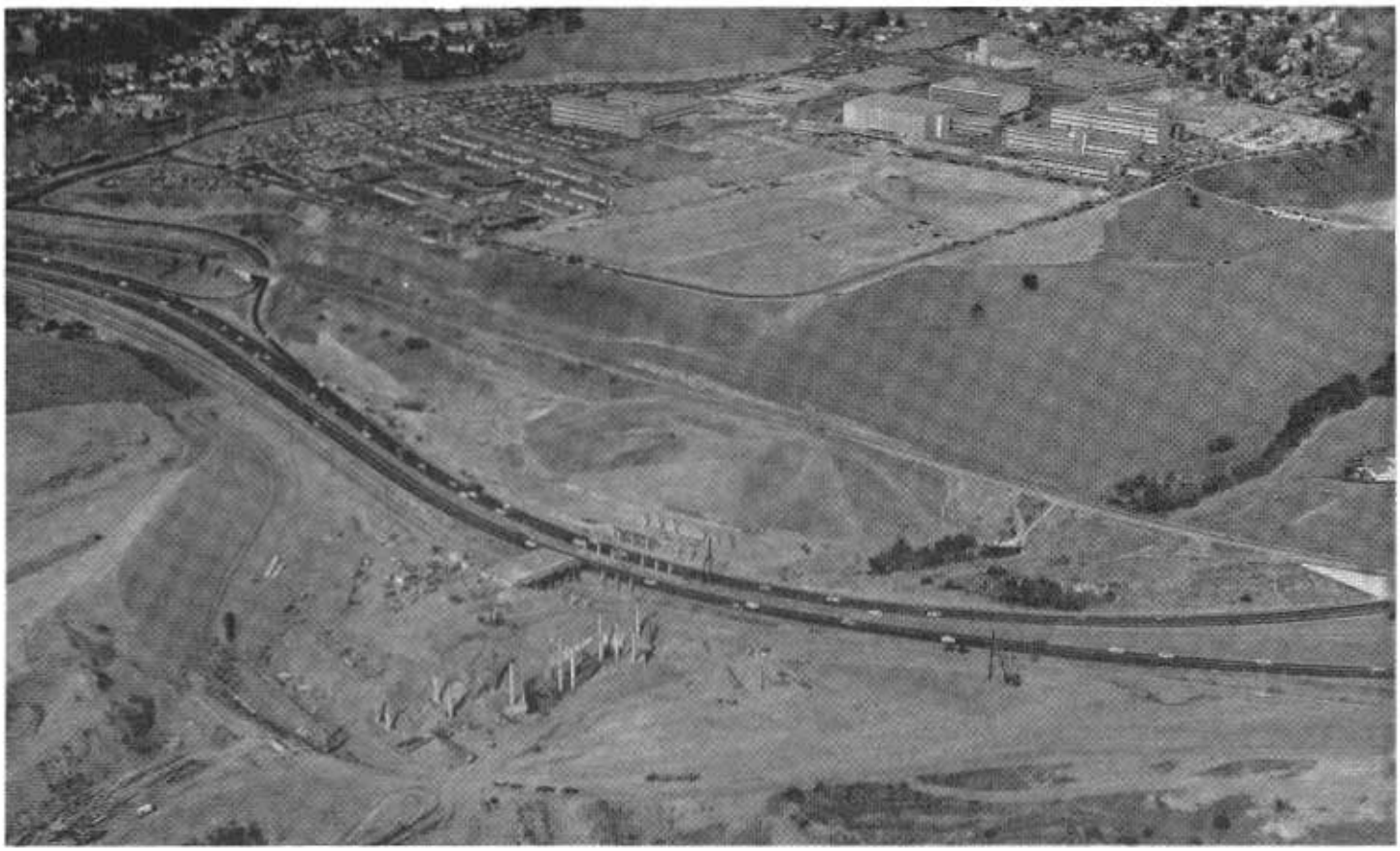
Under preliminary engineering study is the section westerly of Glendale Boulevard to junction with the Hollywood Freeway and the section northerly from Avenue 36 to junction with the Foothill Freeway.

Golden State Freeway

One of the most important routes in District VII in point of traffic service and relief to existing overly taxed major arterials such as the Hollywood Freeway—which has an average daily count of 194,000 motor vehicles westerly of the 4-level structure—will be the Golden State Freeway, completing an "East Loop" bypass around the Los Angeles Civic Center to a junction with the San Diego Freeway north of the City of San Fernando.

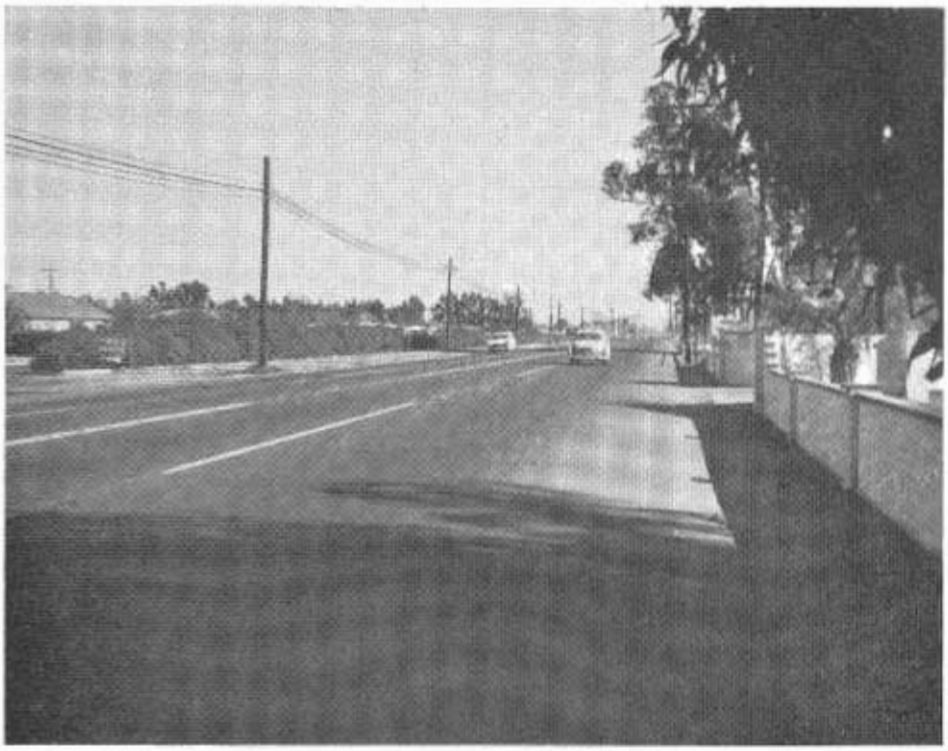
When completed it will effectively skirt present traffic concentrations in the "slot" or hub area of Los Angeles and provide a more direct alternate route with low-percentage grades for truck traffic plying between the north valley and greater Los Angeles markets and industry to the south. (For a complete discussion of the Golden State Freeway see article "Freeway Loop," by Lyman R. Gillis, District Engineer, *California Highways and Public Works*, September-October 1959.)

Construction is in progress on four separate jobs along the route of the Golden State Freeway north: Sixth Street to Mission Road, 3.1 miles, under $7,626,500 contract to Vinnell Company, Inc. and Vinnell Construc-



An aerial view northward showing construction work on the interchange which will connect the existing San Bernardino Freeway and the Long Beach Freeway extension. Los Angeles State College is in the background.

A view of the completed Lincoln Avenue widening project in Anaheim.



A view eastward along Garden Grove Boulevard in Garden Grove.

tors, with an estimated completion date of February 1960; Mission Road to Pasadena Avenue, 1.2 miles, under $3,040,500 contract to Boesplug & McLaughlin, with an estimated completion date of February 1960; Burbank Boulevard to Roscoe Boulevard, 4.1 miles, under $8,324,000 contract to Ukropina-Polich and Kral, with an estimated completion date of May 1961; and Roscoe Boulevard to Lankershim Boulevard, two miles, under $3,478,200 contract to B. J. Ukropina, T. P. Polich, Stevel Kral and John R. Ukropina, with an estimated completion date of May 1961.

The Golden State Freeway in the Los Angeles-Burbank area is completed from Glendale Boulevard north for 7.6 miles to Burbank Boulevard. The most recent construction, extending the freeway 1.6 miles between Alameda and Burbank Boulevards at a cost of $4,240,000 (State's share), was completed on August 5, 1959.

The 1959-60 Budget made provision for continued construction on the Golden State Freeway and the Pasadena and Glendale Freeway interchanges in the sum of $19,500,000. Work on this double project, which would extend the Golden State Freeway from Pasadena Avenue north to Glendale Boulevard, was deferred because of lack of federal funds and will be advertised for construction early in 1960. The 1960-61 Budget includes $14,000,000 for the Golden State Freeway—6.4 miles from Osborne Street north to San Fernando Road near the Foothill Boulevard interchange (also some construction on the San Diego Freeway).

Thus, the Golden State Freeway from the East Los Angeles Interchange just north of Olympic Boulevard to junction with the San Diego Freeway near the City of San Fernando is for the most part either completed, under construction or financed for construction. The sole exception is a short link of 2.4 miles between Lankershim Boulevard and Osborne Street, which awaits future financing. There is reasonable expectation now that this will all be completed and opened to traffic within the next three years.

Harbor Freeway

The Harbor Freeway, with termini 22.2 miles apart, extending between the four-level structure in the Los Angeles Civic Center and Battery Street in San Pedro, is completed for 10.6 miles as far south as 124th Street and for 2.5 miles from Pacific Coast Highway to Battery Street.

On September 26, 1958 another contract in excess of $8,000,000 was started on the Harbor Freeway. This project, when completed sometime in August 1960 will extend the Harbor Freeway 4.7 miles southerly from 124th Street to a connection with Figueroa Street approximately half a mile south of 190th Street.

The work includes constructing an eight-lane freeway, 17 bridges, pumping plant and 10 retaining walls. The bridge structures cover the field rather well, inasmuch as they include steel girder, prestressed girder and box girder construction. On- and off-ramp facilities are being constructed at El Segundo Boulevard, Rosecrans Avenue, Alondra Boulevard and 190th Street with a full interchange constructed at State Sign Route 14 (Artesia Boulevard).

The two most interesting features of construction were that of the Dominguez Channel Bridge structure and that of excavating some 140,000 cubic yards of "hot" rubbish from old dumps on either side of the Dominguez Channel. The work of excavating and disposing of trash was further complicated by the fact that the bottom portion of this material was below sea level as well as below the water elevation in the channel. The trash material consisted of nearly all combustibles in varying stages of decomposition. The material, upon being exposed to the air would flame up and smoulder with a very disagreeable odor. The contractors, J. E. Haddock, Ltd., and Ukropina, Polich and Kral, excavated this material by various types of operations, i.e., dozers and self-propelled scrapers, rear-dump two-wheeled trailers, etc. The bottom portion, a wet material, was excavated by a 1½-cubic-yard dragline into rear-dump two-wheeled trailers.

The Dominguez Channel Bridge is a three span, prestressed, concrete girder bridge, some 311 feet in length. Earth dikes were constructed across the channel above and below the structure and the resulting area was pumped dry. The footing piles, footings and columns were then erected. The 56 concrete girders were cast on the adjacent freeway grade, using steel forms, and post-tensioned. These girders were erected using, among other various sizes of cranes, a new 80-ton truck crane, which is believed to be the largest in this area.

The only other major construction on the Harbor Freeway during 1959 was incidental to the future Santa Monica-Harbor Freeway interchange at Venice Boulevard, where bridge structures were built across the Harbor Freeway. In order to carry out the work, a full eight-lane asphalt-paved detour was looped around the construction site to provide uninterrupted flow of Harbor Freeway traffic (an estimated 190,000 vehicles per day). The exceedingly complicated timing of traffic shifts from the old roadway to the new and back again, the engineering of the transition moves, and the general co-ordination of the operation was a singular achievement on the part of contractor's crews and state engineers. This spectacular detour, in service for 14 months (until October 4, 1959) and handling approximately 70,000,000 cars and trucks in the interim, was built at a cost of $380,000. After completion of the Santa Monica Freeway structure, the detour was razed and the salvage materials utilized for other construction. (See article "First Contract" by Lloyd A. Compton, Resident Engineer, Bridge Department, *California Highways and Public Works*, July-August 1959.)

The interchange facility between the Harbor Freeway and the San Diego Freeway will be built as a part of the construction on the San Diego Freeway between Carson Street and 190th Street which is financed in the 1959-1960 fiscal year budget. There will then remain four miles between the San Diego Freeway interchange and Pacific Coast Highway, estimated to cost $7,000,000, that will require future financing to complete the Harbor Freeway for its entire length of 22.2 miles.

From the latest 1959 traffic counts, the average daily traffic on the Harbor Freeway immediately south of the four-lane grade separation is 195,000 vehicles.

Hollywood Freeway

The Hollywood Freeway and the Hollywood Freeway Extension together total 16.8 miles in length, extending from Spring Street in the Los Angeles Civic Center via Cahuenga Pass in Hollywood to junction with the Golden State Freeway near Wentworth Street in the San Fernando Valley.

At present the Hollywood Freeway is completed to Moorpark Street in North Hollywood, where it interchanges with the Ventura Freeway. A $3,000,000 item in the 1960-61 Budget will extend it 0.7 mile north to Magnolia Boulevard and will include the following structures: Tujunga Avenue undercrossing, Magnolia Boulevard undercrossing, Morrision Street pedestrian undercrossing, and Otsego Street pedestrian undercrossing.

North of Magnolia Street the Hollywood Freeway Extension is under design, and right-of-way is being acquired for future construction.

Imperial Freeway

In Orange County the Route 176 freeway is referred to locally as the "Imperial Freeway," taking its name from the fact that the northerly end ties into Imperial Highway. The freeway route adoption by the California Highway Commission on January 15, 1952, included 3.1 miles extending from Yorba Linda Boulevard to the Riverside Freeway. A two-lane bridge on this freeway route has been completed over the Santa Ana River, which, with approaches, cost approximately $280,000. This two-lane bridge, which is now operating carrying two-way traffic, will become a one-way bridge when the second structure is built alongside to convert this route to a full freeway. Design work on this freeway is now in progress.

Laguna Freeway

This is the official name given State Sign Route 185 between the City of Laguna Beach and the Santa Ana Freeway. It is 8.4 miles long. Two miles of the freeway were recently completed to expressway standards at a cost of approximately $500,000. This construction covered two lanes of the ultimate four-lane freeway. The work was carried out in conjunction with Santa Ana Freeway construction.

Preliminary design plans are now in progress for the remaining 6.4 miles of this freeway in order that, when funds become available, freeway construction can be carried out to connect with the completed expressway on this route within the City of Laguna Beach at the southerly end of this freeway.

Long Beach Freeway

South of the Santa Ana Freeway the 16.8 miles of the Long Beach Freeway to Pacific Coast Highway in Long Beach were completed in 1958, and details of construction costing $50,000,000 including right-of-way were described in the September-October 1958 issue of *California Highways and Public Works*.

A minor improvement of considerable importance was completed July 30, 1959, which provided a new off-ramp for northbound traffic from the Long Beach Freeway to Long Beach Boulevard in the City of Long Beach at a cost of $40,000. Mention should also be made of the fact that southerly of the official south end of the Long Beach Freeway at Pacific Coast Highway, the City of Long Beach during 1959 opened to public traffic extensive roadway and bridge construction as far south as Broadway. This construction, designed and financed by the City of Long Beach, has done much to provide adequate terminal facilities for the Long Beach Freeway and has greatly facilitated traffic movements in this area.

Long Beach Freeway Extension

The Long Beach Freeway Extension northerly of the Santa Ana Freeway will ultimately provide an eight-lane full freeway between the San Diego Freeway in Long Beach on the south and Huntington Drive near Alhambra and South Pasadena on the north.

The current contract extends the freeway from its present northerly terminus at the Santa Ana Freeway to 0.2 mile north of the San Bernardino Freeway, a distance of 3.74 miles.

Upon its completion in early 1961, the new link will serve to reduce congestion in the metropolitan Los Angeles area by providing a more direct route between the San Gabriel Valley communities and the cities located between Los Angeles and Long Beach. It will then be possible, for example, for a resident of West Covina to travel via the San Bernardino and Long Beach Freeways to the harbor area without being compelled to "run the gauntlet" through downtown Los Angeles and the already crowded freeways in the Civic Center area.

Webb and White, R.B. Potashnick and W. J. Disteli, with a contract allotment of approximately $6,651,500, began work on February 11, 1959, in the existing rubbish dump paralleling Laguna Wash toward the northerly section of the project. In this area, approximately 295,000 cubic yards of refuse material was removed to the disposal area immediately adjacent to the freeway. This work was necessary in the early stages to permit the construction of a concrete lined channel and reinforced concrete box culverts to relocate Laguna Wash. Continuous maintenance was required to control fires started by spontaneous combustion as the rubbish excavation operation progressed.

The first order of work was the excavation and grading of the Higgins local material site located just south of the San Bernardino Freeway. A timetable for grading designated areas there assured relocation of the brickyard facilities without undue disruption of production operations. To date, grading operations have proceeded according to schedule, and the Higgins Brick Company yard has been relocated with a minimum of disturbance.

Detours were constructed at the Third Street separation and the Humphreys Avenue, First Street and Brooklyn Avenue overcrossings before the existing streets were closed for the construction of bridges. Work is proceeding on schedule on all of these structures, as well as on the bridge over Whittier Boulevard, and on the various structures in the San Bernardino-Long Beach Freeway interchange area. There are a total of 13 bridges on the project, with the various types including welded steel girder, reinforced concrete box girder, and precast prestressed concrete box girder. Bridge lengths vary from a 70-foot single span to a 15-span structure with a total length of 1,135 feet, and foundation treatments vary from spread footings to concrete and steel piles.

In the San Bernardino-Long Beach Freeway interchange area, limitations on the sequence of operations assure uninterrupted traffic flow on the San Bernardino Freeway and on Ramona Boulevard (the existing South Frontage Road). During the period in which the 70 precast girders are placed and the falsework erected for structures across the San Bernardino Freeway, traffic will be detoured around the construction area between the hours of 1 a.m. and 5 a.m. Bridge construction includes a project total of 20,190 cubic yards of class A concrete, 4,140,000 pounds of bar reinforcing steel and 654,000 pounds of structural steel.

The highway portion of the work includes a total of 2,036,200 cubic yards of roadway excavation, with 56,885,400 station yards of overhaul. There is an additional source of material north of the San Bernardino Freeway, which may be used after the excavation in the Higgins Brick Yard area has been completed.

Before such additional material may be hauled from the area north of the San Bernardino Freeway, the southbound separation structure and Ramona Extension structure must be adequately reinforced and protected from damage by overloaded carry-alls.

Material selected from roadway excavation between Hubbard Street and Hammel Street, and material from structure excavation from the county storm drain has been designated for use as subbase material over the entire length of the project. Since the contractor also has the option of producing structure backfill material from the roadway prism, the importing of material is required only for the untreated base and surfacing.

Also included are 43,000 cubic yards of structure excavation and 68,000 cubic yards of structure backfill, with excavation for several large structures being paid as roadway rather than structure excavation.

Erosion control work will be done, with straw and seed application to all medians and freeway embankment and excavation slopes for a total of 285,000 square yards. Installation of sprinkler

line cross-overs will be made during the course of this project, available for future construction of a sprinkling system.

From the latest 1959 traffic counts, the average daily traffic on the Long Beach Freeway near Pacific Coast Highway is 52,000 vehicles.

Marina Freeway

A section 3.9 miles long in the Culver City-West Los Angeles area was adopted on December 16, 1959 as a freeway by the California Highway Commission. The estimate of cost for ultimate development to eight lanes is $30,800,000 for right-of-way acquisition and construction. The Marina Freeway will provide traffic service for the motorists using recreational facilities in the Santa Monica Bay area, and it could eventually serve as a part of the East-West Slauson Freeway which was included in Senate Bill 480.

Newport Freeway

This state highway route was declared a freeway by action of the California Highway Commission for various units between the years 1947 and 1954. Between Newport Beach and Costa Mesa for 3.3 miles the route has been completed to expressway standards.

For a length of 2.7 miles in and adjacent to the City of Costa Mesa between 19th Street and Palisades Road, Contractor R. J. Noble Company is now engaged in construction of the west frontage road which will later adjoin the ultimate six-lane freeway. By carrying out this construction now, it will be possible to operate this portion of the route as a four-lane divided highway by utilizing the existing pavement for northbound traffic and the west frontage road now under construction for southbound traffic. The contract allotment is $568,000.

Designs are now being completed on the portion of the Newport Freeway between the Santa Ana Freeway and its junction with the Riverside Freeway. For this 8.4 miles, the 1960-61 fiscal year budget contains an item of $8,800,000 for construction of a four-lane freeway. It is anticipated that this project will be advertised during the early part of 1961.

The relocation of a section of U.S. 101 Alternate in the Pacific Palisades slide area has been completed.

An aerial view westward of the San Bernardino-Golden State Freeways interchange east of downtown Los Angeles.

This aerial view westward shows a new section of the Riverside Freeway in Orange County with the Placentia Avenue overcrossing in the foreground.

Ojai Freeway

A section of the Ojai Freeway between existing US 101, in the City of Ventura and 0.4 mile south of Mills School was completed to four-lane freeway standards in 1956.

Preliminary plans for improving the section between 0.1 mile south of the Southern Pacific Railroad tracks and Foster Park have been completed insofar as the geometric design and grades are concerned. This permits protection of the right-of-way in areas where commercial developments are active.

Studies are now in progress looking toward the location for this freeway extending from Foster Park to the City of Ojai. As soon as these studies are completed, a public meeting will be held to inform the public officials, property owners and interested parties as to the details.

Pomona Freeway

The California Highway Commission on October 28, 1959, adopted a freeway routing for 2.3 miles of the Pomona Freeway in the Monterey Park-Montebello area between Woods Avenue and Potrero Grande Drive. This recent adoption together with the previously adopted portions by actions of the California Highway Commission on April 21, 1954; April 20, 1955; June 21, 1955, and November 20, 1958, completed the location of the freeway betweeen the Santa Ana Freeway and Pomona.

Aerial surveys are under way on the recently adopted portion and preliminary design work has been started. Design work is continuing on the westerly portion between the Santa Ana Freeway and Woods Avenue, and discussions have been held with the City of Los Angeles and Los Angeles County relative to freeway agreements.

Freeway agreements covering the easterly portion between Potrero Grande Drive and Brea Canyon Road (Route 19) have been executed with Los Angeles County and presented to the City of Industry. The easterly portion of this route, which traverses the San Gabriel Valley in the vicinity of the City of Industry, is currently in a transitional stage from agricultural usage to industrial and residential usage. Close co-operation between the Division of Highways design engineers and the local governmental engineering staffs and the engineers for the property owners engaged in development has worked out to mutual advantage of all parties concerned by coordination of design efforts. This is a good example of the mutual benefits obtained when there has been adoption of a freeway location by the California Highway Commission well in advance of private property developments.

Pacific Coast Freeway

From the City of Oxnard in Ventura County, 18.1 miles of US 101 Alternate has been adopted by the California Highway Commission as a part of Pacific Coast Freeway. Of this section, the northerly 7.2 miles from the City of Oxnard to Calleguas Creek was completed to full freeway standards November 15, 1957, at a cost of $2,400,000.

In 1955, at the time a state beach was being developed along this highway in Orange County, the Highway Commission adopted a 4.5-mile length of Pacific Coast Freeway from Huntington Beach to Newport Beach. The purpose of this adoption, upon which as yet no construction has been carried out, was to protect this state highway so that its effectiveness as a traffic-carrying artery would be preserved.

Another section, also in Orange County, 0.7 mile in length, was adopted by the California Highway Commission to provide an extension of this route to connect with the new San Diego Freeway at Serra Junction in the vicinity of Doheny Park. Construction in the estimated amount of $117,000 is now being carried out on this unit in connection with the contract now under way on the San Diego Freeway from San Clemente to San Juan Capistrano.

During 1959, the consulting firm of Moran, Proctor, Mueser, & Rutledge completed comprehensive investigations and studies of landslide conditions along the Pacific Palisades and in adjacent areas to the Pacific Coast Highway in the Cities of Santa Monica and Los Angeles and in the Los Angeles County area for a short distance to the west of the incorporated areas. This engineering study of sliding conditions in the Santa Monica area was author-

ized by the 1957 Legislature which provided the sum of $300,000 for this purpose. A copy of the report has been filed with the State Legislature. The State Department of Public Works in co-operation with the Cities of Santa Monica and Los Angeles, and the County of Los Angeles is currently preparing a review thereof which will also be presented to the Legislature. This study will provide comprehensive engineering data which will be valuable in determining future development of properties along the Palisades as well as of Pacific Coast Freeway.

Pasadena Freeway

The Pasadena Freeway is 8.2 miles in length, extending from the four-level structure near the Los Angeles Civic Center to Glenarm Street in Pasadena. The first unit, a six-lane freeway, was completed and opened to traffic on December 30, 1940. The last unit of construction on this freeway was completed and opened to traffic on September 22, 1953. The total cost of the Pasadena Freeway was $11,800,000.

The southerly two miles of this freeway that is referred to as the Elysian Park section is an eight-lane freeway and it is now carrying, according to the 1959 traffic count, an average daily traffic, of 118,000 vehicles.

At the southerly end of the Pasadena Freeway, 1959 traffic counts indicate the average daily traffic using the four-level interchange system with the Harbor and Hollywood Freeways to be 324,000 vehicles.

Riverside Freeway

The Riverside Freeway was officially named by the California Highway Commission in October 1957. The 19.1 miles in District VII comprise portions of State Highway Routes 175 and 43 from junction with the Santa Ana Freeway near Buena Park to the Riverside county line. There are 6.1 miles of full freeway and 13.0 miles of expressway in this district.

The last section of construction, 2.7 miles in length, extending from Spadra Road in Fullerton to Placentia Avenue in Fullerton and Anaheim, was opened to public traffic November 18, 1959. This was the last unit of construction to complete the Riverside Freeway either as a four-lane expressway or a four-lane full freeway throughout its entire length in this district.

The last unit of the Riverside Freeway was awarded under a 300-working-day contract to Ukropina, Polich, Kral and Ukropina on September 19, 1958, and was fully completed in January 1960. The contract allotment was $2,609,000.

Five of the bridges on this section are composite welded steel girders with reinforced concrete decks on reinforced concrete bents and abutments. The sixth, the Lemon Street Overcrossing, is of reinforced concrete box girder construction on reinforced concrete bents and abutments. All bents and abutments are on drilled cast-in-place concrete piles except for the bents of the Lemon Street Overcrossing which are on spread footings. At the North Anaheim Overhead the freeway crosses over the main line track between Los Angeles and San Diego of the Santa Fe Railroad and also over a branch line track of the Union Pacific Railroad.

The freeway is on embankment except at the westerly end where it is depressed at Lemon Street and Spadra Road. With the exception of approximately 80,000 cubic yards of roadway excavation obtained from the depressed freeway section near Lemon Street and from excavation at cross streets, embankments were constructed using imported borrow from various sources. part of the contract was the excavation of the Raymond Street Retarding Basin for the Orange County Flood Control District which provided 236,000 cubic yards of borrow. The basin site was approximately one-fourth mile south of the freeway. Approximately 135,000 cubic yards of borrow was obtained from the Placentia Avenue Retarding Basin, also owned by the OCFCD near the easterly end of the

Looking west along a new section of the Ventura Freeway through the Woodland Hills area in the San Fernando Valley. In the foreground is the Topanga Avenue interchange.

project. Arrangements to obtain material from this site were made by the contractor. An additional 520,000 tons of imported borrow and imported subbase material were obtained from the site of a future settling basin on property owned by the Orange County Water District. Arrangements for use of this site for imported borrow were made by the State in advance of the contract and the use of this site was at the contractor's option. The site is approximately two miles east of the easterly end of the project and the material was hauled in bottom-dump trucks with semitrailer and trailer.

The volume of approximately 5,700 cubic yards of concrete used in drainage structures exceeded the 4,400 cubic yards used in the construction of the six bridges. In the vicinity of East Street a triple 10 x 7-foot reinforced concrete box culvert 760 feet in length was constructed across the freeway and East Street on new alignment of Carbon Canyon Wash Channel. On completion of the culvert the flood control district excavated an earth channel connection downstream to the Raymond Street Retarding Basin and an earth pilot channel upstream for a distance of approximately 1,500 feet to join the existing channel. Future improvement of this channel upstream is planned by the flood control district.

San Bernardino Freeway

The San Bernardino Freeway was completed throughout its entire length of 30.6 miles from the Santa Ana Freeway near the Los Angeles River to the San Bernardino county line in Claremont during 1956. A complete description of this freeway was given by District Engineer Lyman R. Gillis in *California Highways and Public Works*, July-August 1956. Since that time many improvements of a more or less minor nature have been made.

During 1959, in connection with the contract under way on the Golden State Freeway, a substantial improvement in the alignment of 1.4 miles of the San Bernardino Freeway has been completed and is now in use by public traffic. The curvature has been materially improved from the Macy Street Bridge to the Cornwall Street Bridge. The change in the alignment of the San Bernardino Freeway was necessary in order to work out satisfactory interchange facilities with the Golden State Freeway.

Early in 1960 it is expected that contracts will be started for widening projects on the San Bernardino Freeway for which there are allocations in the 1959-1960 fiscal year budget. These widening improvements are as follows:

- San Dimas Avenue to San Bernardino county line—5.7 miles—widening from four lanes to six lanes—$1,500,000. (Bids opened January 28, 1959.)
- Rosemead Boulevard to Puente Avenue—6.5 miles—widening from six lanes to eight—$2,250,000.
- From Long Beach Freeway to Rosemead Boulevard—5.3 miles—widening from six lanes to eight—$2,000,000.

From the latest 1959 traffic counts, the average daily traffic on the San Bernardino Freeway in the vicinity of Soto Street is 112,000 vehicles.

San Diego Freeway

The route of the San Diego Freeway extends from junction with the Golden State Freeway near the San Fernando Reservoir on the north to the San Diego county line in San Clemente on the south. It is 90 miles in length. Portions of this route are constructed, under construction or budgeted for construction and on other sections of the route right-of-way is being acquired and freeway design is in progress. Two projects are under construction now: in West Los Angeles between Venice and Jefferson Boulevards, and in Orange County between San Juan Capistrano and San Clemente.

The West Los Angeles contract between Venice and Jefferson Boulevards consisting of an eight-lane freeway 2.32 miles in length was awarded to Guy F. Atkinson Company on October 17, 1958. The contract allotment is $5,257,500. The work includes grading and surfacing with portland cement concrete on cement-treated subgrade, nine bridges (all undercrossings) and 21 retaining walls; the major portion of the embankment is comprised of 1,050,000 cubic yards of imported borrow and originated from the Mulholland Summit Cut approximately 10 miles north of the contract limits. This cut is located at the crest of Sepulveda Canyon nestled in the middle of the Santa Monica Mountains at the intersection of the future San Diego Freeway and scenic Mulholland Drive. The Guy F. Atkinson Company was the third contractor to haul material from this site and the total yardage removed to date approximates 4,250,000 cubic yards with an equal amount remaining to be excavated under a future contract. The yardage involved approximates very closely the "Big Cut" of the Carquinez Bridge project (see the article in the January-February 1959 issue of *California Highways and Public Works*).

The design provides for 1:1 cut slopes with a 30-foot wide bench at every 60 feet in elevation or a 1½:1 basic slope with a maximum cut face of 310 feet just southerly of old Mulholland Drive.

To date three bridges on the West Los Angeles job are completed; three are in the deck construction stage; one in abutment wall construction; one in the pile drilling stage; and the remaining one being excavated to bottom of footing grades. The contractor anticipates paving operations to start in the middle of April 1960 with completion of the contract to be in June 1960.

Bids were opened on February 19, 1959, on a section of the San Diego Freeway in Orange County, between 1.4 miles south of State Sign Route 74 (Ortega Highway) in Capistrano Beach and Avenida Ramona in the City of San Clemente. The 7.7-mile contract, awarded on March 3, 1959, to Guy F. Atkinson Company at a bid price of $6,117,307, is expected to be completed in December 1960. The six- and four-lane freeway, work on which started on April 8, 1959, is being constructed on new alignment approximately one-half mile northerly and inland of present US Highway 101. Bridge construction, drainage structures and grading operations are the major items of work thus far, with the contract 35 percent completed. Drainage facilities include four reinforced concrete arch culverts.

In the 1959-1960 fiscal year budget, there are three allocations for construction on the San Diego Freeway that total $17,600,000, and in the 1960-61 fiscal year budget there are also three allocations for further construction on this freeway, that total $27,650,000, all six items of which are scheduled for advertising during the year 1960.

These allocations will accomplish the following:

(1) Completion of the San Diego Freeway through the Santa Monica Mountains to provide 14.3 miles of continuous freeway from Jefferson Boulevard in Culver City to Burbank Boulevard north of Ventura Freeway, and, in addition, provide for grading future freeway construction northerly from Burbank Boulevard to Nordhoff Street. Further grading for future freeway northerly from Nordhoff Street to the northerly terminus of the San Diego Freeway at junction with the Golden State Freeway will be done in connection with construction going forward in 1960 on the Golden State Freeway in this vicinity which is financed from 1960-61 fiscal year funds;

(2) Structures and approaches on the San Diego Freeway between Manchester Boulevard and Vesta Street in the City of Inglewood;

(3) Completion of a nine-mile length of the San Diego Freeway from 174th Street in Torrance to the Long Beach Freeway at the westerly outskirts of Long Beach. This will also include interchange facilities with the Harbor Freeway and the Long Beach Freeway.

Right-of-way acquisition is in progress financed from the $22,825,000 budgeted in the 1959-60 fiscal year. The extensive program of right-of-way acquisition on the San Diego Freeway will continue since the California Highway Commission in the budget for the 1960-61 fiscal year allocated $14,600,000 for rights of way on the San Diego Freeway.

The San Diego Freeway was completed and open to traffic from Burbank Boulevard to Valley Vista Street in San Fernando Valley (along with a portion of the Ventura Freeway), a distance of 1.2 miles, on July 3, 1958, at a construction cost of $2,838,000; on the West Los Angeles side of the Santa Monica Mountains, two miles were added between Casiano Road and Ohio Avenue in 1957 at a cost of more than $4,500,000; and on February 19, 1959, 3.6 miles were added between Ohio Avenue and Venice Boulevard at a cost of $6,190,400.

Considerably more mileage of the San Deigo Freeway has been constructed in Orange County since early

Looking northwest toward the Harbor Freeway with the Los Angeles downtown area in the foreground showing parking space areas which have become available as obsolete buildings are torn down.

Another section of the San Diego Freeway in Orange County has been completed. This southward view shows the Niguel Road-El Toro Road interchange.

An interconnecting roadway is being constructed between U.S. 101 (foreground) and the San Diego Freeway (background) in the Capistrano Beach area. The view is eastward.

1958, when a $899,000 contract extended it from junction with the Santa Ana Freeway near El Toro Marine Corps Air Station to Niguel Road. On August 13, 1959, an eight-mile section costing $4,099,900 was opened from Niguel Road to Trabuco Creek, where it joins another four-mile section through San Juan Capistrano completed on December 1, 1958, under $4,233,200 contract. The southernmost San Diego Freeway project through San Clemente to the San Diego county line, 1.8 miles, was completed on October 20, 1958, at a cost of $2,724,000.

San Gabriel River Freeway

Construction plans are now in preparation for the entire 22.6 miles of the San Gabriel River Freeway extending from the Garden Grove Freeway in Orange County to the San Bernardino Freeway in Los Angeles County. Interchange facilities will be provided between this freeway and the San Diego, Garden Grove, Artesia, Pomona and San Bernardino Freeways, as well as with major county roads and city streets.

This freeway passes through portions of the Cities of Norwalk, Santa Fe Springs, Baldwin Park, Long Beach, Downey and Industry. Freeway agreements have been executed by all of these cities and also Los Angeles County, except in the case of the City of Industry which now has the State's proposal under discussion with favorable action anticipated in the near future. Right-of-way acquisition, looking toward future construction when funds are available, is in progress.

Terminal Island Bridge

The Highway Commission on August 28, 1959, adopted as freeway the 1.6-mile length of the location routing for the proposed San Pedro-Terminal Island Bridge in Los Angeles County. This freeway route adoption extends from Harbor Boulevard in San Pedro to Mormon Street on Terminal Island. The action by the commission followed a public meeting held in San Pedro on June 25, 1959. Financing has been arranged including a proposed $6,000,000 revenue bond issue by the California Toll Bridge Authority. Rights-of-way are being acquired, and it is expected that this project, estimated to cost about $20,000,000, can go to contract in mid-1960.

Santa Ana Freeway

The Santa Ana Freeway is now completed throughout its entire length of 43.1 miles between the Los Angeles Civic Center in Los Angeles County and junction with the San Diego Freeway near El Toro MCAS in Orange County.

Two important items of reconstruction were completed during 1959 on the Santa Ana Freeway. Two bridges were built that were made necessary in connection with Orange County flood control developments that were completed on February 27, 1959, at a cost of $192,000. The necessary construction to convert the old four-lane freeway to six-lane width for 4.3 miles between Rosecrans Avenue and Buena Park, costing approximately $1,100,000, was completed May 12, 1959. The Santa Ana Freeway is now completed to six- and eight-lane standards between the Los Angeles Civic Center and the City of Anaheim, and to four-lane standards southerly thereof.

Included in the 1960-61 fiscal year budget is an item of $800,000 for widening the Santa Ana Freeway from six lanes to eight lanes from the Long Beach Freeway to Atlantic Boulevard. Relative to this widening a public meeting was held in Los Angeles on December 1, 1959. It is anticipated that this widening construction will be advertised early in 1960. From the latest 1959 traffic counts, the average daily traffic on the Santa Ana Freeway in the vicinity of Soto Street is 142,000 vehicles.

Santa Monica Freeway

The Santa Monica Freeway is 17.2 miles in length extending from the Santa Ana Freeway near Soto Street in East Los Angeles to Lincoln Boulevard in Santa Monica. It is a part of what is called "the Los Angeles Freeway Loop" and as such was described in detail by District Engineer Lyman R. Gillis' illustrated story published in the September-October 1959 issue of *California Highways and Public Works*. Since this story was written, the Peter Kiewit Sons' Company contract for bridge structures on the Santa Monica Freeway over the Los Angeles River and the Santa Fe and Union Pacific Railroads was completed and accepted December 1959.

Included in the 1959-60 fiscal year construction program are three projects on the Santa Monica Freeway extending from Eighth Street at the west end of the now completed Los Angeles River Bridge that is now completed to Oak Street, immediately west of the Harbor Freeway. Budget items for these three projects total $24,700,000. It is anticipated that contracts will be advertised for this construction, to be financed from 1959-60 fiscal year budget allocations, early in 1960.

In the 1960-61 fiscal year budget, there is an item of $5,000,000 to extend construction on the Santa Monica Freeway westerly for 0.4 mile from Oak Street to Hoover Street. It is anticipated that contract for this work will be advertised during the early part of 1961.

Engineering, design and preparation of contract plans are now in progress on all remaining sections of the Santa Monica Freeway from Hoover Street, Los Angeles, westerly to Lincoln Boulevard in Santa Monica. Right-of-way negotiations are also in progress. From Hoover Street to La Cienega Boulevard, at present writing, 36 percent of the necessary right-of-way has been obtained. On the section from La Cienega Boulevard to Lincoln Boulevard, 27 percent of the required right-of-way has been obtained.

Santa Paula-Santa Clara River Freeway

Two sections of State Sign Route 126 have been adopted as freeway by the California Highway Commission. These total 19.3 miles in length and extend from the Ventura Freeway to Orcutt Road near Santa Paula and from the Los Angeles-Ventura county line to US 99 near Castaic Junction.

For the freeway section between Ventura and Santa Paula, acquisition of right-of-way is proceeding rapidly. To date approximately one-fourth of the total of 330 parcels has been acquired. Construction plans for the 5.5-mile section between the Ventura Freeway and Wells Road are nearing completion. Contract plans for the easterly portion between Wells Road and Santa Paula are progressing rapidly.

Ventura Freeway

Design and preparation of contract plans continue on the Ventura Freeway between the west city limits of Los Angeles and the Santa Barbara county line to convert all remaining expressway sections to full freeway status.

Bids were opened February 11, 1960, for construction of a 4.6-mile section through the City of Ventura from 0.3 mile east of Telephone Road to Palm Street. The 1959-60 fiscal year budget contains an allotment of $9,341,000 to finance this construction. Another section to the west, three miles in length between Palm Street and the Southern Pacific Railroad Solimar Overhead, is tentatively scheduled for contract advertising in the summer of 1960. The 1960-61 fiscal year budget allocates $6,500,000 for financing this construction. Included in this latter project is an interchange and connection with US 399, the Ojai Freeway.

West of the Ventura River to the Santa Barbara county line, alignment has been set, including realignment out in the ocean at the Chanslor-Western Oil Refinery. Construction to four-lane freeway with right-of-way for six lanes is proposed. A public meeting was held on March 10, 1959, for the purpose of acquainting the public with plans for this section of US 101 north of the City of Ventura. At this same meeting sections of the Ojai Freeway, US 399, and the Coast Highway (US 101 Alternate) adjacent to the Point Mugu Missile Base were discussed.

On February 17, 1959, a two-mile link of full freeway in the San Fernando Valley area of the City of Los Angeles from the Hollywood Freeway at Moorpark Street west to Laurel Canyon Boulevard, at a construction cost of $4,466,400, was completed.

Currently there are two other projects under construction on the Ventura Freeway within the city limits of Los Angeles, in the San Fernando Valley.

The most easterly construction project on this freeway is that lying between Laurel Canyon and Sepulveda Boulevards, under contract since July 8, 1958, to Peter Kiewit Sons' Company. This project is 4.3 miles in length and was let at a contract bid of $8,898,472. In addition to the main Ventura Freeway, construction includes relocation of Mulholland Drive over the future San Diego Freeway through the Santa Monica Mountains.

Plans on the main contract call for grading, structures and paving eight lanes of concrete on cement-treated subgrade. Major contract items include 2,450,000 cubic yards of roadway excavation, 7,950,000 mile-yards of haul, 217,500 tons of imported subbase materials, 164,000 tons of untreated base, 51,500 cubic yards of concrete pavements in widths of 24 feet, 32,480 cubic yards of bridge concrete, 66,060 lineal feet of concrete and steel piling, 1,800,000 pounds of structural steel, 1.02 miles of sanitary sewer pipe, and 2.7 miles of storm drain pipe. The estimated completion date of this Ventura Freeway project is for late March or early April 1960.

Bids were opened on August 14, 1958, for a second construction contract on the Ventura Freeway between Encino Avenue and Kelvin Avenue in the City of Los Angeles, a distance of 3.9 miles.

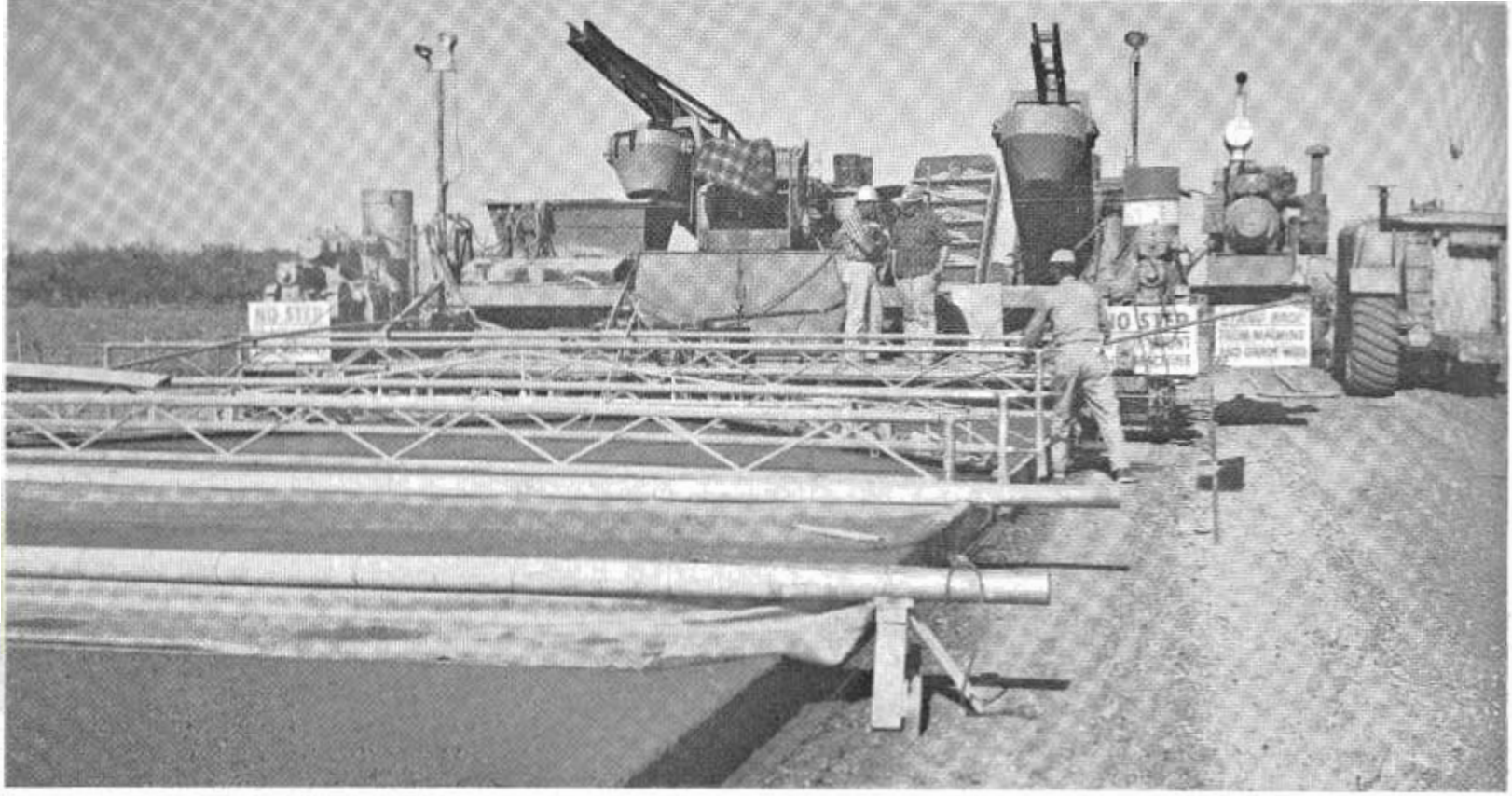
The low bidder was Oberg Construction Corp. and Oberg Bros. Construction Company at $5,312,645.

Work consists of grading and surfacing for an eight-lane freeway with portland cement concrete on cement-treated subgrade, eight bridges, six pedestrian undercrossings and one pedestrian overcrossing. City streets were reconstructed where they join on and off ramps and Burbank Boulevard was reconstructed on new alignment to reduce the skew where the freeway crosses overhead. Completion is expected for the early part of April 1960.

The 1960-61 state highway budget contains $4,400,000 for construction of 2.2 miles of the Ventura Freeway from Buena Vista Street in Burbank east to junction with the Golden State Freeway at Griffith Park. This project will advertise for bids sometime during 1960.

In addition, construction funds have been budgeted for landscaping the Ventura Freeway from Colfax Avenue to the San Diego Freeway ($250,000) and from Encino Avenue to Kelvin Avenue ($240,000).

. . . Continued on page 65



A new slip-form paver in operation on the Vacaville-Dunnigan Cut-off (State Route 90) near Woodland.

Slip-form Paving

Hailed as Major Advance In Construction Practice

By LEIGH S. SPICKELMIRE, Assistant Construction Engineer

P.C.C. slip-form paving made its debut in California state highway construction during the late months of 1959, and immediately became the focal point of wide interest among highway engineers who see in the method not only a major advance in concrete paving practice but the potential of reduced paving costs.

Early last year the highway construction industry, represented by the Griffith Company of Los Angeles, proposed a demonstration of the capability of a slip-form paver manufactured by a California firm. Their plan was to pave a trial section in the Los Angeles River channel invert contract they then held with the Corps of Engineers under simulated highway conditions for evaluation by the Division of Highways. This proposal was accepted and as a result of critical review and testing of the 24-foot wide concrete slab constructed in that trial section Mr. G. T. McCoy as State Highway Engineer authorized the use of the slip-form paving method in state highway construction on an experimental basis.

Two paving contractors, Gordon H. Ball, Inc., of Danville and Griffith Company of Los Angeles, immediately requested permission to employ the revolutionary method on several of their going highway contracts.

Three Jobs Chosen

Contracts selected for the initial slip-form pavement construction in California were:

Contract 60-3TC9-FI, road III-Yol-90-A,B,Win., Gordon H. Ball and Gordon H. Ball, Inc., contractor. This project, located near Woodland, includes the construction of approximately 14 miles of two-lane 24-foot wide P.C.C. pavement, and in two interchange areas the ultimate four-lane divided section is being built, requiring 47,890 cubic yards of Class B concrete.

Contract 60-10TC4-FI, road X-Yol-90-A, Gordon H. Ball and Gordon H. Ball, Inc., contractor. This project joins the south end of the above contract at Putah Creek and extends the 24-foot wide two-lane P.C.C. pavement approximately six miles farther to the south, requiring 17,070 cubic yards of Class B concrete.

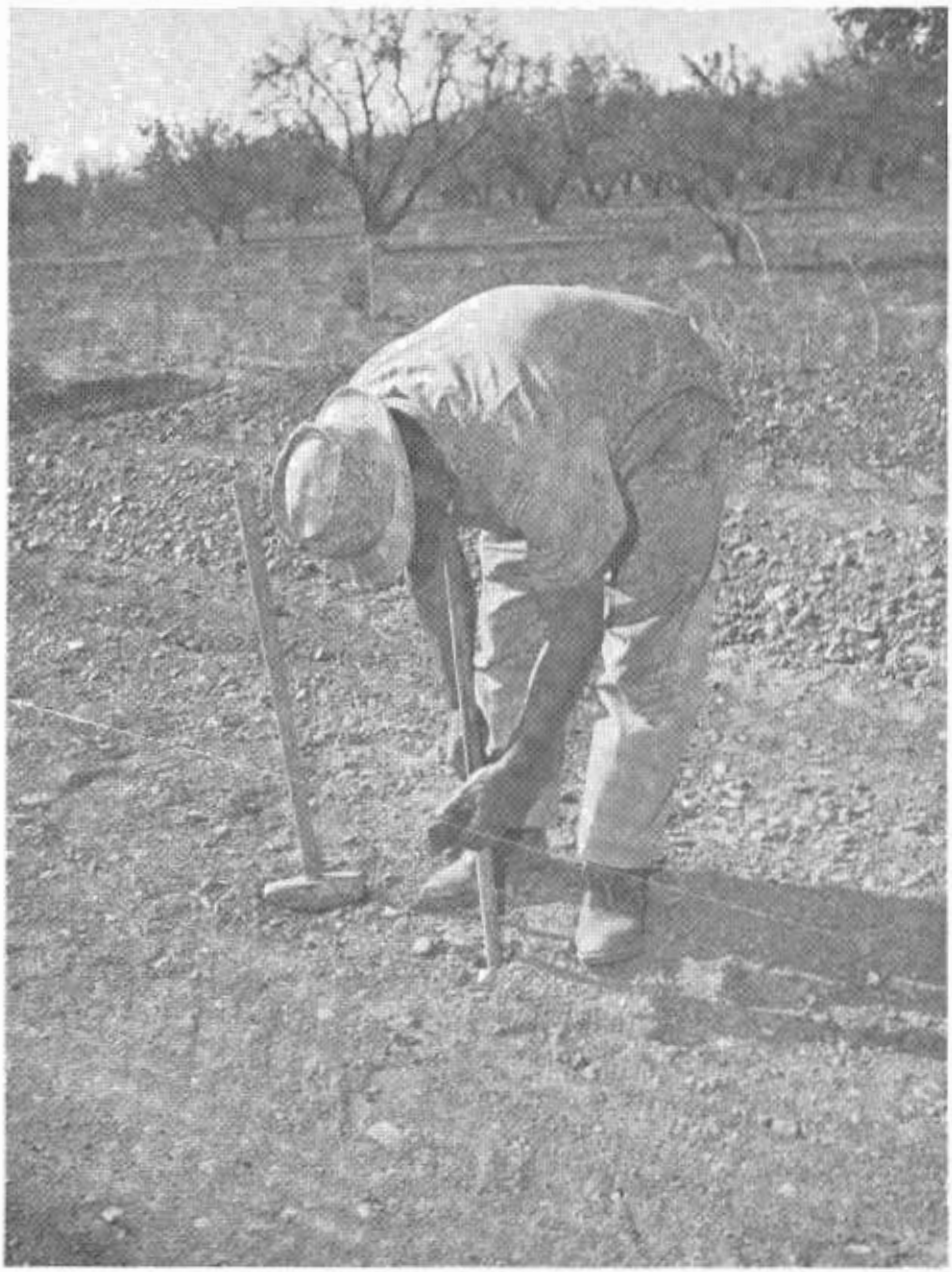
Contract 59-6TC10-F, road VI-Fre, Mad-4-C,A, Griffith Company, contractor. This project, located immediately north of Fresno, includes construction of approximately 15½ miles of 24-foot wide P.C.C. pavement, 7.705 miles of four-lane divided freeway, requiring 47,400 cubic yards of Class B concrete.

The two contracts with Ball which adjoin as indicated above, were adapted to a continuous paving operation from

one end to the other and were in many aspects equivalent to a paving project approximately 20 miles in length amounting to a total of 64,960 cubic yards of concrete.

Paver Described

The slip-form paver used consists essentially of two self-propelled crawler track assemblies with treads 20 inches wide and 18 feet long which support the main body through four heavy duty hydraulic rams, two at each track assembly. The main body consists of the structural support members, a traveling receiving hopper, a fixed full width feed hopper, full width transverse vibrating tubes mounted in the throat of the feed hopper, a primary screed or extrusion meter which is full width and 80 inches fore and aft, a secondary screed or transverse float which is full width and approximately 24 inches fore and aft, a transverse weakened plane joint cutting bar mounted between the primary and secondary screeds, slab depth side forms 15 feet long beneath the main body, a "V"-shaped finish float at the rear, a longitudinal weakened plane joint cutter mounted near the apex or leading end of the "V" float, a timing device at the rear of one track assembly for automatic interval control of transverse weakened plane joints, a 100-kva. diesel generator power supply, a control panel for the operator, and an electrical guidance system. Multiple lengths of trailing forms 15-feet each are attached as necessary to the rear end of the side forms beneath the main body.



A tensioned piano wire is installed to guide the slip-form paver.

Reinforcing Steel Used

In order to provide for installation of 30-inch lengths of No. 4 reinforcing steel as tie bars across the longitudinal center joint an apparatus was developed on the job prior to start of work on the initial District III contract. This apparatus attaches to the front plates of the feed hopper and consists of two reels of baling wire and a drum guide arrangement.

The device is designed to feed two strands of baling wire over the guide drum and into the center of the slab at middepth. Adequate room is provided between the reels of baling wire and drum guide for an operator to affix tie bars at 30-inch intervals by twisting a strand of baling wire around each end of the bar.

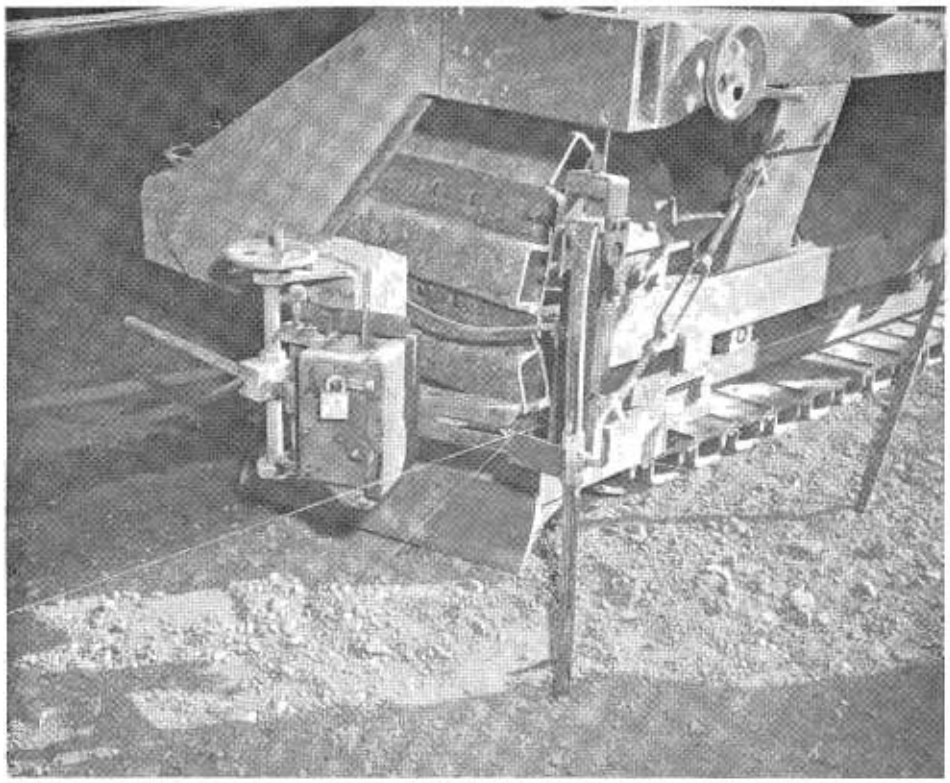
Steady but light tension is maintained in the baling wire by the forward advance of the paver operating against the resistance of previously installed bars.

Perhaps the most important distinguishing characteristic of this slip-form paver is the guidance system which maintains the machine on predetermined alignment and grade for the completed pavement.

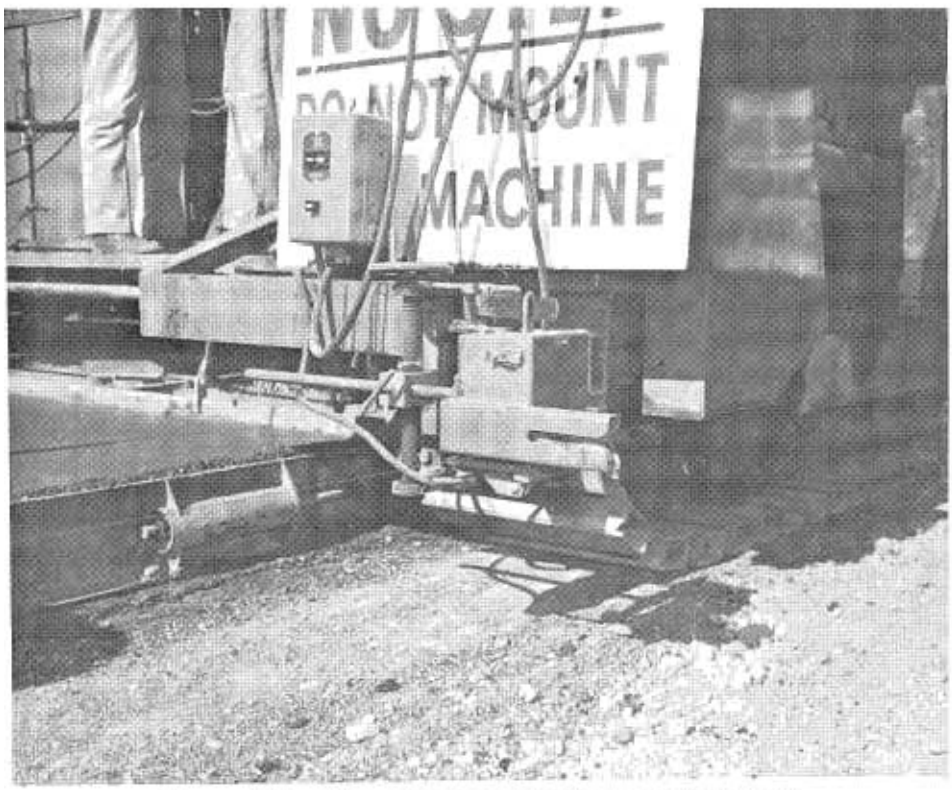
Such guidance is accomplished through the use of a meticulously accurate installation of two lines of tensioned 16- or 18-gage piano wire at pre-established and constant lateral and vertical offset from each edge of pavement. These wire lines serve as guides for the paver.

Feelers Actuate Switches

Sensing elements which operate along these wire guides are attached to the main body of the paver and consist of a slotted feeler, which straddles the wire, together with sensitive limit switches which are actuated by the feelers.



A close-up of the paver showing the left front elevation control probe passing by a stake with the steering control probe just behind the stake.



A close-up of the right rear elevation control probe on the slip-form paver.

Five of these sensing elements, or probes as they are referred to, are used. Four are mounted with the feeler in horizontal configuration and furnish elevation control while one element is mounted with the feeler in vertical configuration for steering control.

Probes for elevation control are mounted at each corner on the main body by extension arms which position the elements around and clear of the track assemblies so that the feelers are over the wire guides.

Each elevation control probe triggers the operation of one of the hydraulic rams. When a signal is transmitted from any one of the probes the hydraulic ram corresponding to the position of that probe either raises or lowers. In raising or lowering, the ram moves the corresponding corner of the main body of the machine up or down which, since the probe is attached thereto, repositions the probe in relation to the wire guide and ends the signal for correction. As the main body of the machine raises or lowers the screeds are raised or lowered also because they are attached integrally thereon.

The cumulative effect of the operation of all four elevation control probes is to continuously maintain the screeds of the paver in proper attitude and position in respect to the preset wire guides.

Automatic Control

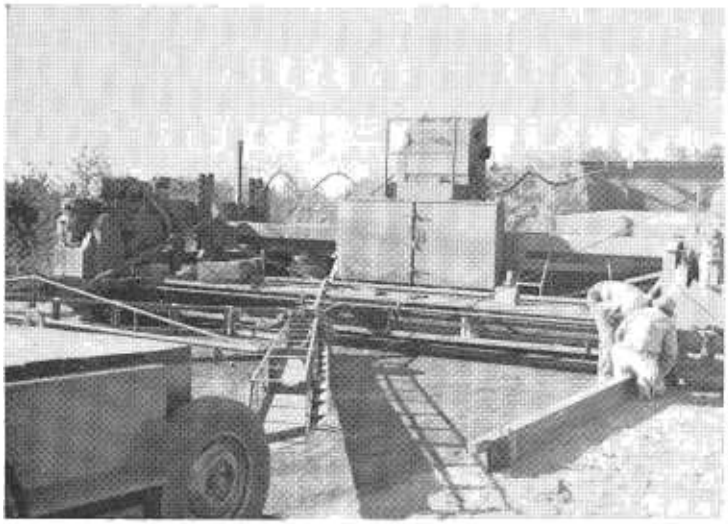
Alignment or steering control is provided through the operation of one probe which can be mounted at either forward corner of the paver. This probe furnishes control automatically over the differential speed of the two independently propelled track assemblies.

Subgrade Preparation

Gordon H. Ball, Inc., forces began construction of cement treated subgrade on the job near Woodland (60-3TC9-FI) in September and completed this work for the entire contract, 210,000 square yards, in eight working days. All C.T.S. construction was performed before starting the paving operation.

Subgrade construction consisted of cement treating four inches of 1½-inch maximum untreated base aggregate, 26 feet wide.

Elimination of side forms by the slip-form operation enabled construction of the cement treated subgrade 12 inches beyond the edges of the



A rear view of the slip-form paver.

The belt conveyor discharge for the paving mixers.

concrete pavement on either side for better control of edge pumping by the completed slab.

The material to be treated was already in place on the roadway. Thus construction procedures consisted of: (1) bringing the top of compacted untreated material to proper grade and cross-section; (2) loosening and forming the top four inches into two equally sized windrows side by side on the roadbed; (3) distributing the proper quantity of cement into notches formed in the top of each windrow; (4) mixing; (5) spreading and compacting; and (6) finish grading to final grade and cross-section.

Normal procedure for header board paving involves similar general procedures for subgrade construction; however, conventional subgrading equipment operates on the side forms. For slip-form paving such side forms are not used and different methods become necessary. Furthermore, very accurate subgrade both under the track assemblies as well as under the pavement is needed for optimum performance of the paver and minimum overrun of concrete quantities.

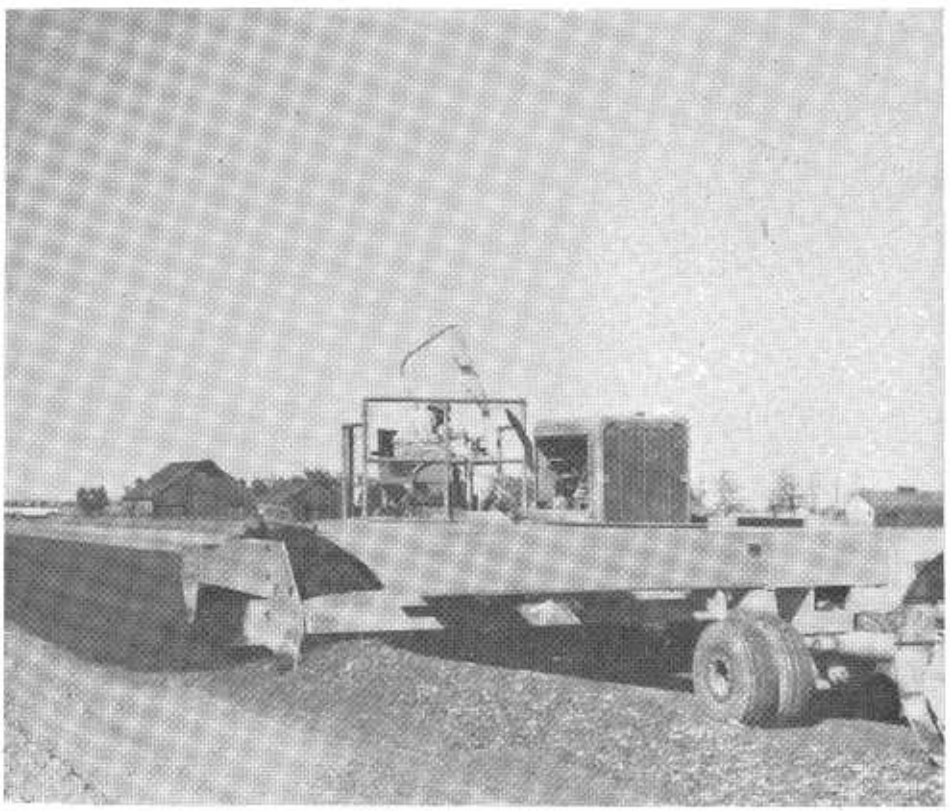
Longitudinal Space Reduced

Ball's method was to do initial grading and windrowing with a motor grader operated to blue tops set by his forces from the engineer's control stakes. Control stakes were set at the lateral offset of 3.71 feet, which would conform to the offset of the control wire to be installed for the subsequent paving operation, at the elevation for bottom of pavement, and at 50-foot interval along line. Where vertical curves were encountered the longitudinal interval between control stakes was reduced to 25 feet.

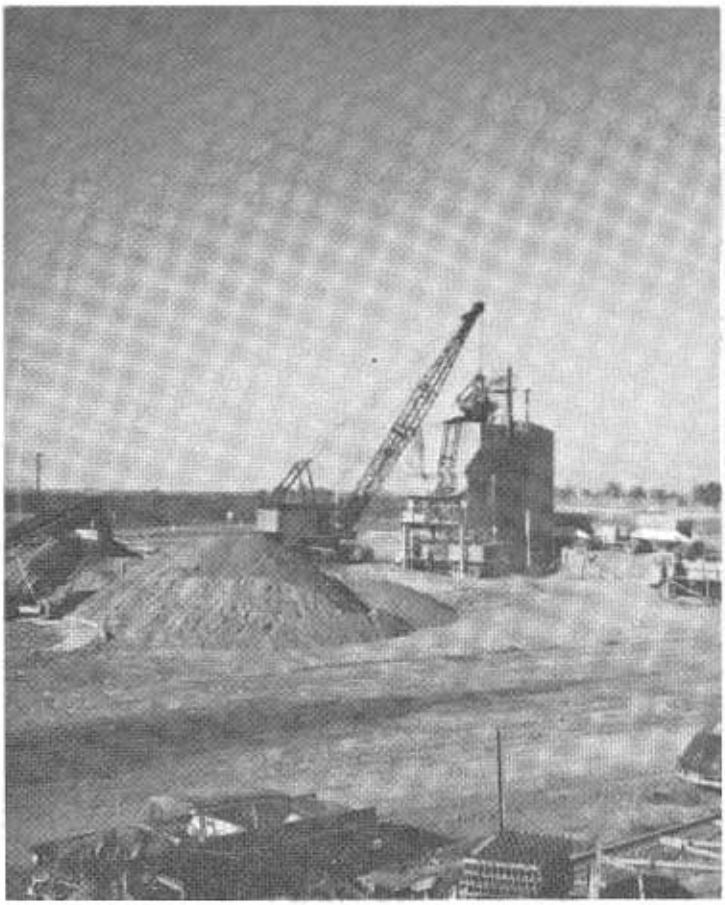
Cement was distributed on the windrows with a distributor and mixing was accomplished with a large self-propelled road mixer. Initial spread of the mixed subgrade materials was accomplished with a spreading device on the mixer.

Following initial compaction a tractor-towed spreader with automatic hydraulic controls for control of cross-slope and longitudinal grade was employed to perform finish grading.

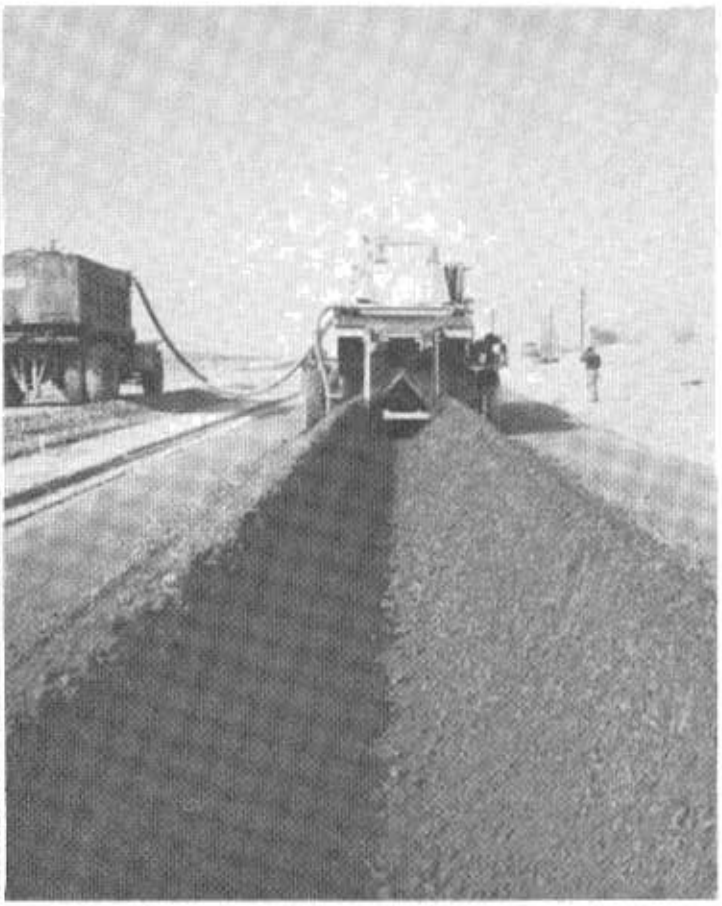
During the operation of this tractor-towed automatic spreader, Ball's stak-



A tractor-towed spreader with automatic hydraulic controls does the finish grading of cement-treated subgrade.



A triple batch plant set up for the Vacaville-Dunnigan Cut-off project near Winters.



A rear view of a mixer discharging cement-treated subgrade material.

A front view of a mixer for cement-treated subgrade showing the bucket conveyor.

ing crew kept constant check of both the finished grade and the cross slope by use of templates.

With the application of an asphaltic curing seal the subgrade was ready for pavement construction.

Construction of cement treated subgrade by Griffith Company on their contract near Fresno varied from that described above. In this instance the materials to be treated were not already in place when the operation was started but were imported and spread in a single windrow through an enlarged spreader box as part of this phase of work. Cement was distributed to this single windrow with a distributor similar to that used by Ball; however, the most significant change was in the equipment used for mixing.

Assemble Self-propelled Unit

In order to mix the outsized windrow comprising all materials for a 4-inch-deep treatment 26 feet wide, Griffith employed a self-propelled

pugmill mixer assembled by their own forces.

This unique machine, labeled irreverently by someone as "the Monster," elevates all materials in the windrow by bucket conveyor onto an overhead enclosed belt which feeds the forward end of a double-shafted pugmill mixer. Mixed materials are discharged onto the subgrade in twin windrows.

Spreading and compaction is performed conventionally with blade and rollers and final grading is performed to blue tops by a blade with automatic control.

Paving Operation

For his jobs in Districts III and X, Ball utilized a triple batch plant. Initially this plant was charged by a single clamshell shovel. During later stages of the work a belt conveyor was added for charging the sand.

Pay Loads Maintained

For transporting the dry batches to paving mixers on the grade Ball utilized his big fleet of fast and large batch trucks with specially designed six-batch bodies. This efficient lineup of batch trucks with their driver-controlled air-actuated batch gates and big pay loads maintained a fast-paced schedule and eliminated the conventional dump men at each mixer.

Mixing was performed by a pair of dual drum pavers. And, in keeping with the multitude of other innovations on these three spectacular jobs, each mixer was modified to discharge the mixed concrete by belt conveyors instead of the usual bucket.

These 30-foot self-driven belt conveyors were specially constructed and were mounted on reinforced booms controlled by the mixer operator.

The two mixers are operated on the pavement subgrade side by side immediately in advance of the slip-form paver. Openings at approximately 500-foot intervals are made in the wire guides to permit ingress and egress of the batch trucks which line up on the subgrade in front of the mixers.

As paving progresses this entire equipment train progresses down the grade at approximately eight feet per minute. When one opening in the wire guide is passed by the batch trucks and another is opened up, workmen quickly splice in the missing portion of wire and the operation continues without interruption.

The slip-form paver with its insatiable appetite sets the pace for the entire operation.

Each mixer moves forward six or seven feet between each batch while the skip is in the up position. This puts them in position to discharge the succeeding batch into the receiving hopper of the slip-form paver while the mixer is stationary and the paver steadily advancing.

Delivery Rate Varies

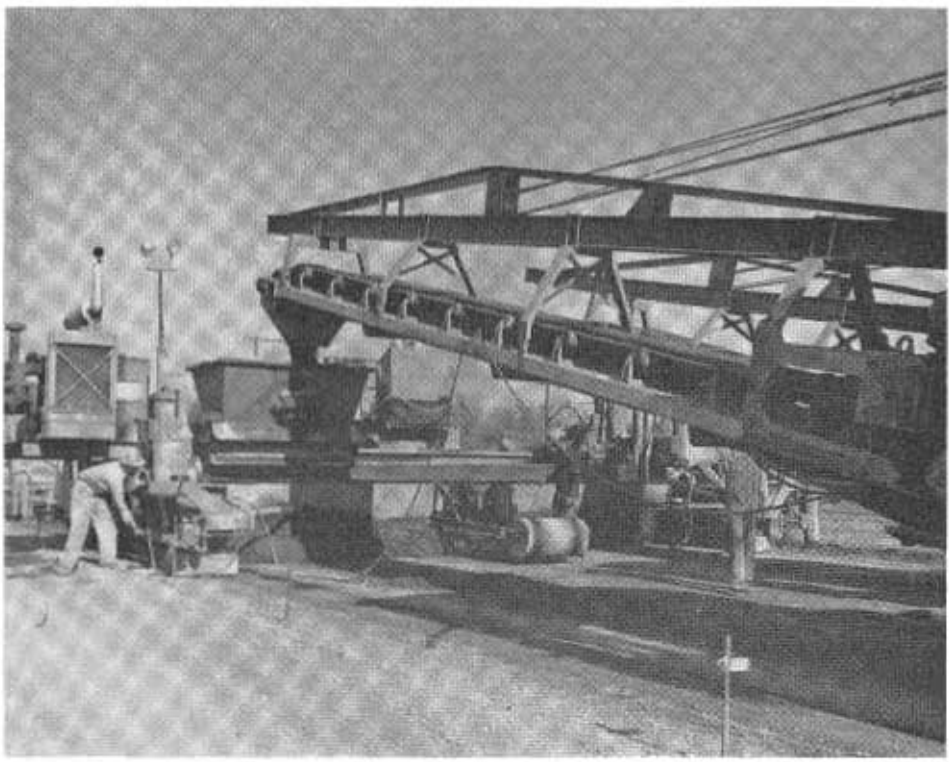
In order to compensate for variations in the rate of delivery of mixed concrete the paver is provided with controls at the operator's position for varying the speed from zero to maximum paving speed of approximately 15 feet per minute. This is a rheostat control for electric propulsion motors with smooth and infinite change of speed within the range. Maximum forward travel speed is 32 feet per minute.

Upon discharge of concrete into the receiving hopper the operator distributes it laterally into the feed hopper below by propelling the receiving hopper from side to side and opening the gate thereon.

Concrete is vibrated from the feed hopper under the primary screed and

A close-up of the slip-form paver showing the right rear hydraulic ram in the center of the photo.

A device for installing reinforcing steel as tie bars across longitudinal weakened plane joints.



A paving mixer charging the slip-form paver during operations on the Vacaville-Dunnigan Cut-off job.

consolidated into place as the paver moves forward.

At pre-established intervals, as determined automatically by the timing unit, a vibrating tee iron transverse joint cutter is hydraulically rammed into the fresh concrete. This produces a ⅜-inch-wide groove approximately three inches deep in the pavement. Since the joint cutter is located between the primary and secondary screeds the second screed irons out any irregularity in the surface caused by cutting the groove.

Immediately behind and centered on the secondary screed a vibrating tool is installed to cut the longitudinal centerline joint. This device produces a groove approximately ⅜-inch wide and two inches deep down the center of the 24-foot wide pavement.

Trailing Forms Needed

Attached to the side forms beneath the main body of the paver are 30 to 45 feet of trailing forms on each side. Actually the length of trailing forms can be varied readily by simply attaching additional lengths. Under the conditions encountered on the District III and X jobs it was found that 30 feet of trailing forms is adequate.

Floating freely on the surface of the fresh pavement between the trailing forms a "V"-shaped float is towed by an attachment at the apex. This chevron float acts to establish the desired finish on the pavement and floats out many minor deviations particularly at the transverse weakened plane joints.

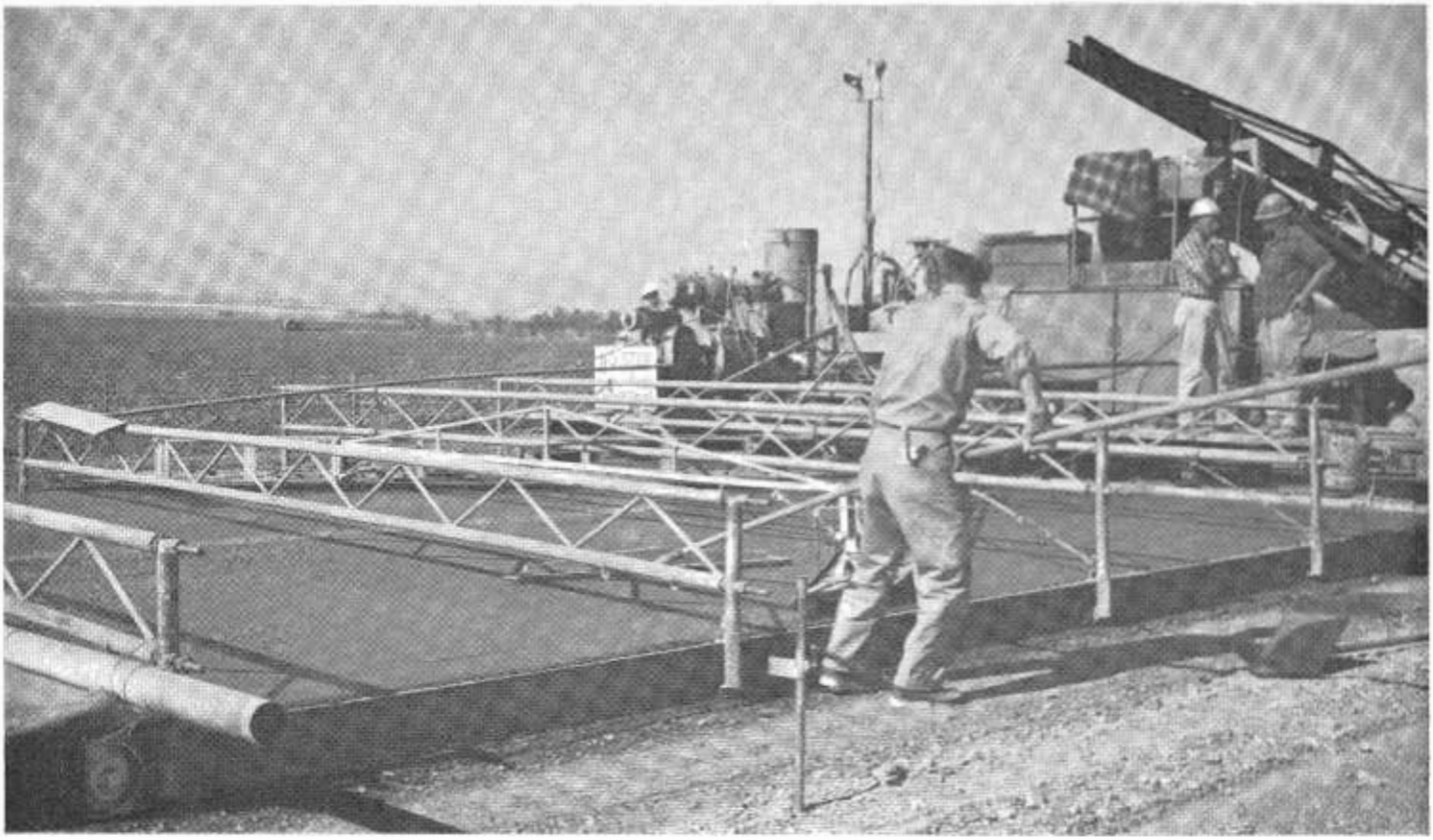
Attached just aft of the apex of the chevron float a simple jointing tool finishes the longitudinal joint which on the Ball contracts was left an open groove.

Edging and any necessary hand-floating and finishing is performed between the trailing forms and behind the chevron float.

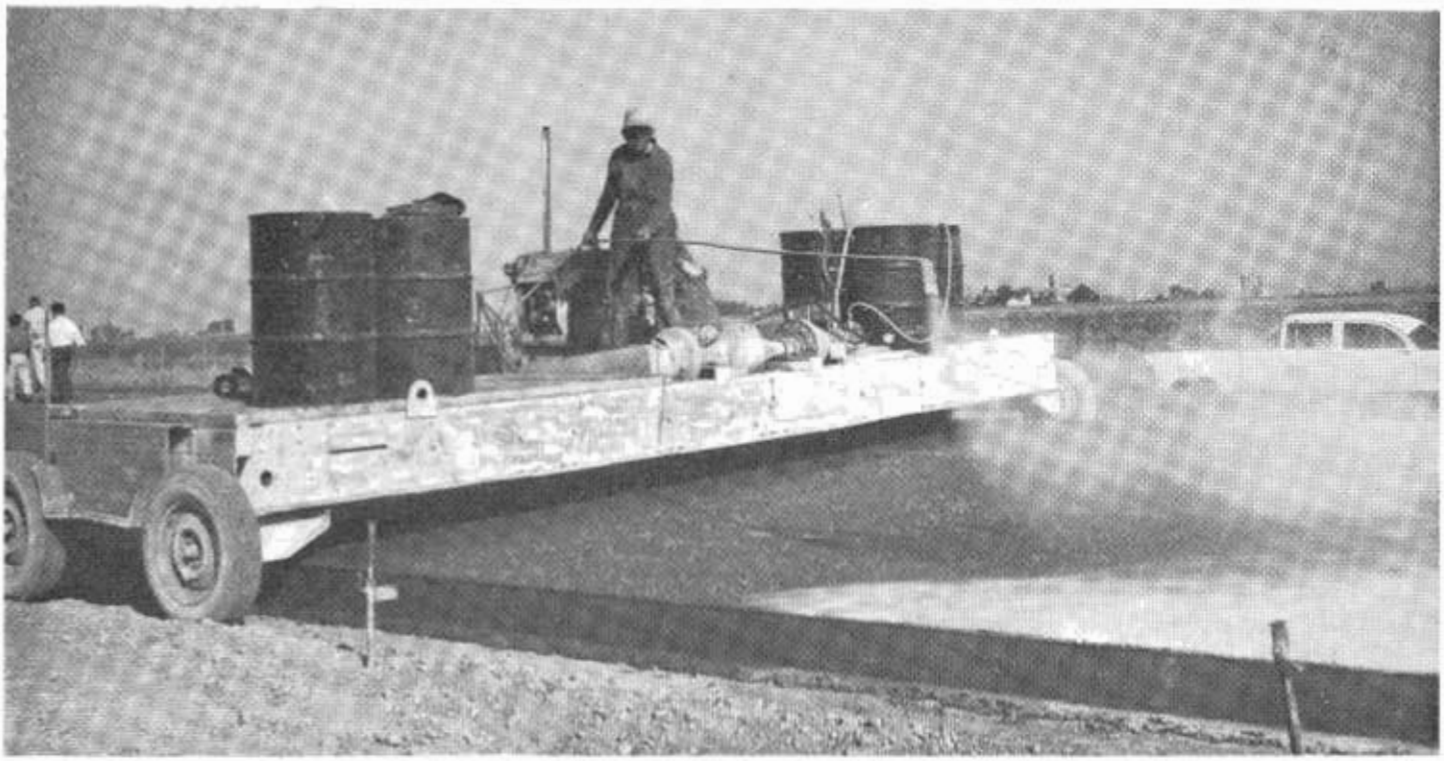
One burlap drag attached to the rear trailing form cross brace followed by a second burlap drag pulled by hand 10 or 15 minutes later completes the finishing operation.

Curing Seal Applied

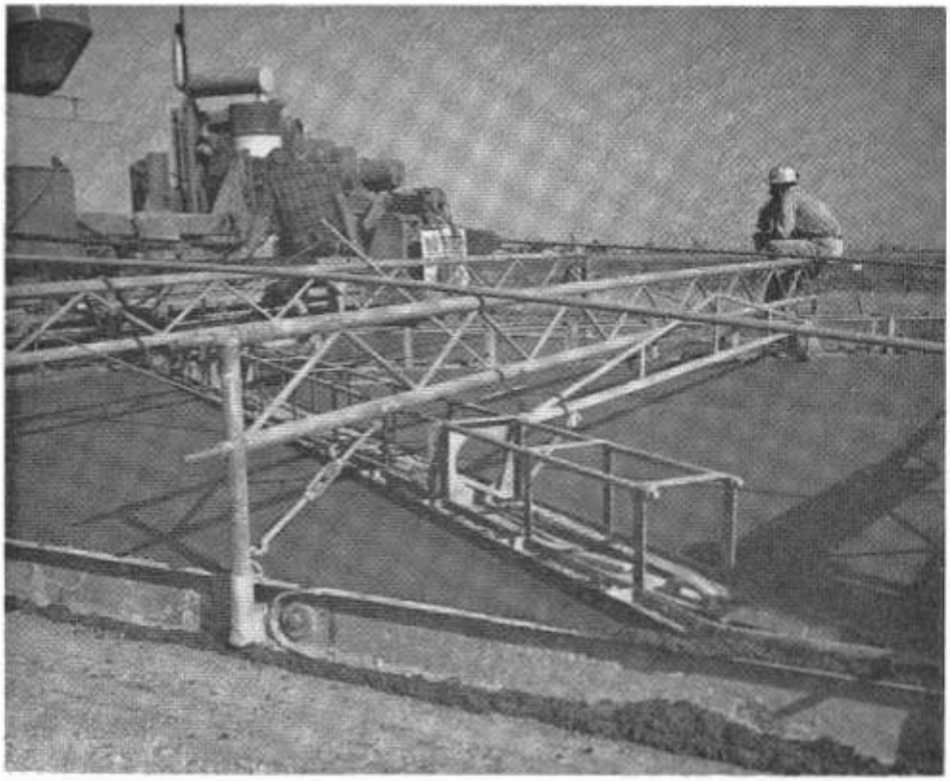
A pigmented compound is applied by hand-operated spray bar at one gallon per 150 square feet as a curing seal. To enable the spray operator to be in position to reach both sides of the pavement a self-propelled bridge is used. The traveling bridge is steered by a simple braking system through an automotive rear axle drive assembly. Efficient operation requires one oper-



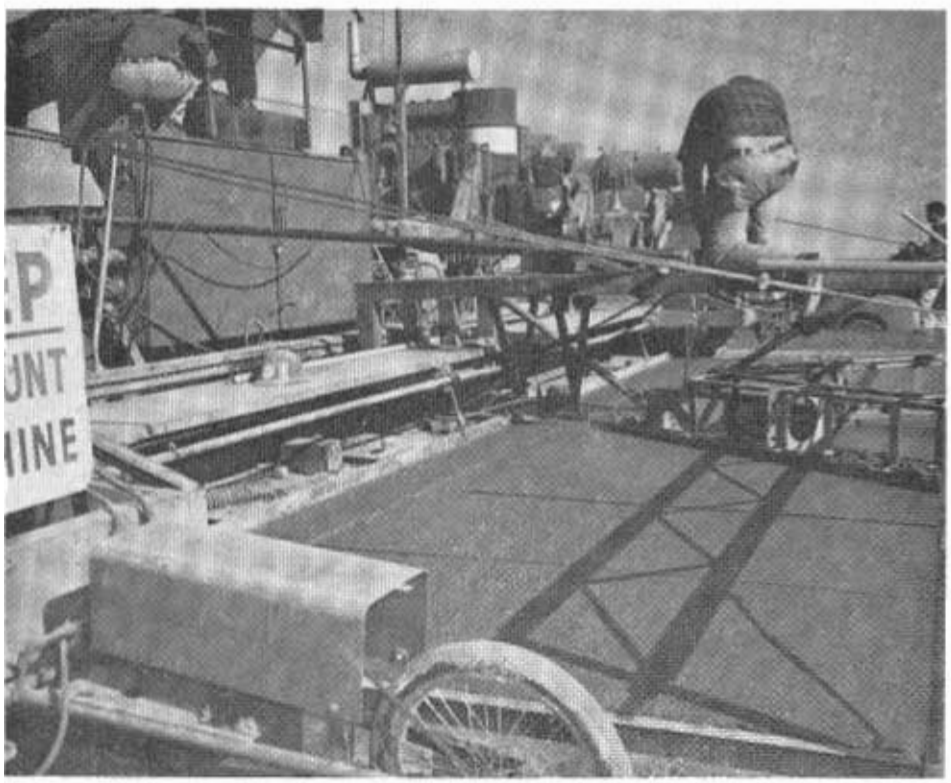
Hand-finishing and edging between the trailing forms.



Applying pigmented curing compound from a self-propelled bridge.



A view of the paver showing the "V" float between the trailing forms.



A close-up of the paver showing a device cutting longitudinal weakened plane joint at the center of the picture.

ator to steer and one to apply compound.

Job superintendent for Gordon H. Ball on his District III contract for $1.4 million is Merrill Dubach; paving superintendent is Bill Appel; and paving foreman is Bill Southworth. Hal Lopez is resident engineer for the State Division of Highways, and Bill Cruthirds is paving inspector.

Ball's personnel on the District X contract for $1 million are the same, and George Demetrus is resident engineer for the State, with Don Pontius as paving inspector.

Job superintendent for Griffith's contract for $3.2 million in District VI is Ernie Arant; paving superintendent is Gordon McGrew; and paving foreman is J. Bittner. Nelson Humiston is resident engineer for the State, and Carl Haney is paving inspector.

Smoky Buses, Trucks Will Be Controlled

Governor Edmund G. Brown has announced a campaign to remove "visible smoke and oily soot from smoky buses and trucks" from the State's highways, especially where they pass through populated areas.

He said he is making an urgent request to trucking firms and bus operators, asking them to bring all such vehicles into compliance with existing state laws on the subject by February 15, 1960.

The Governor said he has set that date for a stepped-up enforcement campaign by the California Highway Patrol.

Governor Brown said that he has been assured by technical experts that excessive smoke can be cleared up by proper engine adjustment, and, in the case of some diesels, by proper fuel.

He said the 60 days between December 15 and February 15 would give operators plenty of time to make necessary adjustments to comply with the law. The Governor said that adequate methods of measuring smoke density are already in use by the California Highway Patrol.

California Highways...1959

An Annual Report

By J. C. WOMACK, State Highway Engineer

The report which appears on pages 29 through 44 basically covers the 1958-59 fiscal year, but has been revised to include important developments extending to December 31, 1959. Copies of this report may be obtained upon request.

CALIFORNIANS have built a thriving economy and a bountiful way of living on a foundation of mobility—freedom of movement afforded by millions of cars and trucks.

Favored with diverse industrial resources, expanses of rich farmland, vast recreational areas, and a mild and generous climate, the people of this State have called upon motor transportation and good roads to bind these assets into a great and dynamic society.

Today the automobile has an essential role to play in nearly everything Californians do. The family car serves as a combination shopping cart, commute bus, dump truck, and vacation liner; and heavy transport vehicles and smaller trucks carry produce, raw materials, and goods to the manufacturer and the merchant.

These close ties between motor transportation and day-to-day living help to explain why there are more cars and trucks in California than in any other state.

Motor vehicle registration is now nearing the 8,000,000 mark, slightly more than one car or truck for every two of the State's 15,550,000 citizens. Last year Californians traveled an enormous total of 65 billion miles on the State's roads, streets, and highways.

The present reliance on highway travel will become even greater as the State's population and traffic continue to increase.

Conservative estimates indicate that by 1980 there will be twice as many cars and trucks as now on the road in California, and the number of miles covered each year on the State's roads, streets, and highways will be about three times greater.

This new section of U. S. Highway 40 sweeps in graceful curves through the rugged terrain of the Sierra-Nevada east of Colfax. Several large-scale freeway projects were completed on this major Interstate Highway in 1959.

Recognizing the importance of adequate highways to serve the acute motoring needs of the present, as well as the demands of the future, Californians have given continuing support to an extensive program of state highway improvement while exploring additional methods of transportation such as rapid transit.

On the basis of several comprehensive traffic and financing studies since World War II, the State Legislature

has implemented pay-as-you-go highway development through realistic user taxes.

A recent overall study of this type was the basis for the California Freeway-Expressway System which was adopted by the 1959 Legislature. This statewide master plan calls for construction by 1980 of a 12,400-mile network of controlled access highways reaching into every corner of the State.

While exerting leadership in these long-range planning matters, the Legislature has continued to delegate to the California Highway Commission the authority and responsibility for determining highway routes and allocating construction funds.

These legislative policies have insured the continuity of the highway program, making possible the steady and orderly construction progress which has given California a system of highways often described as the best in the nation.

Today, California has more miles of toll-free multilane divided highway than any other state, and work is going ahead on new improvements as the State strives to keep pace with its still mounting highway needs.

The State Division of Highways, a unit of the Department of Public Works, handles the day-to-day administration of California's highway program, working in conformance with state law and policies of the Highway Commission. The division is in charge of all state highway planning, design, right-of-way acquisition, construction and maintenance. Its activities cover the entire range of highway work from large scale freeway and bridge construction to small but essential maintenance jobs.

State highway development and operation for the fiscal year ending June 30, 1959, are reported in the 13th Annual Report to the Governor by the Director of Public Works. That report contains sections on each phase of the highway program. It also includes detailed financial tabulations, contract statistics, and other data.

Some of this information, together with other more recent data, is included here.

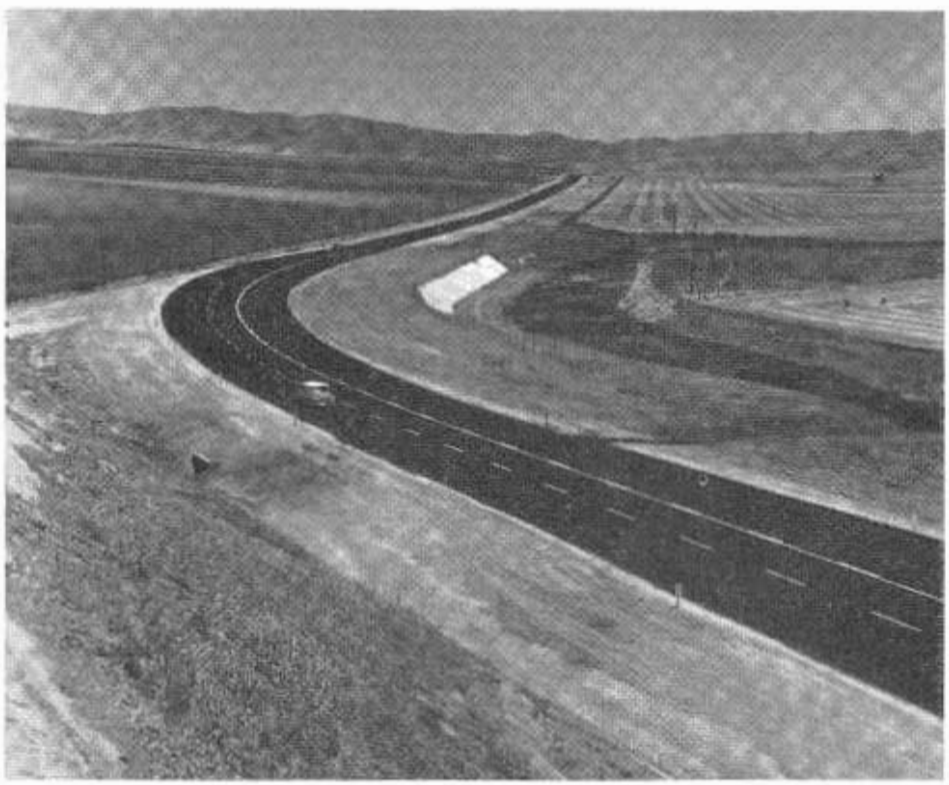
In 1959 there were significant developments in the major areas of financing, planning, construction, and highway research:

1. California suffered a $70-million setback, largest of all the states, as federal financing for the National Interstate Highway Program was cut back sharply.

2. Long-range prospects for highway development were brightened, however, when the Legislature adopted the monumental California Freeway-Expressway System master plan (Senate Bill No. 480).

3. Many long-awaited highway projects were completed, under construction, or budgeted to close freeway gaps on heavily traveled through routes or provide new links in the basic freeway networks of metropolitan areas.

4. The Division of Highways completed an important phase of continuing research on development of center strip barriers as a means of further improving the already favorable safety record of the State's freeways.



This new stretch of highway on State Sign Route 41 near Shandon in San Luis Obispo County was one of the many highway improvements completed last year in rural and scenic areas of California.

Financing Emergency

California's highway program weathered a period of acute uncertainty about federal financing in 1959 due to shortages in the national highway trust fund. Prospects for a time were so uncertain that it was necessary to suspend advertising for bids on new highway projects.

With the largest stake in the interstate program of any of the states, California faced the possibility of seeing its federal interstate highway apportionment plummet from $250,000,000 for 1959-60 to nothing at all for 1960-61.

Fortunately, this threatened total reduction did not come about. A partial solution to the federal financing dilemma was finally worked out in Washington. This compromise financing method, however, left California with about $70,000,000 less in federal funds than had previously been counted on for the 1960-61 fiscal year.

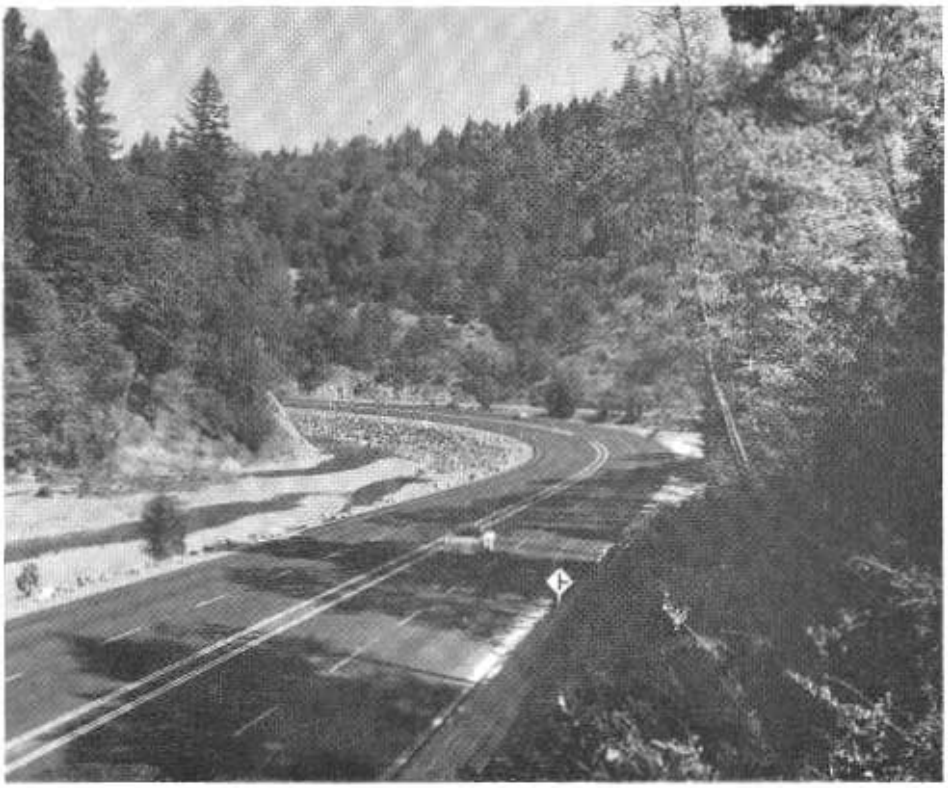
When the 1960-61 federal apportionment for interstate highways was announced last October, it included only about $180,000,000 for California instead of the $250,000,000 which had been expected under the schedule set by Congress in the Federal Highway Acts of 1956 and 1958.

The extensive revision of plans and schedules necessitated by the reduced federal apportionment is reflected in the 1960-61 State Highway Budget adopted in October 1959 by the Highway Commission.

Many important projects have been delayed. Right-of-way acquisition has been curtailed. The orderly processes of advance planning have suffered.

As Director of Public Works Robert B. Bradford pointed out in a recent address, the immediate federal financing crisis is ended and there is reason to believe that the interstate highway program will now go ahead on a sound basis and gradually regain its lost momentum.

"Some time in 1960," Director Bradford said, "we expect to be notified of our federal interstate apportionment for the 1961-62 fiscal year. We hope it will be based on a firm foundation. Certainly nobody wants to repeat the confusion and controversy of 1959. We know that congressional studies of various phases of the program, including financing, are under way, and we trust they will produce some sound fiscal results."



Freeway and expressway development on U. S. Highway 101, one of the State's main north-south traffic arteries, is proceeding at a rapid pace. This section of expressway in northern Mendocino County was opened last year.

Freeway-Expressway System

California became the first state to have an official long-range master plan for a statewide network of limited access highways on June 19, 1959, when Governor Edmund G. Brown signed legislation establishing the 12,400-mile California Freeway-Expressway System.

The plan calls for $10.5 billion in freeway and expressway construction during the next 20 years, assuming there is no change in the present highway financing structure. It was adopted by the 1959 Legislature in Senate Bill No. 480.

This measure was introduced by Senator Randolph Collier of Yreka, Chairman of the Joint Interim Committee on Highway Problems. It became effective September 18, 1959.

Governor Brown said the signing of the bill was "a momentous occasion in our State's history.

"This will eventually result in linking all cities of 5,000 or more persons, and it will carry 59 percent of the total vehicle travel when completed," the Governor said.

As adopted by the Legislature, the freeway-expressway system included 10,800 miles of highways which were already under state jurisdiction as part of the 14,000-mile State Highway System. An additional 1,600 miles of the freeway-expressway system routes were streets and roads maintained by cities and counties or new roads not yet built.

Over a 20-year period of use, the freeway-expressway system will return user benefits amounting to nearly twice the estimated $10.5 billion cost. This means savings in 20 years to the motoring public of some $20 billion.

Routes in the system have been designated by the Legislature in a general way. In most cases, only the termini have been named in law.

General legislative descriptions of this type will provide the guidelines for studies and public discussions leading to the adoption of more precise routes and decisions on details of design.

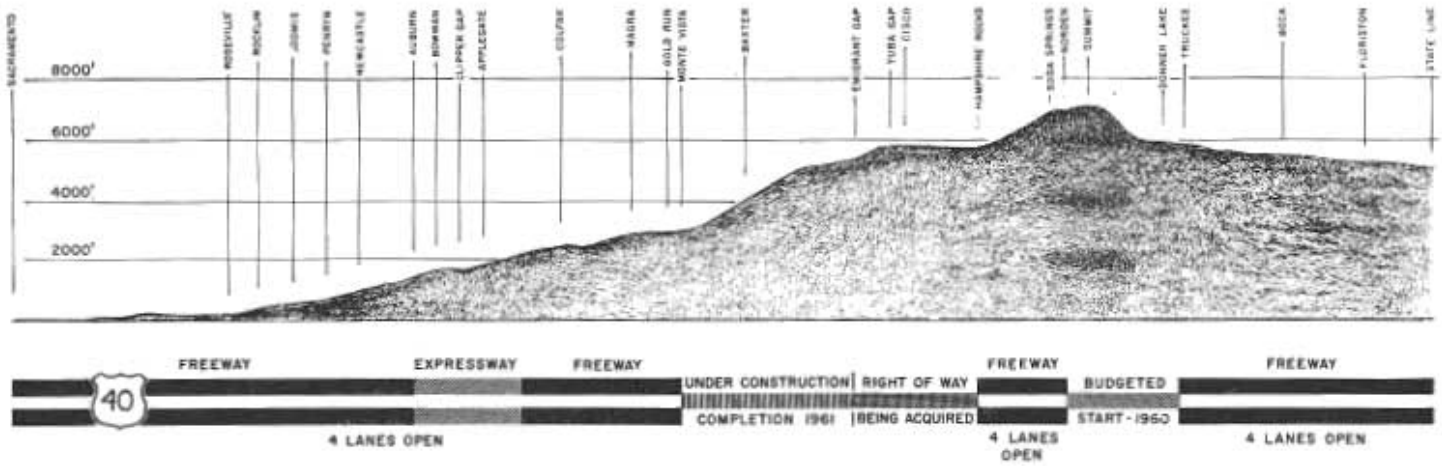
Standards for each of the routes, such as the number of lanes and the extent of access control, will vary with local needs and conditions. The type of facilities to be built will range from eight-lane full freeway in large population centers and on major through highways to two-lane expressways in sparsely settled areas where there is relatively little traffic.

Provision is also made for continuing review of the freeway-expressway system plans. The Division of Highways is required to submit a progress report to the Legislature every four years, beginning in 1963, and to suggest possible revisions as indicated by changing growth and economic patterns.

Suggested revisions are to be considered by the Legislature through its own committees and through advisory committees of city and county officials which the Legislature may appoint.

While work is progressing on routes included in the system, other state highways will not be neglected. The law calls for concurrent improvement of these highways according to relative deficiencies and traffic conditions.

Studies leading to the overall plan were requested by the 1957 Legislature in Senate Concurrent Resolution



No. 26. Two years of intensive work went into the plan, involving the most comprehensive analysis of motor vehicle traffic, population, and economic conditions ever developed in California for highway planning purposes.

The Division of Highways worked closely with other agencies in preparing the plan. A Legislature-appointed committee of city and county officials acted in a technical advisory capacity. County and city planning and engineering staffs extended full co-operation. The Automotive Safety Foundation of Washington, D.C., and the Institute of Transportation and Traffic Engineering of the University of California also assisted.

Construction Progress

Hundreds of highway construction projects were completed throughout the State in 1959, and at the end of the year many others were under construction or budgeted.

By the end of 1959, California had 2,147 miles of multilane divided highway in operation and another 235 miles under construction, as compared to 1,973 miles in operation and 359 under construction a year earlier. An increasing percentage of this divided highway mileage was of the full freeway or expressway type.

The construction emphasis continued to be on the development of full freeways. Experience with various highway designs, both in California and elsewhere, has repeatedly shown that freeways carry more traffic with greater safety than any other type of highway; and unlike other highways, the capacity of freeways is not reduced by the development of roadside businesses and subdivisions.

These longterm dividends result from basic freeway design features—control of access, the elimination of cross traffic and left turns in front of oncoming vehicles, and the separation of opposing traffic by a dividing strip.

Californians were driving on 760 miles of completed full freeways by the end of 1959. Another 187 miles were under construction.

Also in operation at the end of the year were 840 miles of expressway—divided highway with most of the features of a freeway, but with some intersections at grade.

Most expressways are designed for future conversion to full freeway status. A number of controlled-access two-lane highways (two-lane expressways) have also been completed in recent years, mainly in rural and mountain areas where traffic is comparatively light.

In the Los Angeles area large-scale freeway projects were completed in 1959 on the Ventura, Golden State, Riverside, San Diego, Santa Ana, and Santa Monica Freeways.

Current construction activity is being concentrated on a number of key routes in order to speed progress toward an integrated freeway network for the entire metropolitan region and to relieve traffic pressure on existing central area freeways in the vicinity of the Four-Level Interchange.

At year's end a spectacular series of high-priority projects was in progress or budgeted on the portions of the Golden State and Santa Monica Freeways which will form the long-planned "East Loop" bypass around the central district.

This close-in bypass will extend from San Fernando on the north to the Harbor Freeway south of the civic center, providing an alternate route for a great deal of the traffic now using existing downtown freeways.

One of the most complex projects along this route was under way at the end of 1959—construction of the mammoth East Los Angeles Interchange. This interchange will connect the Golden State, Santa Monica, and Santa Ana Freeways and the proposed Pomona Freeway.

On the San Diego Freeway, another key route in the regional freeway system for the Los Angeles area, projects were in progress or budgeted to complete 14.3 miles of freeway from Culver City to north of the Ventura Freeway and nine miles from Torrance to near Long Beach. Considerable grading and structure work on other sections was also provided for in the budget.

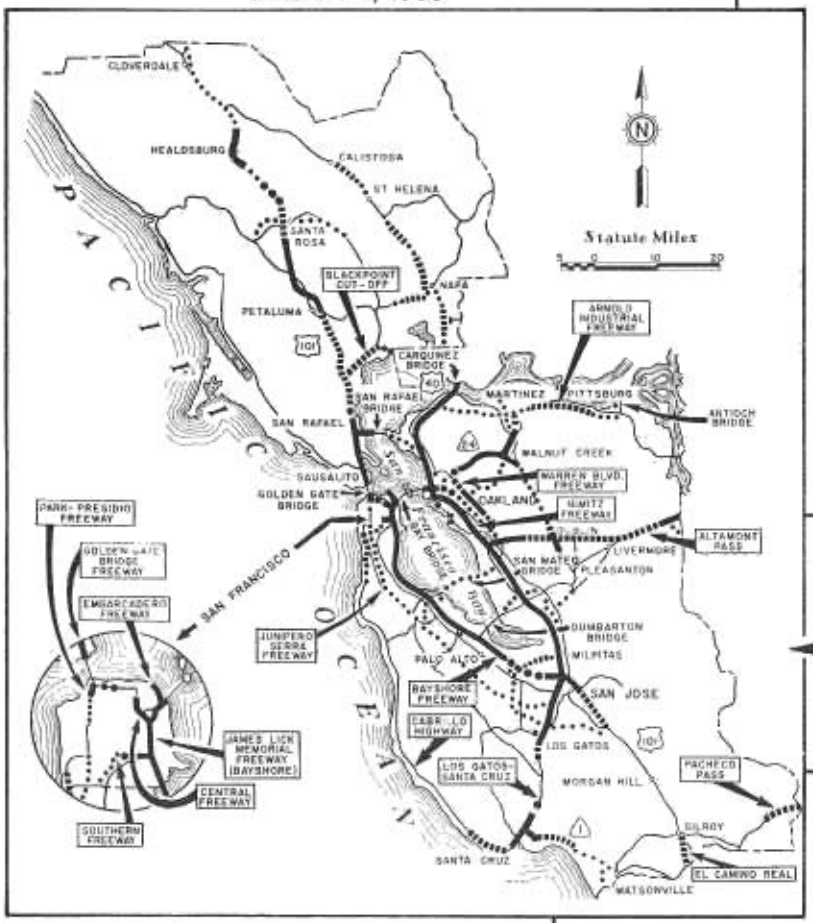
Work was continuing on a project to extend the Long Beach Freeway from the Santa Ana Freeway to the

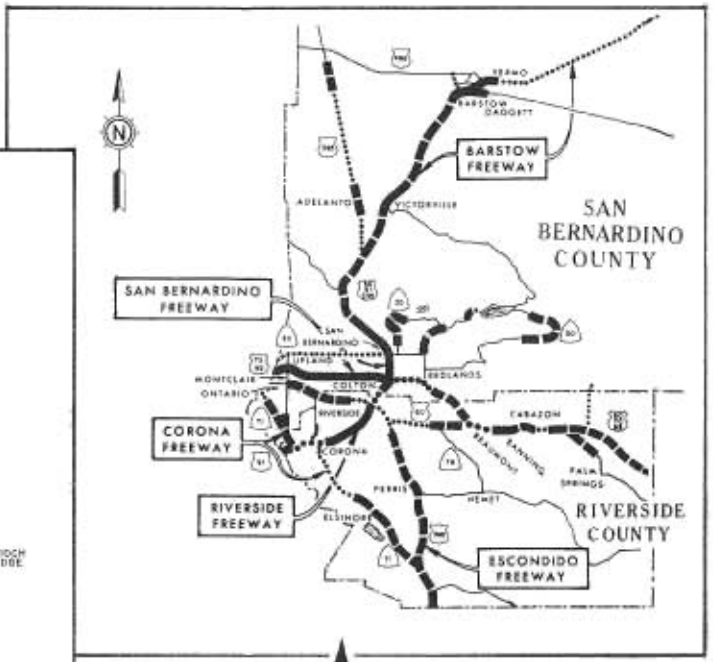
FREEWAY MAPS

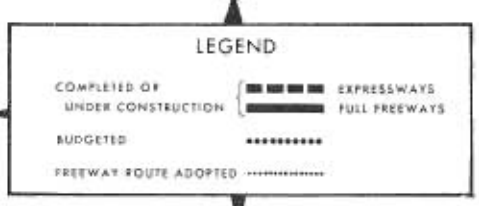
The maps on these pages show the expanding freeway and expressway networks in the San Francisco, Los Angeles, San Bernardino-Riverside and San Diego areas as well as the status of U. S. Highway 40 from the San Francisco Bay area to the Nevada state line.

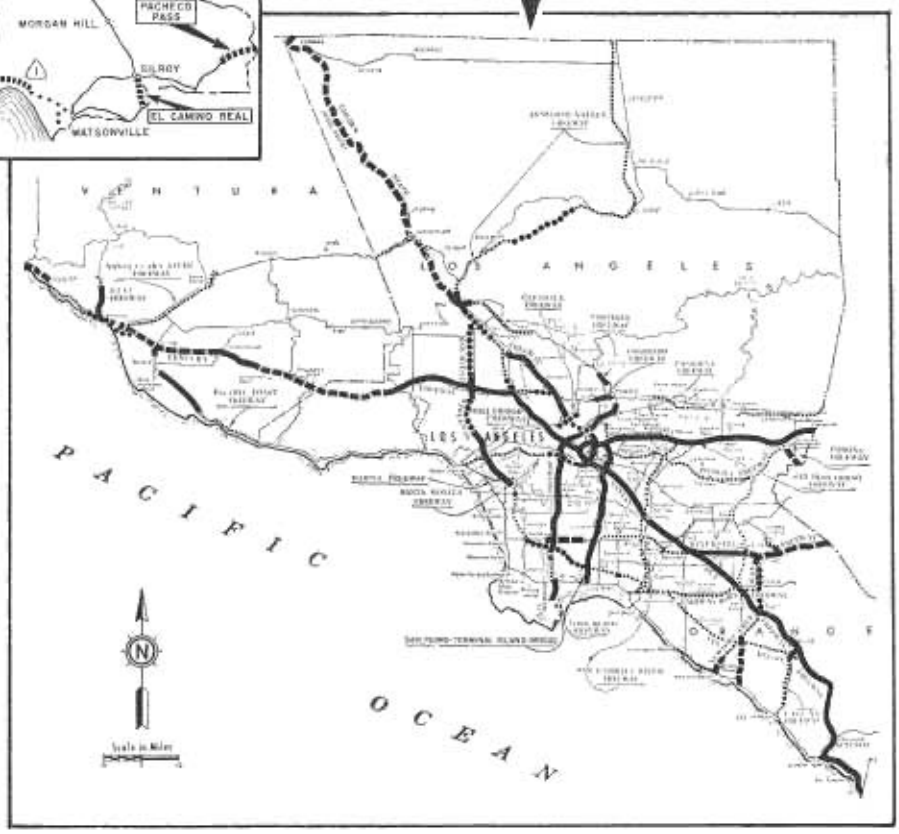
FREEWAY PROGRESS ON STATE HIGHWAYS

JANUARY 1, 1960









San Bernardino Freeway. A job was also under way on the Harbor Freeway which will carry freeway development on this route southerly to 190th Street.

Two nearly completed sections on the Ventura Freeway in the San Fernando Valley and a third under construction on the San Diego Freeway in Orange County will close the remaining gaps in 90 miles of continuous full freeway on US 101 between San Clemente and the west city limits of Los Angeles. A freeway project on US 101 in the City of Ventura was advertised for bids late in the year.

The last expressway sections of the San Bernardino Freeway were converted to full freeway with completion of separation structures in San Bernardino County. Freeway sections were also completed through San Bernardino. A gap-closing freeway project on the Riverside Freeway was also completed between Colton and Riverside.

Several other large-scale projects were progressing in Riverside County, including freeway construction between Riverside and Corona. Nine miles of freeway was under construction on US 60-70-99 west of Indio, and a new bridge was being built over the Colorado River at Blythe. Work was beginning on a freeway through Barstow.

Bids were to be opened in February 1960 on a freeway project at Beaumont, and two newly budgeted projects will complete freeway development through Redlands on US 70-99.

In San Diego County work continued on the conversion from expressway to freeway on U. S. Highway 80 between San Diego and El Cajon, and work was completed late in the year on a freeway project on Sign Route 94.

Funds were budgeted for a portion of the north-south freeway on US 101 through San Diego and for freeway construction on Sign Route 73 near Escondido.

The rapid development of US 101 to freeway and expressway standards continued with new projects recently completed, under construction, or budgeted in each of the coastal counties between the Los Angeles area and the San Francisco Bay region, as well as in Marin, Sonoma, Mendocino, and Humboldt Counties to the north.

A long section of Sign Route 41-US 466 was improved to two-lane expressway standards in eastern San Luis Obispo County.

In San Francisco a new section of the Central Freeway was completed, and construction was going ahead on an initial unit of the Southern Freeway.

Bids were to be opened in January on the first unit of the MacArthur Freeway (US 50) in Oakland, and work was in progress on a second underwater tube (Webster Street Tube) between Oakland and Alameda. Funds were budgeted for an additional two-lane bore at the Broadway Tunnel on Sign Route 24 in Oakland.

Work started last year on the bond-financed Benicia-Martinez Bridge and approaches in Solano and Contra Costa Counties, and a contract was awarded in January on construction of an adjoining section of freeway on the Vallejo-Benicia Highway.

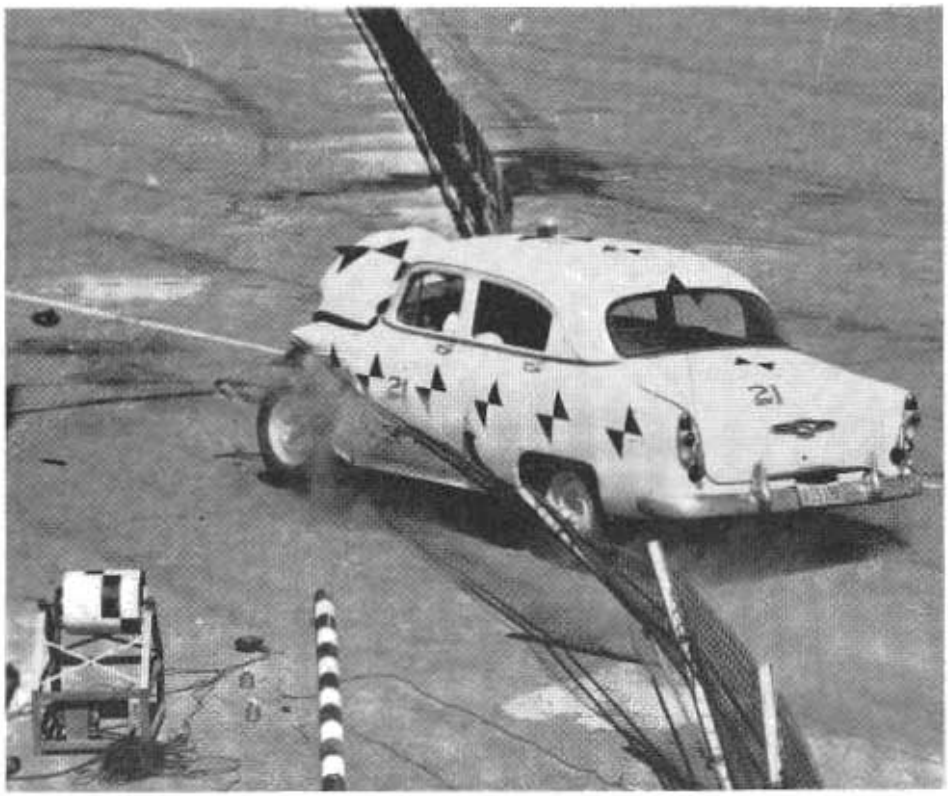
One project was completed and another nearly finished on the Vacaville-Dunnigan Cutoff (Highway Route 90) to provide the initial two lanes of a future freeway on a long section of this interstate route.

Between San Francisco and Sacramento nearly all of US 40 is developed to multilane divided standards. Projects to convert additional sections from expressway to freeway were budgeted or under construction.

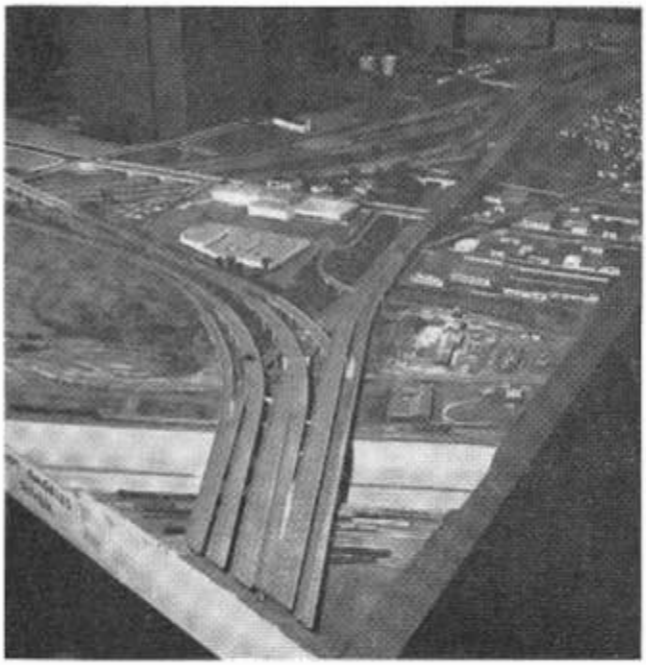
East of the State Capitol more improvements were completed on this interstate highway in 1959 than in any previous year.

Five new sections of full freeway, totaling 37.5 miles, were opened to traffic. At the end of the year only 35 miles of the old two-lane mountain highway remained, of which 13 miles was being converted to freeway in two construction projects.

On US 99, the heavily traveled north-south valley route, new freeway sections were opened south of Sacramento, and structures and grading had been constructed on the South Sacramento Freeway with additional



A series of impact tests was conducted in 1959 in connection with continuing research into the possible use of barriers in the center strip on freeways. A fence-cable barrier, shown as it successfully halts a radio-controlled sedan going 60 miles an hour, was one of the new barrier designs found to be most effective.



The design model (above) previews the future appearance of the East Los Angeles Interchange and the Los Angeles River Bridge (foreground) on the Santa Monica Freeway. Both are units of the future "East Loop" bypass. The interchange is now under construction, and the bridge (photo at right) was completed in 1959.

funds budgeted to complete this freeway section.

On the Stockton Bypass work was completed on some interchanges, and construction was also in progress on freeway units north of Fresno and on the Grapevine Grade in Kern County.

A new four-lane bridge to replace the old and substandard structure over the Yuba River on US 99E at Marysville was nearly completed.

On the north state portion of US 99 projects were completed, under construction, or budgeted to provide 30 miles of continuous freeway and expressway in the Sacramento River Canyon from north of Shasta Lake to north of Dunsmuir. Another big project was under way north of Weed.

The projects listed are by no means all of the large-scale freeway and expressway jobs completed or in progress during the past year. There were also major reconstruction and realignment projects on major highways in rural and scenic areas, plus minor improvements and spot corrections on all types of state highways.

Freeway Safety Research

California's freeways for many years have had a better safety record than all the other types of highways in the state.

For the past five years, the fatality rate on freeways has been about one-third the rate on conventional rural highways, and the overall accident rate has been about one-half the conventional highway rate (see accompanying chart).

On top of this, freeways are tremendously efficient. In many instances, the daily traffic loads now carried by freeways could not be handled by any other type of street or highway. Sections of freeway in Los Angeles, for example, are now carrying an average of about 200,000 motor vehicles a day.

Because of the time-tested safety and efficiency of freeways, possible revisions in design must be approached with deliberate caution. A hasty change might do more harm than good.

Whenever a possible design revision is proposed—especially one related to safety factors—the division considers it in close detail, applying careful statistical and scientific methods in combination with long years of practical engineering experience.

One such design change which has been under study for several years is the possible use of some type of barrier in the center strip on freeways. This has often been proposed as a means of reducing cross-median head-on collisions. (This type of accident happens much less frequently on freeways than most people realize, but when it does it is often spectacular as well as tragic.)

In 1959 the division completed an extensive two-phase study of the median barrier problem, gathering data to supplement somewhat inconclusive studies of the past.

The extensive median barrier research project included a series of laboratory-controlled crash tests and a statistical and engineering analysis of a large number of accidents which occurred over a period of years on various types of divided highways.

The crash tests were conducted by the division's materials and research department. Fifteen different barrier designs were tested.

Passenger cars, and even a large bus, were smashed against a variety of barriers at speeds up to 60 miles an hour. The cars carried an instrument-equipped dummy. Special cameras and testing apparatus also recorded results.

Federal aid secondary county road six miles north of Callahan in Siskiyou County.

Extension of Central Freeway in San Francisco to Golden Gate Avenue near Civic Center.

New freeway alignment of Redwood Highway (US 101) with prizewinning bridge over Eel River. Old bridge at left retained for access to redwood groves and parks.

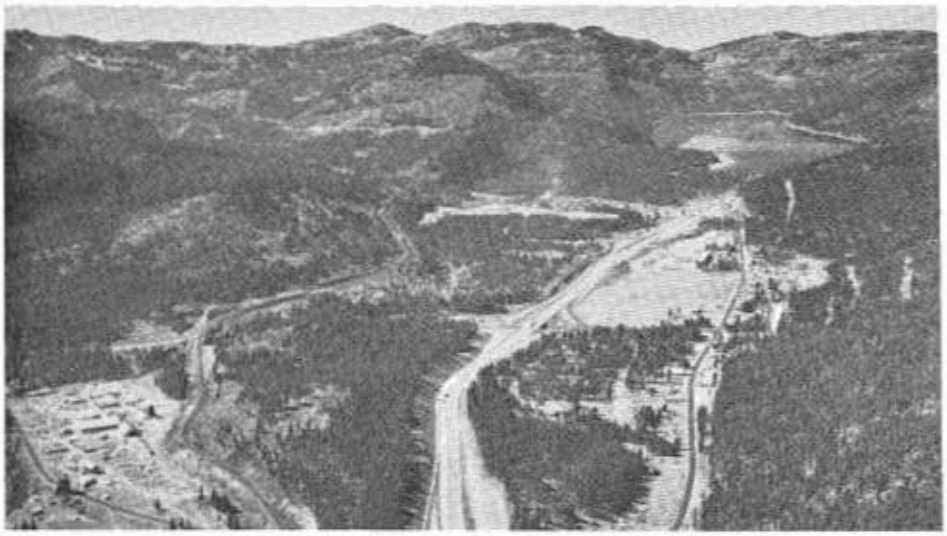
US 101 converted to full freeway through Arroyo Grande in San Luis Obispo County.

Modernization of section of Black Point Cutoff in Marin County and completion of the new Petaluma Creek bridge.

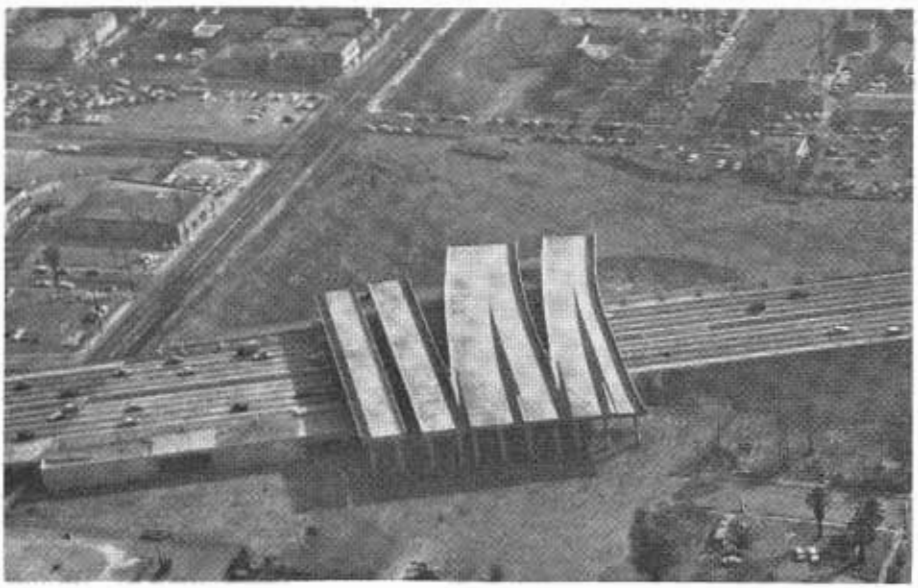
Considerable progress made on conversion of Grapevine Grade, US 99 in Kern County, to eight-lane freeway.

***IN 1959** many hundreds of miles of the California state highway system were realigned and modernized. Some of these were great urban freeways, others were recreation routes or farm to market roads in rural and mountain areas. These photos show a representative selection of these jobs.*

Below: Resurfacing and flood damage repair on State Sign Route 140, the Merced Canyon route into Yosemite.



Five freeway sections on US 40 were completed between Sacramento and Nevada state line in 1959, including this portion east of Donner Lake.



Harbor-Santa Monica Freeway Interchange bridges completed prior to construction of Santa Monica Freeway, to facilitate later contracts.

Object of the tests was to find the types of barriers which would come closest to meeting three exacting requirements:

1. Prevent out-of-control vehicles from crossing the center strip;
2. Reduce the chances of deflection back into the traffic stream;
3. Absorb high-speed impact so as to reduce the threat of injuries to passengers in the car striking the barrier.

The tests showed two barrier designs to be the most satisfactory.

One is made up of chain link fence and three three-quarter inch steel cables. The cables are strung along the fence, two about 30 inches above the ground and the third near the bottom of the fence.

The other design, judged suitable for narrower medians, consists of back-to-back steel guard rails attached to wooden blocks and posts. There is also a supplemental lower rail to the posts. The wooden blocking and prevent vehicles from hooking into posts and the lower rail, it was found, tend to reduce the severity of collisions with the barrier.

The detailed accident study conducted by the traffic department included a careful analysis of 8,000 accidents which occurred on 265 miles of various types of divided highways in 1956 and 1957, plus a review of all fatal freeway crashes in 1956 through 1958.

This study showed that where traffic volumes were not extremely heavy, highways with barriers had higher accident and injury rates than those without barriers.

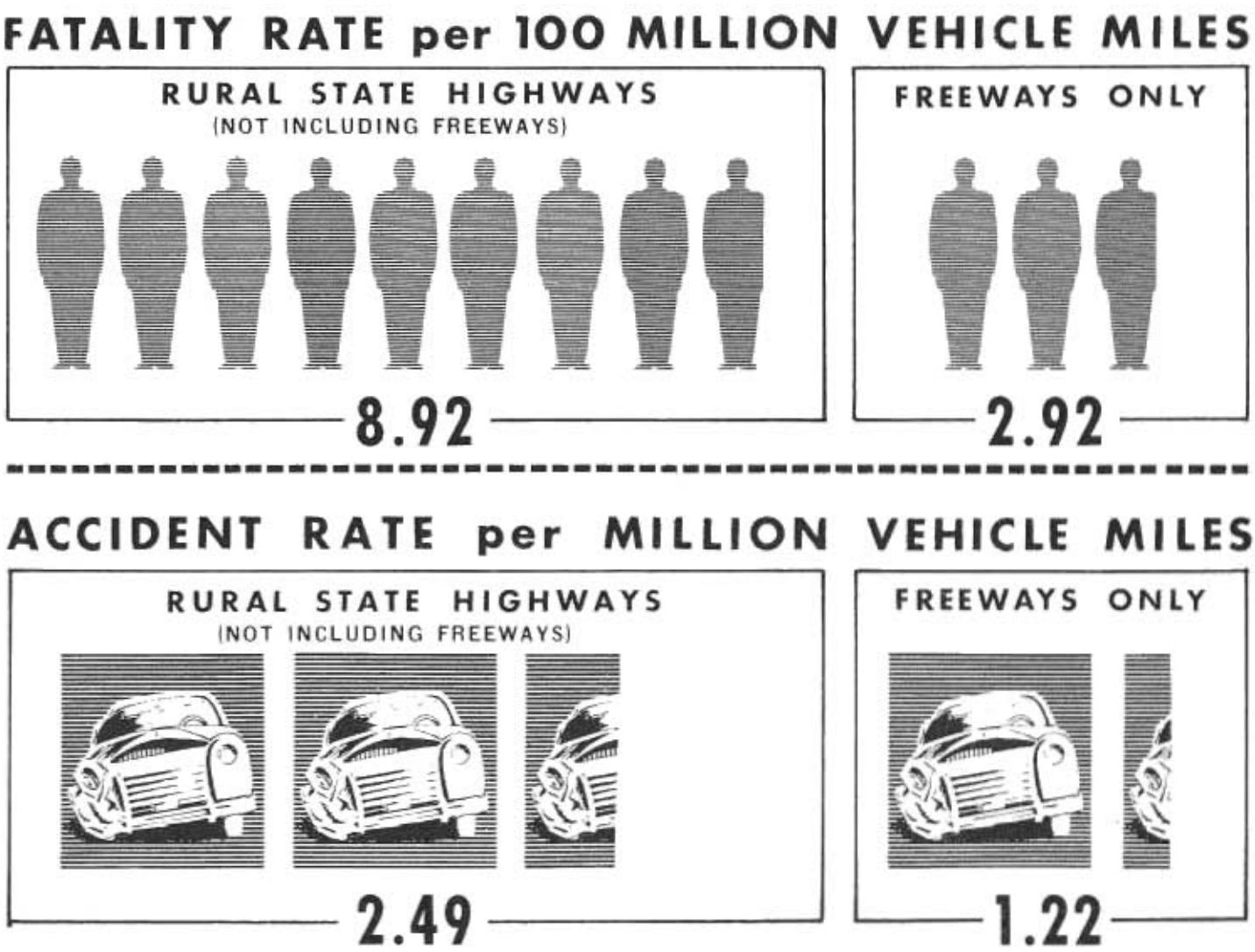
On the other hand, where traffic was very heavy, highways with barriers appeared to have lower accident rates.

As a result of the impact test and accident studies, the new types of barriers are now being installed on some sections of heavily traveled freeway in the Los Angeles and San Francisco Bay regions.

If the new barriers prove to be effective under actual operating conditions, they will be installed on other heavily traveled routes, and at problem locations, in an effort to further improve the already favorable safety record of freeways.

Highway Financing

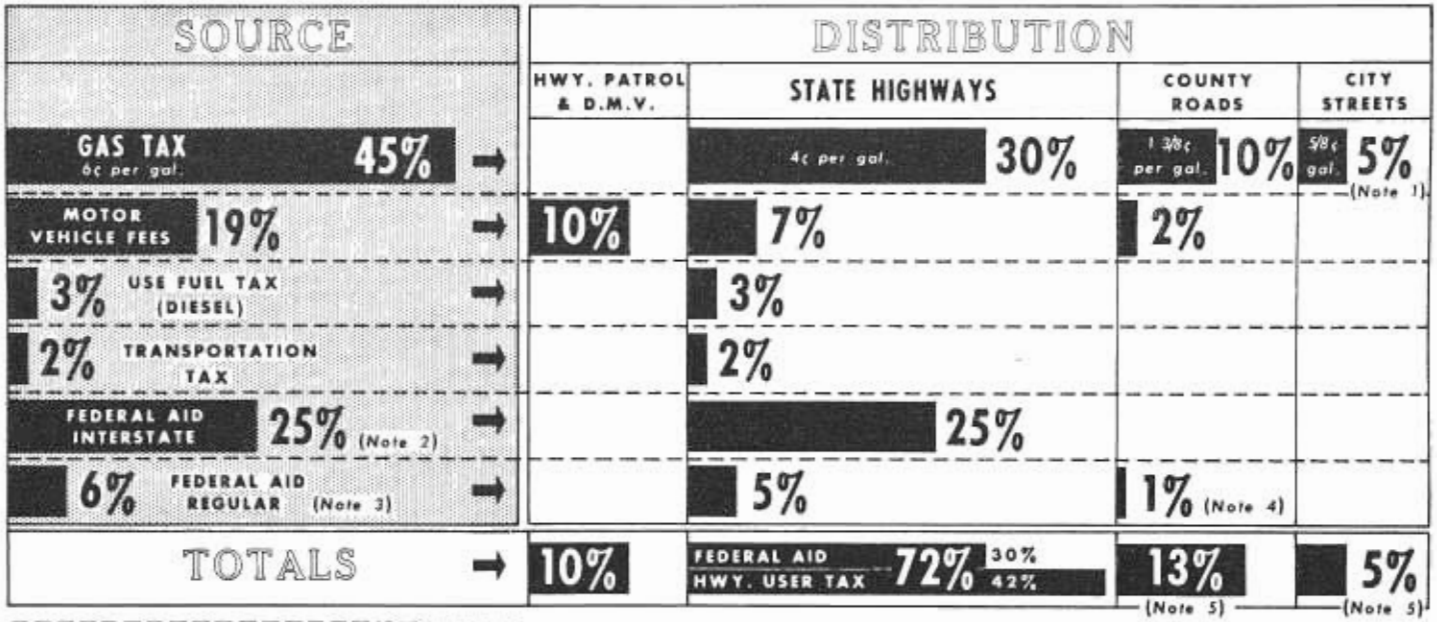
The 1959-60 State Highway Budget contained a total of $497,000,000 for state highway construction and rights-of-way. As adopted by the Highway Commission in October 1959, the

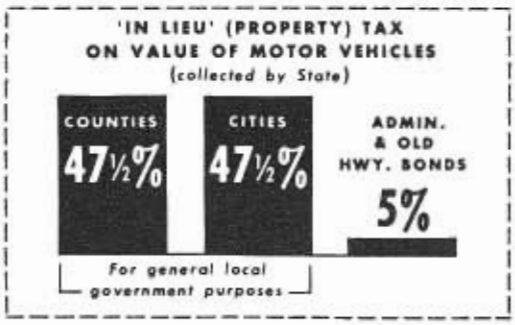


Highway User Taxes Including Federal Aid

Percentages based generally on 1960-61 Budget.

State of California
Department of Public Works
Division of Highways





NOTES

1. *State Highways within cities financed wholly by State and Federal funds.*
2. *Federal Aid Interstate must be matched 9% by State funds from above sources.*
3. *Federal Aid Primary, Secondary, and Urban must be matched 42%, mostly by State funds from above sources.*
4. *Does not include matching funds, up to $100,000 per county per year, from State Highway Fund.*
5. *Does not include $5,000,000 per year State highway matching funds for local railroad grade separations.*

1960-61 Budget provides $452,800,000 for these purposes.

The cutback in federal financing, which was only partly offset by increases in revenue from state sources, is reflected in these comparative construction budget totals for the two fiscal years.

The backbone of California's highway financing structure is the state gasoline tax of 6 cents a gallon. Four cents is applied to state highways, 1⅜ cents goes for county roads, and ⅜ of a cent for city streets other than state highways.

In addition to the gasoline tax, other sources of highway revenue in California are use (diesel) fuel taxes, transportation taxes, and motor vehicle, registration, and weight fees. (Revenue sources and distribution for road purposes are indicated in the accompanying chart.)

A substantial amount of the money for state highways, from the State's 4-cent share of the gas tax, is also used each year to help pay for local city and county projects not on state highways.

For example, state highway funds are made available each year to match federal allocations for county roads, to help pay the cost of city and county railroad grade separation projects, and for city street engineering and administration.

In the 1959-60 fiscal year, state highway funds allocated for these three purposes alone amounted to more than $10,000,000. This money supplements and in effect increases the regular share of the gas tax revenue received by the cities and counties.

According to law, 55 percent of the money available each year for state highway construction, including rights-of-way, is allocated to the 13 southern counties. The remaining 45 percent goes to the northern 45-county group. Each county is guaranteed a minimum share of the construction funds in a specified period of years. Federal highway funds must be applied to routes included in the various federal aid systems of secondary, primary, urban, and interstate highways.

In preparing the annual state highway budget, the Highway Commission must review hundreds of high-priority projects and attempt to choose those which will meet the most acute local and regional needs, comply with federal financing requirements, and at the same time fit logically into the long-range program for highway development on a statewide basis.

Thorough study and comparison of all available data, including compre-

hensive information on traffic volumes, accidents, population changes, road conditions, and other factors, is required.

Highway construction in California is expedited by a particularly helpful provision of state law which permits the award of construction contracts for highway projects as early as January 1, six months before the start of the fiscal year in which the project is budgeted. Last year 112 contracts were awarded before the start of the 1959-60 fiscal year, thereby allowing a longer construction season and advancing the completion date on many projects.

Planning

The Division of Highways prepares plans and estimates on highway projects well in advance of the time when construction is actually expected to start.

This policy of long-range planning enables the Highway Commission to use all revenues as soon as they become available, thanks to a backlog of projects ready to advertise for bids.

The value of this planning program was demonstrated last year when California successfully completed $29,500,000 in construction on state highways with additional unanticipated funds provided under the anti-recession provisions of the 1958 Federal Highway Act.

California received the federal apportionment for this "crash" program in April 1958. Projects financed with the added funds had to be under contract by December 1958, with provision for completion by December 1959.

Under the special federal program, 23 state highway projects, including several multimillion-dollar freeway jobs, were opened to traffic by the December, 1959, deadline. (Additional projects were completed on county roads, as described later in this report.)

The successful completion of the crash program, undertaken on short notice with specified deadlines was possible only because of sound practices of continuing advance planning. Plans and specifications were ready and the right-of-way had been acquired, making it possible to apply the added federal funds to construction projects without delay.

Such rapid utilization of funds means savings in fuel and upkeep expense to motorists who enjoy earlier use of improved highways. More important, it has resulted in earlier elimination of outmoded or congested highway sections, many with high accident rates.

Freeway Route Selection

Essential to the advance planning program of the Division of Highways is the early determination of freeway routes by the Highway Commission.

Before detailed design studies for any freeway project can proceed, of course, the location of the route must be decided upon. Early determination of freeway routes also helps local city and regional planners by fixing permanently one of the major transportation factors of the area.

In California, freeway routes are selected according to policies and procedures which have been established over the years by the commission and the highway division.

Object of these procedures is to insure painstaking study, thorough consideration of all data, and complete public discussion of each possible route.

Briefly, the freeway route selection process is as follows:

General termini for state highways are named by the Legislature. Before possible alternate freeway routes between these termini are even in mind, the Division of Highways gets together with city or county planners and traffic engineers to determine the area's highway needs and general plans. Local government agencies are notified that route studies are commencing. Informal public meetings are often held to explain problems involved and to obtain preliminary ideas.

Working in close co-operation with local technical staffs, the division conducts extensive traffic, engineering and economic studies. All local master plan information is carefully reviewed.

These studies provide the facts necessary for the projection and evaluation of the various alternate routes which might be considered.

Some alternates will be undesirable because they would adversely affect such "controls" as schools, hospitals, cemeteries, important landmarks, or recreational facilities.

Others will be unfeasible for engineering reasons or because they would require too much of the taxpayers' money for the benefits they would provide. Still others will be unsatisfactory because they would provide inadequate traffic service.

Finally, after several years of study and restudy, the division boils down the possibilities to what are considered to be the most suitable choices from the standpoint of traffic service, effect on the community, economic influence, construction costs, and right-of-way costs.

These alternate routes are then subject to intense public review at a series of meetings, both formal and informal, conducted by the Division of Highways. Last year the division held 55 official public meetings on freeway route matters, plus several hundred informal meetings and map displays.

Often these public discussions reveal a course for further investigation. Upon completion of these additional studies, the State Highway Engineer recommends to the Highway Commission the route which appears to offer the best combination of traffic service and community or area benefits. Information on all other routes is also provided to the commission.

The Highway Commission will then take the matter of a routing under consideration.

In particularly difficult cases, the commissioners will decide to get firsthand information from local citizens by calling a public hearing in the area concerned.

In every case, local governing agencies will be notified that if it is considered necessary or desirable, the Highway Commission will hold a public hearing on the matter. Last year the commission held five public hearings in local areas.

Even when no hearing in requested, the commission will announce its intention to adopt a route and withhold action for at least 30 days to allow time for submission of additional data and proposals.

All supplementary information presented at the public hearings, along with the data developed during the comprehensive studies and public

meetings conducted by the highway division, are carefully considered in the commission's deliberations.

Most of these route decisions are extremely difficult, especially in built-up areas. Nearly any route which the commission might select will be unsatisfactory to some individuals, even though this route is the one which offers the best service and the most benefits to the greatest number.

At the end of 1959, there were 5,100 miles of adopted freeway routes in California. This large total is particularly significant as the State embarks on the 20-year freeway-expressway system plan. It means that a great amount of the preliminary spadework has already been completed with routes selected for about 40 percent of the master plan highway mileage.

Landscaping and Planting

California's highways are the scene of an increasing number of planting and landscaping projects. The last three annual budgets adopted by the Highway Commission have provided an aggregate of approximately $12,000,000 for such projects.

Freeway landscaping and planting projects are carefully worked out by the division's staff of landscape architects to serve functional as well as beautification purposes.

Planting of selected trees, shrubs, and plants not only enhances the appearance of a section of freeway, it also meets functional needs such as the screening of headlight glare and noise and the prevention of erosion damage.

Care and control of roadside landscaping and other vegetation is a big and costly job requiring the services of hundreds of landscaping specialists and tree workers.

The division also carries out weed and fire hazard control programs designed to provide protection for agricultural and forest lands bordering state highways. These programs are often conducted in co-operation with other agencies.

Highway Maintenance

Mild weather and light snowfall eased the problems of the division's maintenance crews in 1959. Storm damage to highways was small when compared to previous years, although there were some severe local problems.

Periods of warm weather permitted intermittent openings of such roads as the Deer Creek Highway (Sign Route 32) and the Angeles Crest Highway (Sign Route 2) which are usually closed during the winter.

All of the major mountain pass highways which are closed each year by snow were reopened at the earliest dates in history. The last to be reopened, Tioga Pass on State Sign Route 120, was back in service May 13, 10 days ahead of the previous earliest date.

The maintenance of the State's highways is an important and continuing part of the work of the division. California's varied climate and topography dictate a broad maintenance program requiring equipment and personnel for a wide range of tasks.

In addition to such annual duties as snow removal and repairs after winter storms, the maintenance department is also responsible for such jobs as the care of roadside trees and landscaping, the posting of warning and directional signs, bridge repair, adjustment of electronic traffic signals, and a constant program of resurfacing, patching, sealing, painting, spraying, and shoulder maintenance.

No small job for maintenance crews is the picking up after highway litterbugs. Cleanup work by state forces last year cost more than $600,000.

In an effort to curb this continuing expense, the division maintains hundreds of litter disposal cans along highways throughout the State. Signs indicating the locations of litter cans have also been installed.

To better co-ordinate its broad, statewide activities and to obtain up-to-the-minute reports of road conditions, the maintenance department has developed a radio network which includes 175 radio stations, 23 microwave stations, and 900 mobile radio units.

During the winter, accurate road condition reports are received by radio from the field and supplied to newspapers, automobile clubs, radio and television stations, and other interested agencies through division-operated teletype facilities.

Equipment

The operation and maintenance of California's highways requires a great deal of automotive and maintenance equipment including various trucks, automobiles, graders, snowplows, power shovels, tractors, and miscellaneous items such as rollers, mixers, trailers, hoists, pumps, drills, and mowers.

The division's automotive and maintenance equipment inventory at the end of the 1958-59 fiscal year was $25,700,000.

The Equipment Department carries out a program of continuing research aimed at finding better, more efficient equipment to reduce operating costs. Many new pieces of equipment are designed, assembled, modified, or constructed in the department shops to meet special highway uses.

Among the recently designed or developed equipment items are a new paint striping machine which eliminates the sulky that was formerly pushed in front of the striping truck. New power ladders and improved cranes have also been developed.

During the 1958-59 fiscal year, the division acquired 990 new equipment units with a total value of $4,600,000. Most of these units replaced obsolete or worn out equipment.

George T. McCoy, California State Highway Engineer for 16 years, retired October 1, 1959.

After serving with the Washington State Highway Department, McCoy moved to California in 1927 as an assistance office engineer for the Division of Highways.

He was appointed administrative assistant to the State Highway Engineer the following year. In 1933 he was advanced to the position of Assistant State Highway Engineer, becoming State Highway Engineer in 1943.

McCoy was succeeded by J. W. Vickrey, who died unexpectedly on December 4, 1959.

Vickrey had served with the Division of Highways for 42 years. He was named Assistant State Highway Engineer—Planning in 1947 and Deputy State Highway Engineer—Engineering in 1955.

Materials and Research

The median barrier crash tests described earlier in this report were conducted by the staff of the division's Materials and Research Department.

The department's extensive laboratory in Sacramento, one of the largest of its kind, is headquarters for a statewide research and testing organization which includes specialized branch laboratories in Los Angeles, Bakersfield, Santa Maria, and Berkeley. The department also co-ordinates the technical work of laboratories in each of the 11 state highway districts.

The work of the Materials and Research Department may be classfied in two main categories—testing to make sure the State gets its money's worth from every highway construction dollar, and research to develop better methods and materials.

Although the median barrier tests were probably the most spectacular of the department's recent research projects, there have been several other important areas of investigation.

A practical means of obtaining better nighttime visibility for traffic stripes, especially during rainy weather, has been under study for some time. An improved reflective plastic button has been developed and is now being tried on a section of highway in San Francisco in an effort to solve this problem.

Inexpensive machines to test the smoothness of pavement have been introduced, making it possible to measure and correct rough spots while construction is in progress.

From experience gained in construction of the parallel Carquinez Bridge at Crockett, new methods have been devised for controlling certain types of welds in alloy steel.

The sonics laboratory has conducted several investigations of freeway traffic noise. In general, these studies have shown that most freeways cause less disturbance than ordinary city streets with posted or signalized intersections where traffic moves on a stop-and-go basis.

New Speed Limit

On January 1, 1960, the maximum speed limit for automobiles on California highways was changed to 65 miles an hour as a result of legislation enacted by the 1959 Legislature. A prima facie limit of 55 miles an hour formerly applied, making it permissible to travel at faster speeds under favorable conditions.

Preparations for the new maximum speed limit occupied much of the time of the division's traffic engineers during the last few months of 1959.

From the standpoint of traffic engineering and safety requirements, the new speed limit involved much more than putting up maximum speed limit signs.

There are many sections of highway, especially in and near built-up areas, where the 65-mile limit is too fast for prevailing conditions. About 200 miles of this type of highway were rezoned for slower speeds by the end of 1959. Many of them are now posted as 55-mile zones.

At all highway entrances to California, large signs were installed to warn that the maximum speed limit for autos is 65 miles an hour, all trailers 45 miles an hour, and trucks 45 miles an hour. California's basic speed law, which requires drivers to adjust speeds to conditions, also remains on the books.

Restricted speed zones in California are established by the Department of Public Works on the basis of engineering and traffic studies conducted by the Division of Highways. Enforcement of speed limits is a duty of the California Highway Patrol and local authorities.

Bridges

The Division of Highways Bridge Department, with its own design and construction staff, is responsible for all structures on state highways.

These include elevated freeways, traffic interchanges, overcrossings, undercrossings, highway-railroad separations, underwater tubes, and bridges over rivers, streams, and other bodies of water.

The bridge department also supervises the operation and maintenance of the state-owned toll bridges—the San Francisco-Oakland Bay Bridge, Richmond-San Rafael Bridge, San Mateo-Hayward Bridge, Dumbarton Bridge, and the Carquinez Bridge.

Toll collections began on the Carquinez Bridge on US 40 in November 1958, after completion of the new parallel structure over the Carquinez Strait. Improvements to the old bridge were completed in April 1959.

In its first year of operation as a toll facility, the Carquinez Bridge served more traffic and earned more money than any of the advance estimates had indicated.

In fact, first year revenues of $4,255,075 were higher than the estimated revenues for both the Carquinez and the Benicia-Martinez Bridges for the year 1964. The two bridges are financed by Toll Bridge Authority revenue bonds.

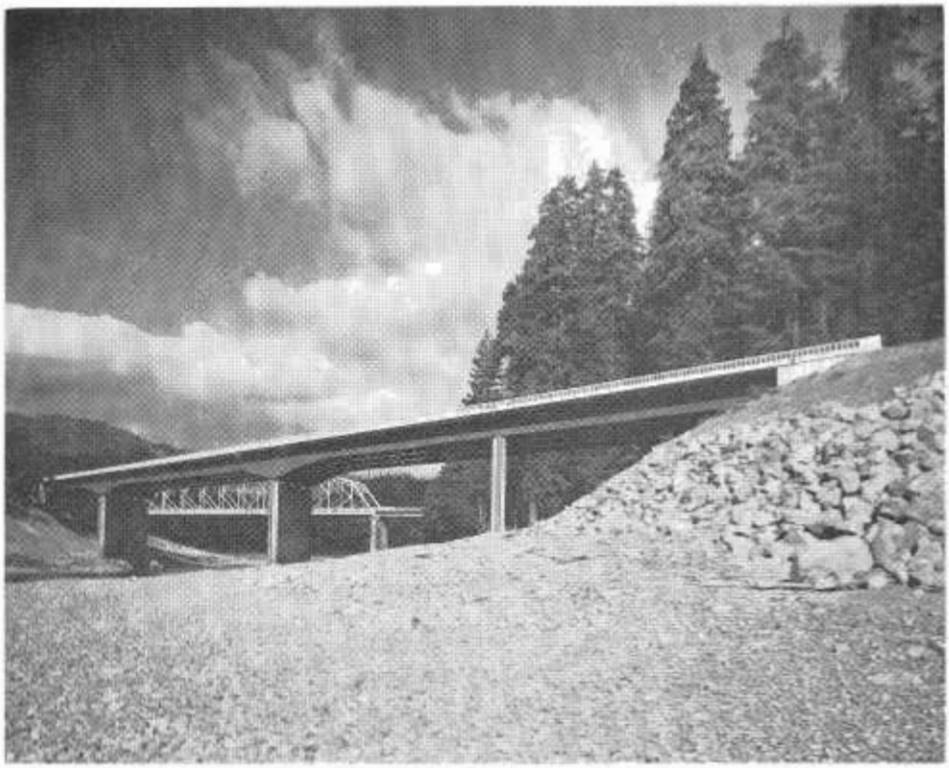
Work started on the Benicia-Martinez Bridge in mid-1959 and completion is expected in late 1962. Two contracts totaling $14,765,000 were awarded for the bridge proper. The toll project will also include freeway approaches in both Contra Costa and Solano Counties.

Located about 200 feet downstream from the existing railroad bridge across the strait, the highway bridge will replace the present division-operated ferry service. It will be of deck-truss type construction with a total length of 6,215 feet and an overwater length of 4,880 feet. The bridge deck will be 187 feet above water at the highest point and 62 feet wide between curbs, providing a four-lane highway with a 10-foot dividing strip.

A method for financing the long-discussed San Pedro-Terminal Island Bridge was decided upon last year, after some 10 years of deliberation and planning. Construction is expected to start in 1960.

This 6,010-foot bridge over the Main Channel of the Los Angeles Harbor will cost an estimated $20,000,000. Financing will be from revenue bonds not to exceed $6,000,000, from State Highway Funds, and from State Highway User Tax Funds available to Los Angeles County and to the City of Los Angeles.

Another long-planned and extensive project got under way last year when work started on the Webster Street Tube, a second underwater tube between Oakland and Alameda. The Webster Street Tube will be about a block west of the present Posey Tube under the Oakland Estuary. The new tube will be made up of 200-foot seg-



Bridges and freeway structures designed by the Division of Highways Bridge Department have been singled out for a number of awards in recent years. Last year this structure across the South Fork of the Eel River on US 101 (Redwood Highway) in Humboldt County was included among bridges judged most beautiful in national competition sponsored by the American Institute of Steel Construction.

ments, prefabricated in drydock, floated to the proper location, and lowered into a prepared trench. The project is expected to be completed around the end of 1962.

Largest of the state-operated toll bridges is the San Francisco-Oakland Bay Bridge, which carried a total of 37,215,818 vehicles during the 1958-59 fiscal year, a gain of 5.6 percent over the preceding year.

Under California law, $5,000,000 is set aside each year in the State Highway Budget to help finance local railroad grade separation projects included on a priority list established annually by the State Public Utilities Commission. These local projects are not on state highways.

The cost of such projects, after deduction of any contribution by the railroad involved, is shared equally by the local agency and the state.

During 1959, the Highway Commission made allocations from the special fund to help pay for local railroad grade separation projects on White Avenue in Pomona, on Beale Avenue in Bakersfield, on Mount Vernon Avenue east of Bakersfield, on 24th Street in Paso Robles, on De La Cruz Boulevard in Santa Clara, on Sutterville Road in Sacramento, and on Center and El Dorado Streets in Stockton.

Right-of-way

A total of 7,785 right-of-way transactions were concluded in the 1958-59 fiscal year. Of these, more than 98 percent were negotiated settlements with property owners. Less than 2 percent were concluded through contested court proceedings.

One big reason for the large number of amicable right-of-way transactions is the State's policy of paying fair market value for required property. In dealings with right-of-way personnel, owners can expect to receive the same amount for their holdings as they would from any other buyer under normal market conditions.

The methods and policies of the Right-of-way Department are outlined in the booklet, "More Than 15 Million People Want My Property," which is mailed to affected property owners before their property is appraised (copies available on request).

Acquisition of rights-of-way in California is expedited in some cases by a special fund which has been authorized by the Legislature.

This $30,000,000 revolving fund has been set up to cover the advance purchase of rights-of-way on which costly improvements are slated. Expenditures from the fund are repaid from regular highway revenue when the construction period is reached for each project.

The effect of this procedure is to provide funds to purchase property before improvements are made, even though actual highway construction may be some years in the future.

During the 1958-59 fiscal year, money from the revolving fund was used to acquire 49 parcels of land—resulting in an estimated savings of $9,320,000.

County Roads

Out of 69,000 miles of county roads in California, approximately 7,500 miles are included in the federal aid secondary system. For the most part these roads are next in importance to state highways in terms of traffic volume and economic service. They are often referred to as "feeder roads" or "farm to market roads."

Projects on these federal aid secondary routes are planned and in most instances constructed under the direct supervision of the county involved. The Division of Highways, under federal regulations, has the responsibility for reviewing and approving these county projects. The division also assists in other phases when requested to do so by the counties.

Working in close co-operation with the division, California's counties compiled a commendable record in the planning and construction of FAS county roads during the past year.

This was particularly true in connection with the use of "crash program" funds made available under the antirecession provisions of the 1958 Federal Highway Act.

The participating counties undertook 67 county road projects with the special funds at a cost of approximately $6,500,000. All but one of the county road improvements were com-

pleted by the December 1959 federal deadline, and the time limit for the unfinished project was extended.

The regular 1959-60 federal apportionment to the counties for use in improving roads on the FAS system amounted to $8,724,389. State highway funds made available to the counties for use in matching this allocation totaled $4,273,060.

The largest source of revenue for all county road purposes is the 1⅜-cent share of the State's six cents a gallon gasoline tax. These funds are distributed directly to the counties by the State Controller, and are administered by local boards of supervisors.

Apportionments are made according to law on the basis of proportionate motor vehicle registration and mileages of county-maintained roads. For 1958-59 the counties received as their share of the gas tax, along with a portion of the vehicle registration fees, a total of $79,595,990.

City Streets

The Division of Highways administers the apportionment on a population basis of the five-eighths cent per gallon share of the gasoline tax which goes to incorporated cities and reviews and approves major city street improvements not on state highways which are financed with these funds.

In addition, the division apportions state highway funds set aside for city street engineering and administration purposes. According to law, this apportionment ranges from $1,000 a year for cities with a population of less than 5,000 to $20,000 for cities of more than 500,000 population.

During the 1958-59 fiscal year, a total of $31,562,053 was paid to the cities in gas tax money and engineering funds. This is an increase of $1,134,401 over the previous year. City street projects approved by the division during the fiscal year numbered 546. City street improvements during the period covered 212 miles.

Construction Contracts

California highway construction is performed under contracts awarded on the basis of competitive bidding. This insures that the public receives the greatest value for its highway construction dollar.

Contractors who desire to bid on state highway projects estimated to cost more than $15,000 are required to be prequalified by the division. Each contractor's financial capabilities, experience, and resources are studied in determining the type and size jobs he is qualified to undertake.

At the end of the 1958-59 fiscal year, there were 1,045 contractors with varying prequalification ratings, eligible for bidding on state highway projects. Total bidding capacity of these contractors was $2,115,000,000.

Of the 624 contracts awarded during the 1958-59 fiscal year, 79 percent were for projects costing less than $250,000. Thus, contractors with limited resources were capable of bidding on the great majority of state highway jobs.

About 12 percent of the contracts were in the $250,000 to $1,000,000 class, and approximately 9 percent went above the $1,000,000 mark.

California Highway Commission

As noted earlier, responsibility for highway route adoptions rests not with the Division of Highways, but with the California Highway Commission, which is a nontechnical, nonsalaried board of business and professional men representing the people of the State at large.

Commissioners are appointed by the Governor, and the appointments are confirmed by the State Senate.

The commission is a seven-man body with the State Director of Public Works, as ex officio chairman, serving at the pleasure of the Governor. The other six members serve four-year staggered terms.

Members of the commission at the end of 1959 were: Chairman, Robert B. Bradford, Director of Public Works; Robert L. Bishop of Santa Rosa; (term expired in January 1960; succeeded by John J. Purchio of Hayward); James A. Guthrie of San Bernardino; Arthur T. Luddy of Sacramento; Robert E. McClure of Santa Monica; Chester H. Warlow of

California's 11 state highway districts are shown on this map of the State. The black dots represent cities in which district offices are located.

Fresno; and Roger S. Woolley of San Diego.

In addition to budgeting highway funds and adopting freeway and highway routes, the commission also approves county primary road systems and authorizes the execution of deeds, condemnation proceedings, and right-of-way abandonments and relinquishments.

Division Organization

Chief of the Division of Highways is the State Highway Engineer. He is assisted by a headquarters staff in Sacramento composed of two deputy state highway engineers, four assistant state highway engineers, a chief right-of-way agent, and a comptroller. Each of the assistant state highway engineers is in charge of a group of specialized units.

The State is divided into 11 state highway districts to provide for localized administration of the highway program (see map). These districts have approximately equivalent state highway mileage. A district engineer is in charge of each district except in the San Francisco and Los Angeles areas where an assistant state highway engineer is in charge.

The district engineer is responsible for all phases of the highway program in his district. Information concerning local highway matters is most readily obtained at his office.

District offices are in these cities:

District I
Eureka
430 West Wabash Avenue
Sam Helwer, District Engineer

District II
Redding
1657 Riverside Drive
H. S. Miles, District Engineer

District III
Marysville
703 B Street
Alan S. Hart, District Engineer

District IV
San Francisco
150 Oak Street
J. P. Sinclair, Assistant State Highway Engineer

District V
San Luis Obispo
50 Higuera Street
A. M. Nash, District Engineer

District VI
Fresno
1352 West Olive Avenue
W. L. Welch, District Engineer

District VII
Los Angeles
120 South Spring Street
E. T. Telford, Assistant State Highway Engineer

District VIII
San Bernardino
247 Third Street
C. V. Kane, District Engineer

District IX
Bishop
South Main Street
E. R. Foley, District Engineer

District X
Stockton
1976 East Charter Way
J. G. Meyer, District Engineer

District XI
San Diego
4075 Taylor Street
J. Dekema, District Engineer

Magazine Marks A.R.W.A. Anniversary

Organized in 1934, the American Right of Way Association observed its 25th anniversary with the December 1959 issue of *Right of Way*, official organ of the association published in Los Angeles as a bimonthly by the board of directors.

The lead article of this issue is the first of three installments on the history of the association, of interest to the right of way fraternity and the general public as well.

Also of interest is the Roll of Honor —charter members of Mother Chapter, Los Angeles 1—1934. Of the 81 charter members, 22 are still in the association and seven of the 22 are with the State Department of Public Works.

Heading the roll is the name of Frank C. Balfour, Chief Right of Way Agent of the State Division of Highways, recognized as the founder of the association and its national chairman from 1945 to 1956.

Balfour joined the staff of the division in the Right of Way Department in January 1931. After brief experience in the field, he quickly recognized the need for sound real estate valuation procedures and training courses for right of way men.

With the advice and encouragement of Spencer V. Cortelyou, then Division of Highways District Engineer in Los Angeles, Balfour enlisted the support of 14 able Los Angeles right of way men, who met October 16, 1934, to hold the first organization meeting of the Southern California Right of Way Agents' Association. In one year the membership of the association more than doubled. Now, with some 7,000 members in the United States and Canada, the organization has 30 chapters and three club affiliates from coast to coast and in Hawaii.

A reproduction of the first issue of *Right of Way*, a modest four-page sheet dated March 20, 1935, monthly bulletin of the Southern California Right of Way Agents' Association and forerunner of *Right of Way*, is tucked into the 25th Anniversary Number.

The seriousness of right of way problems was recognized by the California Highway Commission very early in the beginning of highway development in California. In the May 1, 1913, *California Highway Bulletin* (predecessor of *California Highways and Public Works)* is an article by C. C. Carleton, attorney (retired in 1949 after many years as Chief of the Division of Contracts and Rights of Way of the State Department of Public Works), titled "Securing Rights of Way for the State Roads," in which is written, "The commission, however, has from the beginning realized the importance of acquiring rights of way promptly and systematically." The right of way men know better than anyone how much the problem has been augmented by the fantastic growth of population in California.

The ultimate objective of the association as stated in its anniversary issue: The establishment of a specific major course of study on right of way and land acquisition in colleges and universities.

Plans are being prepared for the acquisition of rights-of-way and start of widening on the San Mateo-Hayward Bridge.

Hayward Attorney is Named to Commission

John J. Purchio of Hayward, widely known attorney, and civic leader, became a member of the California Highway Commission on January 15. He was appointed to the post for a four-year term by Governor Edmund G. Brown upon the expiration of the

John J. Purchio

term of Robert L. Bishop of Santa Rosa, who had served on the commission since January 1956.

Born in New York 45 years ago, Purchio was graduated from Fordham College and Fordham University Law School, served with the U.S. Air Force in Europe as an intelligence officer, and has been engaged in the practice of law in Hayward since 1947.

He has long been active in civic affairs and politics, serving on the city council of Hayward since 1953, including one term as the city's mayor. He resigned from the city council upon his appointment to the Highway Commission.

In connection with his city council activities he has been actively concerned with highway developments in Hayward and other sections of Alameda County as his city's representative on highway committees.

Purchio was recently appointed by Governor Brown to the advisory committee which is assisting the Golden Gate Authority Commission.

He has also been active in the State Bar of California, currently serving on its legislative committee, and was Resolutions Chairman of the 1959 Conference of the League of California Cities.

Purchio is married and has six children. He lives at 2375 Lancaster Court in Hayward.

Latest Cost Index Shows Down Trend

During the fourth quarter of 1959 the California Construction Cost Index continued in a downward course. The index now stands at 229.1, a drop of 31.2 points or 12.0 percent from the third quarter of 1959.

The continued drop is apparently due to extremely strong competition on a number of large attractive projects. The slowdown in highway construction during 1959, due to uncertainty over federal legislation and the depletion of the Highway Trust Fund, served to increase competition over projects on which bids were opened during the last quarter. Reports from other states, and other indexes reviewed below, indicate that the drop is largely confined to California.

The Engineering News-Record Cost Index for the fourth quarter of 1959, which now stands at 334.7, shows a slight decrease under the preceding quarter. It is down 0.1 index point or 0.03 percent. This index is strongly affected by many large projects outside the highway construction field. It is the first decrease since 1949.

The Bureau of Public Roads Composite Mile Index is based on federal-aid highway construction contracts awarded by the state highway departments. The index for the third quarter of 1959 increased 0.5 index point or 0.2 percent from the second quarter of 1959 and now stands at 228.3. However, it is 1.4 percent lower than that for the third quarter of 1958. According to the Bureau of Public Roads, the small fluctuations of the past several years appear to indicate continuance of a trend of stabilization in prices.

John Stanford Named Assistant Director

Appointment of John H. Stanford as Assistant Director of the State Department of Public Works has been announced by Director Robert B. Bradford.

Stanford, a career management worker in state service since 1946, is a

John Stanford

native of Urbana, Illinois, and a graduate of the University of California. He received a master's degree in public administration at Syracuse University, and served as a captain in the Air Force during World War II.

He entered state service with the Department of Finance, later transferred to the Department of Insurance as administrative service officer, and returned to the Department of Finance in 1952 as a senior management analyst. He moved to the Department of Public Works as its supervising management analyst in 1956.

Stanford is a past president of the Sacramento chapter of the American Society for Public Administration and the American Records Management Association, and a member of the Western Governmental Research Association.

He is married and has three children. His home is at 5417 Spilman Avenue, Sacramento.

The State Legislature has added a section to the Vehicle Code permitting the use of approved snow-tread tires in place of tire chains.

Profilograph—1

Devices for Recording Road Roughness Described

By FRANCIS N. HVEEM, Materials and Research Engineer

EVER since roads and highways have been constructed, the people who use them have been keenly aware of the relative degrees of comfort or discomfort experienced in traveling. This awareness has been so deeply ingrained that most languages contain metaphors such as "rough road" or "smooth road" as descriptive of many human experiences involving hardship or good fortune.

> This article is the first of two describing the development of use of devices for measuring the roughness of pavement. This material was also presented before the Highway Research Board at its 39th Annual Meeting in Washington, D.C., January 11 to 15.

There is no doubt that mankind has long thought of road smoothness or roughness as being synonymous with pleasant or unpleasant. Road surface roughness is not easily described or defined and the effects of a given degree of roughness naturally vary considerably with the speed and characteristics of the vehicle. Anyone looking at photographs of Roman roads (Figure 1) must wonder how it felt to ride in a chariot over such surfaces, especially as the chariots had steel or bronze tires and no springs. One might assume that the repair bills on chariots were fairly high, and undoubtedly the occupants had real cause to feel "shook up."

Figure 1. A street in Pompeii showing stepping stones and grooves worn by chariot wheels.

Little Progress at First

As we move into more modern times, references to roads appear in the folk lore, both in song and story and in the literature. We have the wistful song about the high and low roads that lead into Scotland, but roads were little, if any, smoother a hundred years ago than they were in the times of the Romans, and our hardy ancestors were not above complaining about them. The "rocky road to Dublin" is legendary, and it may be that the Irish were more concerned over such things than most because it appears that an Irishman may have been the first man to construct a device for measuring road roughness, at least the earliest reference thus far found is in a book entitled "Road

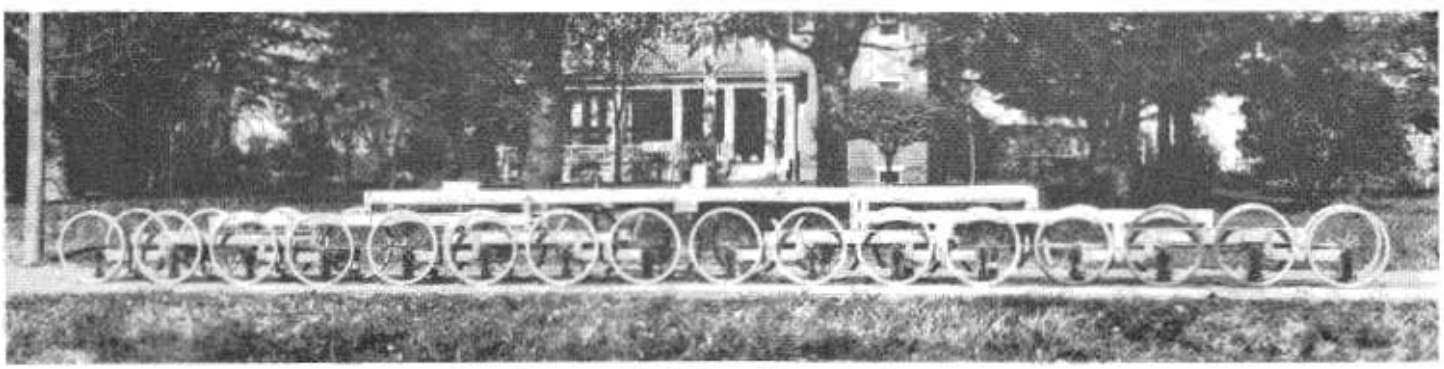


Figure 2. A profilograph constructed by the State of Illinois for the Bates road test, circa 1922.

Making and Maintenance" by Thomas Aitken. This book was published in 1900 and on page 420 there is a discussion of an instrument called the "Viagraph." It is said to be the invention of Mr. J. Brown, an engineer of Belfast, Ireland, and is described as being "a straight-edge, 12 feet long and 9 inches wide, applied continuously to the road surface, along which it is drawn."

This early Viagraph contained "an apparatus for recording on paper a profile of the road surface tested, and the sum of unevenness is indicated by a numerical index." I am mildly chagrined to note this description as I "invented" a device employing the same principle in 1929. Mr. Brown goes on to discuss the gravel and macadam-type road surfaces that were characteristic of his time (in the years prior to 1900) and concludes that steamrollers offer a distinct advantage in effecting a regular and smooth surface. He shows some "autograph records" of macadamized road surfaces and states that, "In the author's opinion, after experience gained in working this instrument over many miles of road and under varying circumstances, a standard of fitness or smoothness of 15 feet of unevenness, or variation from a regular plane, per mile of road might be safely adopted." Mr. Brown's device furnished virtually all the information obtainable from the most modern profilograph units today—except that he measured "roughness" in feet instead of inches per mile.

Accurate Measurement Needed

With the high speeds common to modern vehicles on highways and airplanes on landing fields, even minute deviations in the pavement surface become a matter for concern. In the last 40 years there have been many devices developed for measuring, evaluating or locating the individual high and low spots on a pavement surface. Following Mr. Brown's Viagraph, no record has come to light of similar devices until we come to the era of the Bates road test in Illinois in 1922. Mr. A. C. Benkelman kindly furnished photographs of a Profilometer built by the State of Illinois at that time (Figure 2). Judging from the photograph, this was a most impressive instrument in which the frame was supported by 32 bicycle wheels mounted in tandem. According to reports, this particular model was not too successful and undoubtedly was unwieldy and difficult to handle. It does, however, represent a most elaborate example of the principle which is still being used; namely, a series of wheels mounted on short beams or "eveners" to produce a mechanical integration; that is, the center point of the main frame parallels in elevation at all times a point representing a mean elevation between the high and low spots of the pavement contacted by the series of wheels. By this means, a datum plane is produced to serve as a "plane of reference" for the recording wheel that follows the actual profile of the pavement. All of the straightedge types of which Mr. Brown's pioneer model is an example measure the profile in terms of depth below the peaks or high points on the road surface within the length of the straightedge.

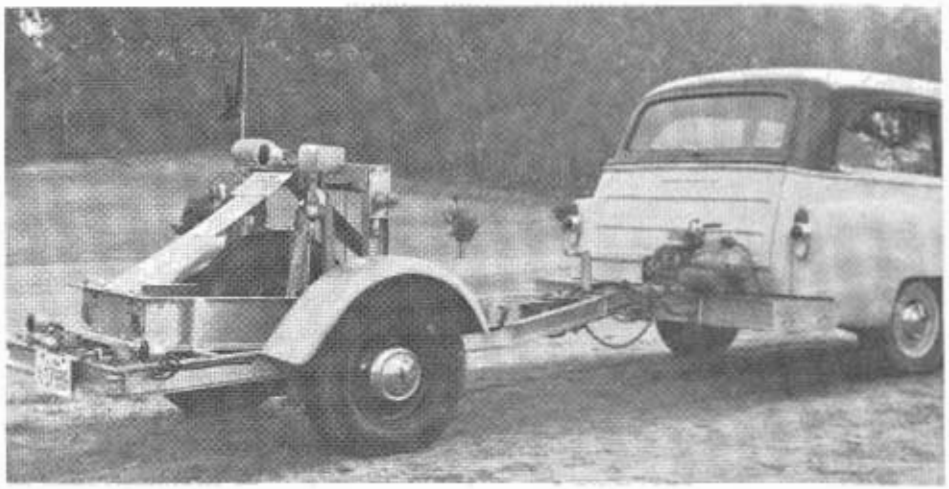


Figure 3. The Bureau of Public Roads Pavement Roughness Indicator, outrigger trailer and tow car.

Profiles Recorded

With the rapid expansion of the motor vehicle and increasing awareness of riding qualities, another type made its appearance. One of the earliest was the "Via-Log" developed in the State of New York. The Via-Log consisted of means for recording a profile on a strip of paper, the stylus being actuated by the vertical movements of the front axle of an automobile with reference to the frame of the car. In order to produce a reading, the car had to proceed at appreciable speed, say 20 miles per hour or more.

Public Roads magazine for September 1926 reports on a variant of this instrument for the measurement of relative road roughness. It is described as consisting of a "rack which is attached in a vertical position to the front axle of the vehicle, Fig. 31. Meshed with this rack is a spur gear which is supported by the frame of the car. Movement of the front axle with respect to the chassis, caused by deflection of the body spring, thus produces translation of the rack and rotation of the gear. This gear is connected through a flexible shaft to a mechanical counter on the instrument

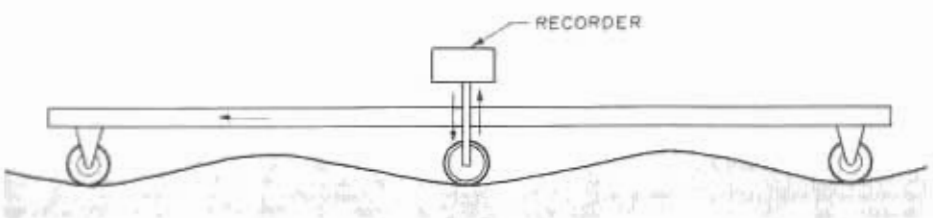


Figure 4. The above diagram illustrates the potential error produced by a device equipped with only three points of contact. The wave pattern corresponds to the spacing of the wheels and the profilograph record will be a strait line.

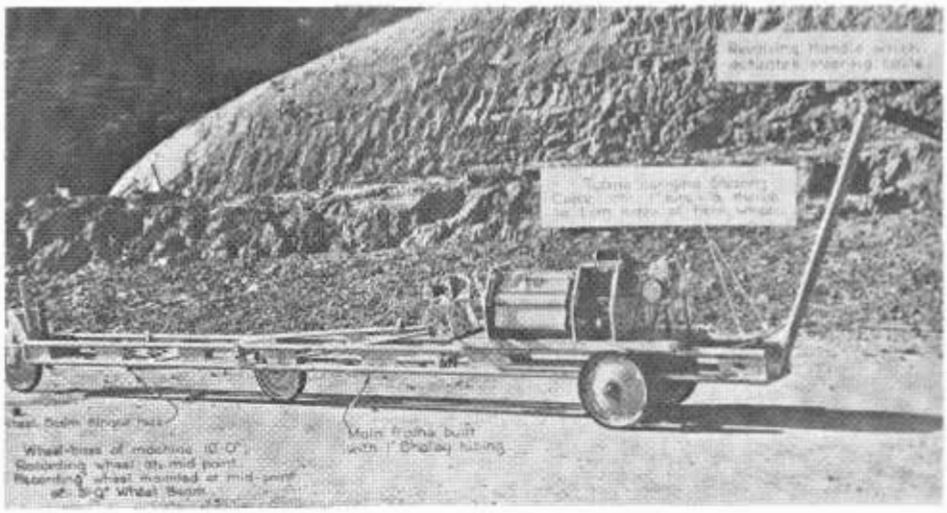


Figure 5. A viagraph designed by the Los Angeles Road Department.

board of the automobile." Modifications and developments of this type have been used for many years in California and by other states and agencies. Constant difficulty was encountered in securing uniformly reproducible readings and results obtained with the same apparatus mounted on different automobiles gave widely different results.

Trailer Unit Developed

The Bureau of Public Roads continued to work on the problem and in *Public Roads* for February 1941 reported on a trailer unit (Figure 3). In principle, this device is similar to those mounted on an automobile except that carefully selected springs, means for dampening and the weight of the unit can be standardized and thus produce an instrument that is not subject to variations such as exist between automobiles of different size and make. This road roughness indicator is probably the one most widely used in recent years, having been duplicated by several states and other agencies. Figure 9 shows traces of the record produced by one of these units operated by Professor R. A. Moyer of the University of California. However, it is subject to the same criticism as applies to recording devices actuated by the front axle of a car. One might quote from an article on "Independent Wheel Suspension" by Maurice Olley, Special Problems Engineer, Cadillac Motor Car Company, "Frequently analysis of a car on the road shows that the average road at normal speeds disturbs the passage of the car by acting as an excitation for the natural frequencies of the car itself. The motion of the car, in other words, is never a true picture of the road surface but is made up of the car-frequencies excited by that particular road surface."

Mr. Olley goes on to discuss the effects of the main frequencies which vary with different cars, the tire frequencies, and the frequencies of the unsprung masses. He further states, "Different types of road excite frequencies of the three groups to different extents." It will be apparent then that the bureau road roughness indicator contains all the elements that exist in the average automobile except, of course, to a considerably different degree. Any recorder actuated by the vertical oscillations of an automobile front axle will show the greatest response to the type of bump which the springs are most effective in absorbing or "ironing" out. Obviously, if a bump on a road is to be felt the

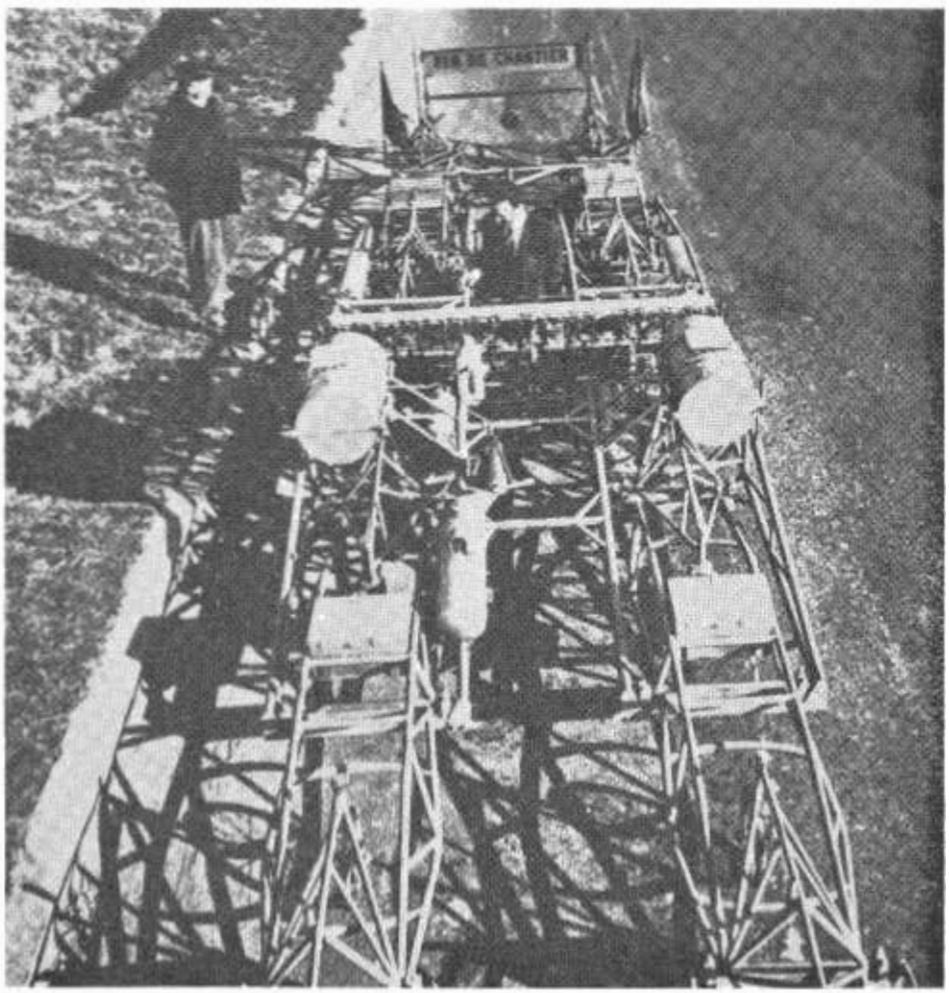


Figure 6. The Viagrahpe-Traceur used in France for delineating the low spots on a pavement preliminary to placing leveling patches.

wheels must lift the car frame and hence there will be relatively less movement between the axle and frame when the shock is not taken up by the springs. While it may be true that rough roads will cause a greater number of vertical movements than will smooth ones, nevertheless a very distorted picture can be obtained from measurements of this type.

German Research

A fairly comprehensive resumé of road profile measuring devices was prepared by Mr. H. Petersen of the Road Research Institute, Technical University, Hanover, Germany, which was published in Strasse in 1939. Many of the following examples or illustrations are taken from Mr. Petersen's compilation.

Undoubtedly, the most simple (even though slow and painstaking) method of gauging road roughness is by means of a straightedge laid on the surface of the road which means, of course, that the straightedge rests on the peaks or high points and the depths of the valleys or depressions are measured from the bottom of the straightedge, a wedge being a convenient means for accomplishing this purpose.

In considering the general problem, it is evident that a true profile of a pavement surface can only be plotted in terms of absolute or relative elevations above some base elevation, sea level, for example. Such profiles are commonplace tools used by engineers for planning and establishing grade lines for roads and are generally developed by plotting elevations from level notes. However, such a process becomes very time consuming and requires painstaking care to produce even an approximately accurate intimate profile of a pavement surface as it will be necessary to take readings every foot or so along the pavement with a high degree of accuracy. However, one or two devices have been built that record the road profile with reference to a carefully leveled beam.

Modification Described

A modification of the simple straightedge is to equip the straightedge with a center wheel that rises and falls as the straightedge is dragged along the surface of the pavement. This is the principle of Brown's pioneer Viagraph and such a device can produce a reasonably accurate record and need not be difficult to construct. However, a straightedge or glider is tiresome and annoying to drag over the surface of a pavement and this drag becomes aggravated if the straightedge is of substantial length.

A third alternative which is an expedient "invented" by many individuals is to equip a beam with one fixed wheel at either end with a center wheel that rises and falls with the inequalities actuating a pointer or a stylus to record this vertical movement on a strip of paper. Many profilometers utilizing this principle have been developed but all have one primary weakness. First, a single bump on an otherwise true surface will be recorded on the graph three times as two depressions and one bump, and if a summarizing counter is used the amount of vertical excursion will be approximately twice that of the true profile. Moreover the aberrations produced by this type of device will vary with the pattern of the road inequalities. A certain sequence of waves can be described for which the recorder will produce a straight line on the graph (Figure 4). These three-wheeled machines will exaggerate some "bumps" and minimize others.

Three-wheel Viagraph

Figure 5 is an example of a three-wheel device with a rather elaborate recording mechanism which was reported on page 12 of *California Highways and Public Works*, December 1939. This Viagraph was designed by Mr. Claran F. Galloway of the Los Angeles County Road Department.

Meanwhile, developments were proceeding abroad. Most of the devices utilize the principle of the Mailander Wave Measurer developed by the Illinois Division of Highways. Other examples utilizing this principle are shown in Figures 2, 6, 8, 16. Through the courtesy of Mr. Raymond Peltier, Director of Research and Testing, Central Laboratory of Bridges and Roads, Paris, France, information has been furnished on developments in France. Two of the French machines are of interest. One (Figure 6) is a large unit equipped with marking devices which delineate by a series of stripes all of the depressions or low spots on an old pavement. These markings serve as a guide to the repair crews who place thin localized patches to cover the markings and hence improve the riding quality by leveling up the surface. A very ingenious design is also used which utilizes the multiple-wheel principle but in a novel fashion. Here the frame of the machine is carried on two center wheels and the individual bogie wheels are interconnected by a continuous cable running over pulleys. These small individual wheels are free to rise or fall, adjusting themselves to the contour of the road surface and, in effect, provide a reference datum for the vertical movements of the frame supported on the center wheels.

Research in England

One of the more interesting and well engineered profilometers was developed many years ago by the engineers of the British Roads Research Laboratory. This multiple-wheel unit employs 16 wheels but so disposed that no two wheels cross the same transverse joint or inequality at the same time. Figures 8 and 9 show the "classifier" from the British machine. This consists of a series of counters arranged to count each complete up and down movement equal to or

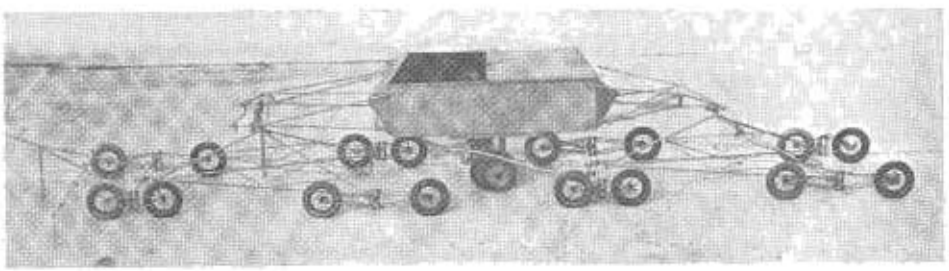


Figure 7. The multiwheel profilometer apparatus of the British Road Research Laboratory.

greater than a given value. Figure 10 shows the unique three-wheeled recording unit used on the British machine.

A distinctly different principle is embodied in the "Profilometer" (Figure 11) used on the A.A.S.H.O. test road. As reported by Mr. W. N. Carey, Jr., Chief Engineer for Research, it consists essentially of a trailer unit which is towed over the track by the instrument van at a speed of approximately five miles an hour. As illustrated by the schematic diagram (Figure 12), the slope assembly S measures the angle "a" between pavement P and trailer bed T. Reference R measures angle "b" between the trailer bed and horizontal. As the trailer is towed over the pavement, two voltages are continuously generated proportional to angles "a" and "b." These voltages are added electronically to produce a voltage proportional to angle "c," the angle of the pavement from horizontal. The tangent of angle "c" (slope of the pavement on a nine-inch wheelbase) is recorded as an analog in a recording oscillograph. The record includes pip marks at intervals of one foot on the pavement and other pips indicating the beginning and end of the test section or area of interest.

Operation Speeded

This device has reported advantages such as reasonable speed of operation, good overall accuracy and reproducibility, and the principle permits use of automatic summarization techniques to develop generalized harmonic analyses as a means of converting the wave form into a few numbers. One might judge that the nine inch baseline will introduce some error or aberrations on short wave length bumps. Figures 13 and 14 represent some typical records produced by this instrument. The total cost is reported to be about the same as the California or Michigan Profilograph; namely, about $25,000. Strictly speaking, this profilometer does not produce a profilogram directly although it is possible to reconstruct the profile by means of an electronic chart reader and digitizer. Figure 15 shows a comparison between the graphs taken with the test track profilometer and with the Michigan machine (Figure 16), over the same section of pavement. It will be noted that there is little apparent resemblance between the actual profile as recorded by the Michigan Profilometer and the tape record recorded by the test track unit. Mr. Carey has stated that the test track profilometer record is actually the first derivative of the profilogram.

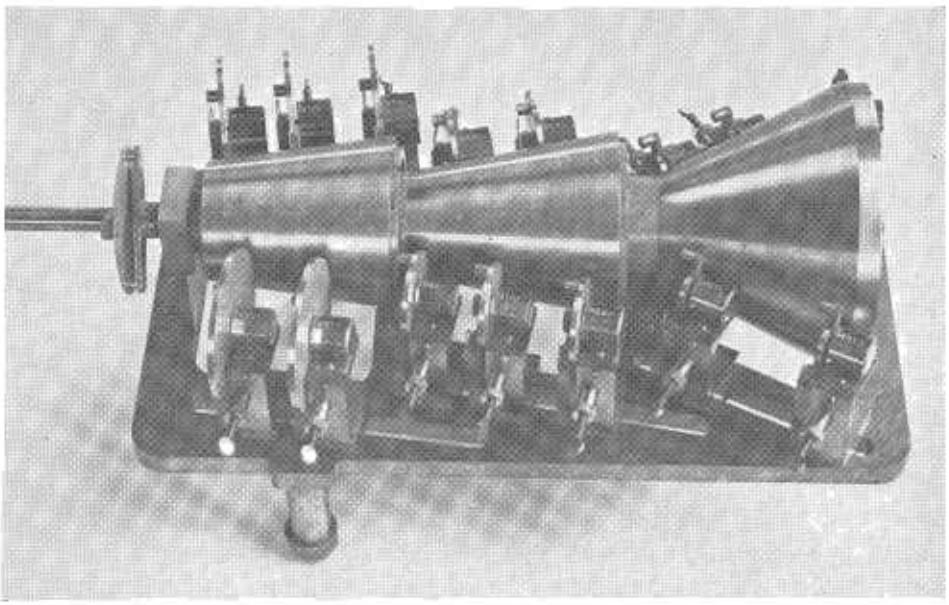


Figure 8. A multiple counter bump classifier used by the British.

Many Approaches

From the variety of devices which have been developed and promulgated by different individuals and agencies, it is evident that this problem has been approached from many different viewpoints, and it is not likely that all will agree upon the relative merits or demerits of the various instruments. It

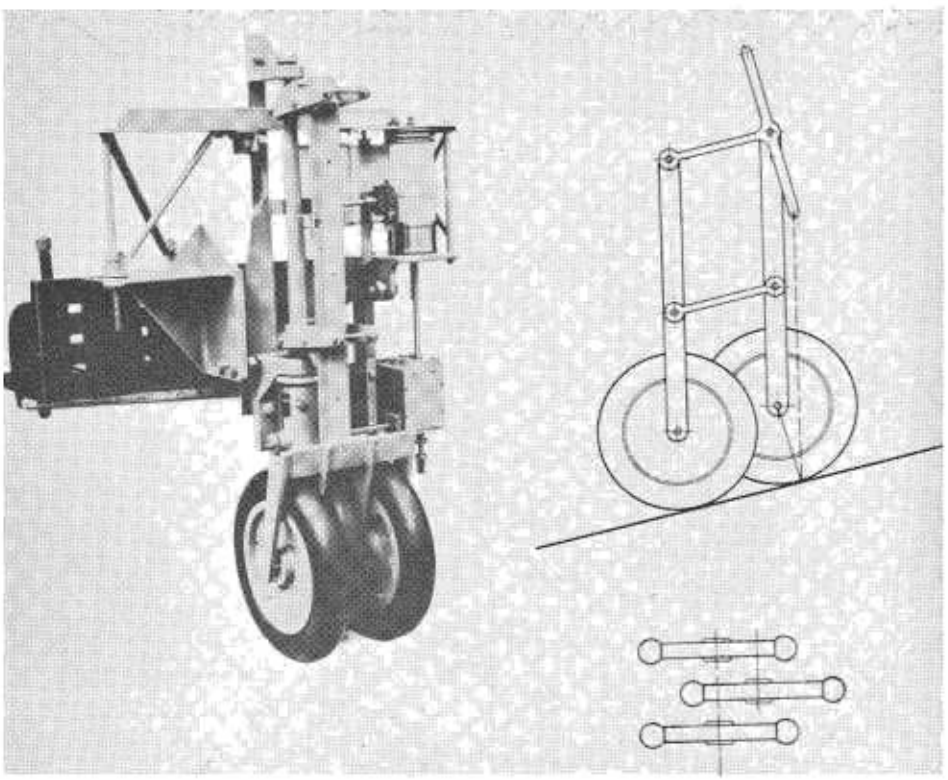


Figure 9. A photo with diagram illustrating the principle of a profile correcting mechanism.

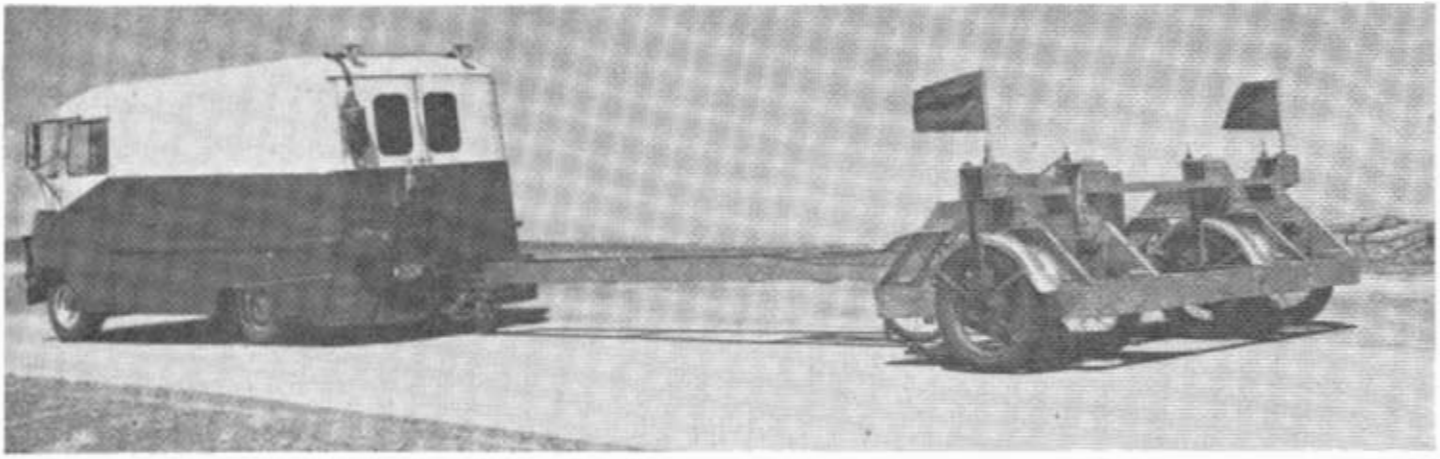


Figure 10. A photograph of the AASHO road test profilometer. (See Figure 11.)

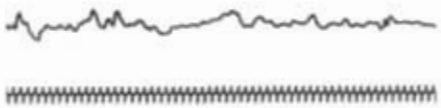


Figure 12. A slope recorder trace of a rough pavement in the AASHO road test (not a profilogram).

Figure 13. A slope recorder trace of smooth pavement in the AASHO road test (not a profile).

seems evident, however, that there are two basic or fundamental differences in the approach. One is to record a profilogram on paper which represents a reasonably faithful picture of the intimate pavement profile. The scale, of course, must be distorted to show up the relatively slight inequalities that are involved in the term "roughness." There are several descriptive terms which are often used more or less interchangeably but which really have different connotations or meaning. One, of course, is the "profile" which represents the contour of the road surface along some single line or path. The term "profile" carries no implication as to whether or not the surface is smooth or rough. The term "pavement roughness" is also frequently used. This, of course, leaves the impression that all pavements must be rough to some degree which, of course, they are.

The second approach is the attempt to measure "riding qualities" which is a term often used more or less interchangeably or confused with the word "roughness." It seems important to emphasize here that the individual who uses a road and drives a vehicle over a pavement is really not much concerned with roughness and even less with considerations of a profile, but is primarily and almost exclusively aware only of the "riding qualities." The term "riding qualities" means the response of a particular individual in a particular vehicle to the particular road surface at typical speeds of operation. The point I wish to emphasize is that an engineer cannot specify such a subjective attribute as "riding qualities" nor can he directly order a pavement contractor to achieve this somewhat elusive condition. By tradition, an egineer or a construction man works to line and grade and hence he can only be expected to produce a finished *profile* within certain limits of variation. We might, therefore, conclude that the profile is the aspect which is of most interest to the engineer.

Basic Assumptions Made

As mentioned by Mr. Olley (quoted above) the roughness of the pavement must be regarded as the source of excitation for the natural frequencies of the vehicle. Most will assume that a perfectly smooth road having neither bumps nor low spots will not excite the vehicle or the passenger and consequently will be smooth riding but there is considerable reason to believe that the most pleasant riding highway surfaces are not those that follow a true plane; on the contrary some undulation in the road surface may break the monotony and definitely add to the pleasant sensations of riding in a motor vehicle. Referring to the profilometer developed and being used on the A.A.S.H.O. test road it might be said to develop some index to the excitation elements in the pavement surface.

It will appear then that the expedients or devices that have been used fall into seven classes which may be described as follows:

. . . Continued on page 68

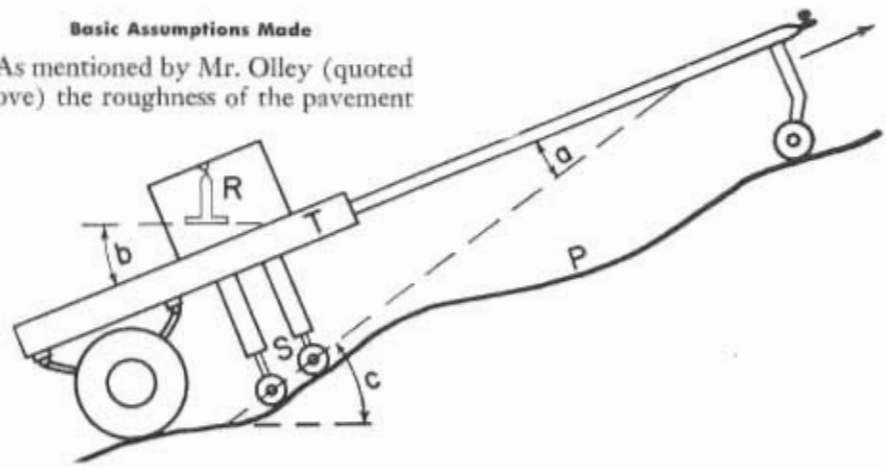


Figure 11. A schematic diagram of the AASHO road test profilometer. (See Figure 10.)

Esplanade

Chico's Historic Roadway Made Divided Four-lane

By E. M. WALL, Resident Engineer

In the 70th anniversary year of its dedication as a monument to the foresight and planning of General John Bidwell, the contract was let in May 1959 for the widening of the main roadway of Chico's famous landscaped Esplanade to accommodate the climbing traffic volume of this rapidly growing Sacramento Valley area.

From dirt to gravel to concrete, it is the fourth surfacing improvement but only the first alteration to the original plan of the Esplanade, with its tree-lined, multipurpose traffic provisions, since it was first laid out 90 years ago—a tribute indeed to Bidwell's vision.

The Esplanade carries one and one-half miles of U.S. Highway 99E from Big Chico Creek, just north of the center of town, to Lindo Channel, about five blocks north of the city limits. It also serves as a main access road to Chico's central business district from the northern residential section. One-way side drives serve the abutting property which is largely residential.

A history of the colorful Esplanade appeared in the May-June 1949 issue of *California Highways and Public Works*.

John Bidwell came to California in 1841 and eight years later purchased a large ranch in the northern Sacramento Valley, then covered with oak trees and tall grass. From this came Chico, founded by Bidwell, and the highly cultivated agricultural area that today surrounds the city.

About 1870 Bidwell planted six parallel rows of honey locusts the full length of what is now the Esplanade. They were all removed in 1914 when they had grown old and maintenance costs had become prohibitive. Two years later they were replaced with six rows of European sycamores, the present trees. The larger part of the Esplanade was annexed by the City of Chico in 1918.

Bidwell designed the Esplanade to carry the heavier carts and wagons as well as through traffic down the center lane which he flanked on either side with a parkway of double rows of trees. In the early days the east parkway was frequently used by horseback riders, and the west parkway was for many years Chico's famous Bicycle Path. With the coming of street cars to Chico, about 1905, the equestrian path was given over to car tracks which are still existent.

Adjacent to the park strips, Bidwell placed outer roadways with a final row of trees that fronted on what later became a choice residential district. Bidwell originally specified that no gravel was to be placed on the side drives, which were reserved for more leisurely travel. But with increasing traffic and the building of fine homes along the Esplanade, the dirt drives became obsolete and were surfaced in 1923.

Roadway is Widened

The graveled main roadway had been replaced with a 15-foot concrete pavement in 1915. Immediately prior to the current widening project the main roadway was a 40-foot, two-lane asphaltic pavement with the original concrete serving as the base of the center. It now has been widened to a four-lane, divided, signalized street with left turn pocket lanes at approximately every other intersection. Previously each cross street went through.

A view of the Esplanade after it had been widened to carry increasing US 99E traffic through the City of Chico. Memorial Way intersection in the foreground.

The side drives were retained as they presently exist.

The new dividing strip will be landscaped with trees and shrubs, except that areas too narrow for planting will be paved. An irrigation system to serve landscaping in the median and remaining separation between the main road and side drives is included in the present contract. Planting will follow completion of the highway as a separate contract.

The project was the result of several years study to find a solution, acceptable to the City of Chico, to Butte County, and to the State, to the problem of handling an increasingly high traffic volume. The 1954 average daily traffic count of 17,500 vehicles, as well as a record of numerous rear-end collisions involving vehicles making left turns, pointed up the need for the present improvement.

Considerable adverse public opinion developed when proposed plans were announced calling for removal of the two rows of trees immediately adjacent to the main road to provide space for necessary widening. The tracks were to remain, but without the separating row of trees. The old Bicycle Path and its inside row of trees was to be eliminated in order to allow for the two additional lanes and new median.

Public Informed

City of Chico officials undertook the job of informing the public about the need of the improvement and its favorable completed appearance. They achieved excellent results through public meetings, mass media, and publication of an illustrated pamphlet showing before-and-after drawings, cross sections, maps of the entire route, and vehicular traffic count chart.

Only one complaint regarding the trees was received at the field construction office, and that was when limbs from trees that were to remain in place were being trimmed to give the required 18 feet clearance above the new pavement.

The project was designed as a joint undertaking by City of Chico, Butte County, and state engineers. The Division of Highways developed the plans and specifications with city and county concurrence on design details. The city and county handled negotiations with the five utility companies whose easements and prior rights-of-way were involved, and acquired necessary additional highway right-of-way near the northern terminus of the job. Ordinarily on state highway projects all the above phases are handled by state personnel.

Bids for the project were opened May 6, with A. Teichert and Son, Inc. of Sacramento low at $490,740.90.

The contractor began tree clearing operations May 26 and removed both rows of trees adjacent to the old main road in about two weeks. Clearing had to be done under heavy traffic conditions, but without serious delay to through traffic. In one instance it was advisable to stop all through traffic for 10 minutes while removing one very large overhanging limb.

Meetings Held

Early after the bid opening, individual meetings were held with each of the utilities concerning relocation of their facilities. Because of the large number of utilities involved, and the possibility of conflicts between the contractor's and utility companies' work forces, a meeting was called of representatives of all utilities, the contractor, subcontractors, and the resident engineer.

During this meeting all were advised of the necessity of keeping through traffic moving at all times. It was also explained that city and county street connections with the Esplanade could be closed only as permitted by the resident engineer, and that all reasonable efforts should be made to see that local residents as well as through traffic have the least possible inconvenience. The work of the contractor and each of the utility companies was discussed, and schedules, including when and where each would work, were set up with the condition that all adjustments to the schedule be cleared through the resident. This arrangement worked out very well and all utilities completed their work within one week of their schedules.

The requirement to keep 24 feet of pavement available to through traffic at all times dictated that southbound lanes—partly lying over the site of the old Bicycle Path—be constructed first. The limited working width, approximately 28 feet, in which to construct the southbound lanes created several problems. One major obstacle was the requirement to compact original ground to 30 inches below finished pavement grade.

Various Methods Tried

The roadway section was first cut to subgrade elevation, 17 inches below finished grade, and various methods and types of equipment were tried to determine which would provide the required degree of compaction. The only method that proved successful was to excavate and windrow a half width at a time to 24 inches below finished grade, and to scarify and compact back to subgrade in four-inch layers with a sheepsfoot roller. The fine, sandy silt material on the site required that the moisture be held to 3 to 5 percent above optimum to get the required compaction.

Because of simultaneous operations by the contractor and subcontractors, care was exercised to insure that the work was done in such a way that no more than two adjacent city streets, or, in some cases, only every other street, were closed at the same time. As a result, a minimum of complaints has been received from adjacent property owners including the few business firms on the Esplanade.

Average daily traffic passing through construction has been 18,000 with 1,400 during the peak hour, 4.30 p.m. Peak-hour traffic has recently increased at the southern end of the project with the start of school. Chico State College, Chico High School, and the Junior High School are all adjacent and have outlet streets to the Esplanade. To date there have been no serious traffic accidents in the construction area.

Ken Fox was project superintendent for the contractor, and D. M. Young was the Division of Highways construction engineer for the project.

INTERSTATE JOB COMPLETED

Highway projects completed during December include 8.8 miles of four-lane interstate freeway on US 40 in the Sierra Nevada Mountains costing approximately $8,952,400.

Grant Line

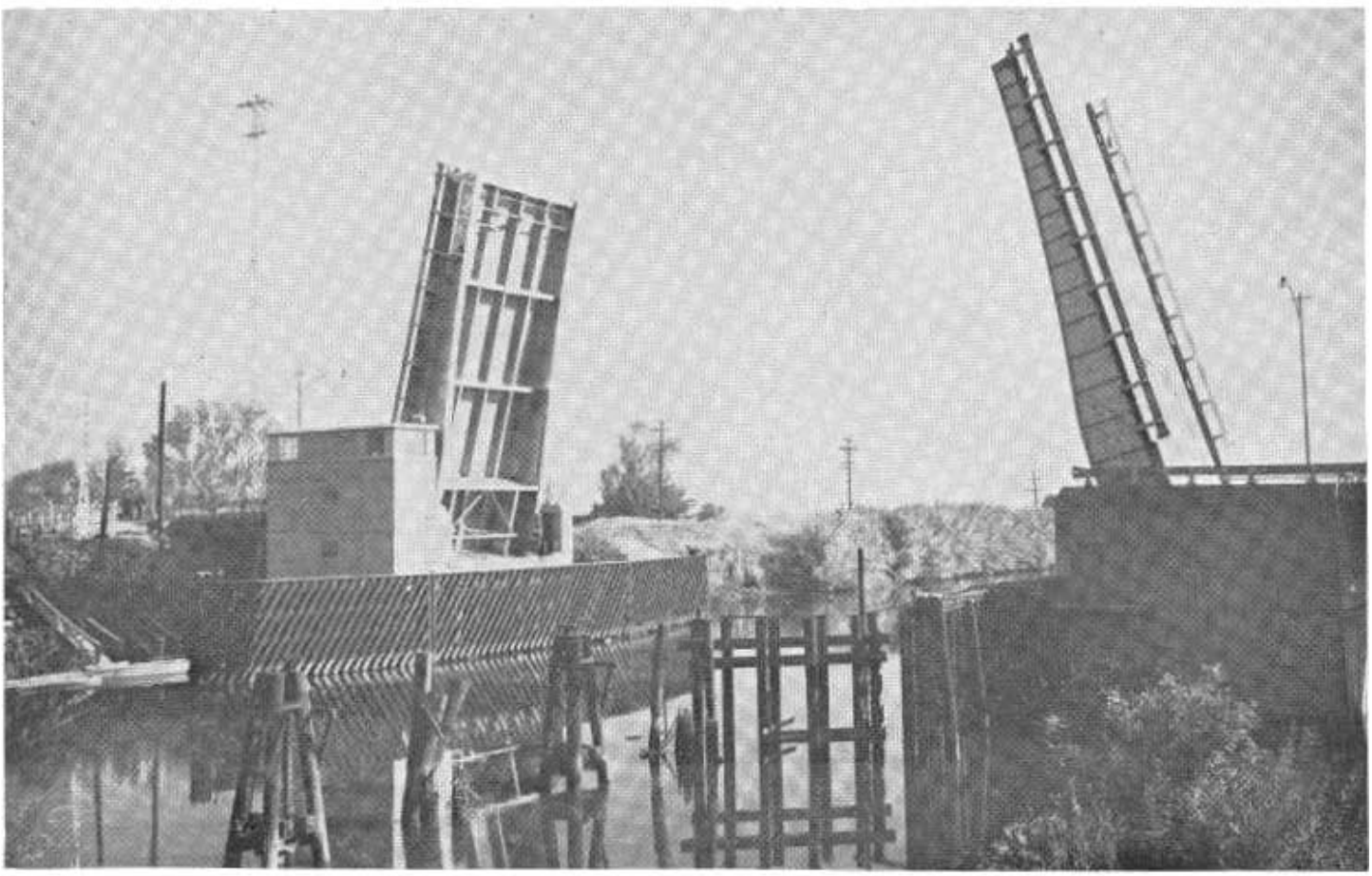
Bascule Span Drawbridge Built Across Canal With F.A.S. Funds

By CLEMENT A. PLECARPO, Deputy Director of Public Works, County of San Joaquin

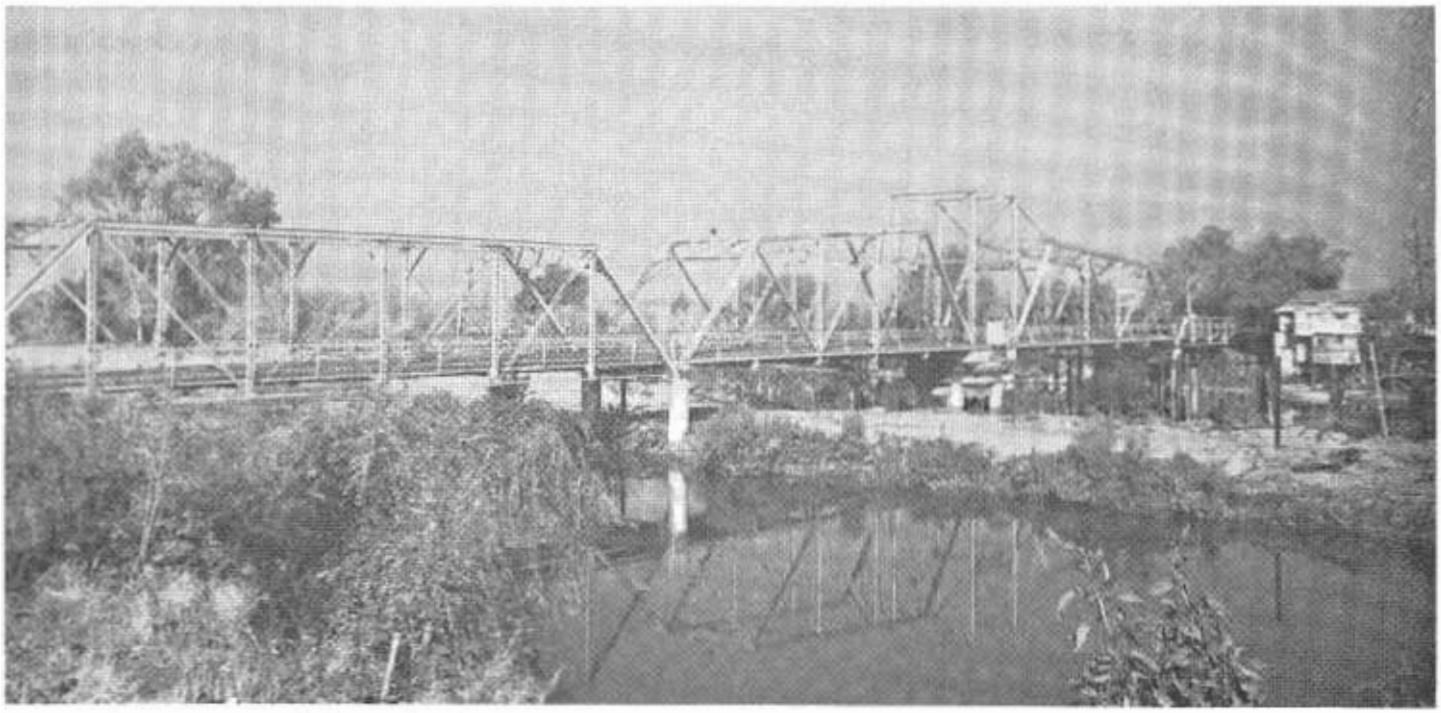
On April 27, 1863, the State Legislature approved an act which provided for the legal procedures necessary in order to acquire swamp and overflow lands. On May 26, 1877, William Irwin, Governor of California, signed a patent granting to Tide Land Reclamation Company the title to all lands between Middle River and Old River, lying north of "El Rancho Pescadero" (now Union Island and Victoria Island located north of Tracy in San Joaquin County). An attempt to reclaim the land was made by the Tide Land Reclamation Company along with George W. Kidd, Thomas H. Williams and David Bixler. The attempt apparently ended in failure because on April 15, 1879, the company conveyed to Williams and Bixler all of the lands involved.

It was sometime during the period from 1882 to 1890 that Williams and Bixler constructed the "Grant Line Canal," sometimes referred to as the "Bixler Canal." The two men constructed it on their own land north of the "Grant Line," and proceeded with the reclamation of their land with some help from the United States Government, who put a dam in Paradise Cut. Later, Phillip Fabian and others constructed a canal immediately south of the Grant Line Canal using horses with Fresno scrapers. Thus, was a manmade barrier placed between the fertile island country to the north, and the shipping point of Tracy to the south.

On September 6, 1904, the board of supervisors directed the county surveyor to prepare plans and specifications for a steel drawbridge across Grant Line Canal. On May 2, 1905, bids were opened with Clark and Henery of Stockton the lowest of eight bidders at $18,770. The high bid was $24,579. The structure consisted of one 230-foot steel through truss swing span; one 126-foot through truss fixed span; one 70-foot, and one



The new double bascule span drawbridge over the Grant Line Canal constructed by San Joaquin County under the Federal-aid Secondary Program.



The original Grant Line Canal bridge completed by San Joaquin County in 1906. Although still standing, it is incapable of carrying heavy tonnage trucks.

60-foot pony truss spans supported on concrete cylinder piers and concrete abutments for a total length of 496 feet. On May 8, 1906, the County of San Joaquin accepted the bridge as completed.

On August 29, 1904, Bixler had conveyed to the County of San Joaquin right of way for a road across Union Island and for approaches to the proposed bridge. On March 17, 1906, Fabian and his associates conveyed for $175 two acres of land for the southern approach. Thus was the manmade barrier broken and a route opened from Stockton through the rich delta islands to the City of Tracy.

Time and the continuing development of mechanical vehicles forced the posting for restricted load of 16 tons per vehicle, 21 tons per semi-trailer combination, and 25 tons per truck and full trailer. Thus was a barrier again placed by man between Tracy and the rich delta islands.

The county attempted to break the barrier in 1946 and 1947 by preparing plans and specifications to construct a new bridge as an F.A.S. project, but the estimate of cost was higher than the county could finance and the project was dropped.

In 1956, the board of supervisors, upon the recommendation of Mr. L. H. Bradley, the Director of Public Works for San Joaquin County, authorized the construction of the Grant Line Bridge as an F.A.S. project and on July 26, 1957, a joint field review was held at the site with state, county and federal representatives in attendance. An agreement was made between the State and the county whereby the Bridge Department of the State Department of Public Works would design and prepare the plans and specifications with the county assuming all of the costs. This work was done under the direction of W. C. Kiedaisch. The bridge consists of 12 reinforced concrete slab spans, and one double-leaf bascule span with a lightweight concrete deck, about 471 feet in total length supported on prestressed concrete pile piers, prestressed concrete pile abutments, and reinforced concrete piers with concrete pile foundations, and providing a clear roadway width of 28 feet.

On September 19, 1958, a contract was awarded by the Department of Public Works to Erickson, Phillips and Weisberg, they being the low bidder for $588,847. Ross Phillips was the superintendent for the contractor, who prosecuted the job so capably that the bridge was completed several months ahead of the time limit.

In the late summer of 1959, the County of San Joaquin awarded a contract to A. Teichert and Son, Inc., for the construction of bridge approaches and that portion of Tracy Road (F.A.S. 907) between Grant Line Canal and Old River, at a total contract cost of $95,675.48. Herman Smith was superintendent for the contractor.

Preliminary and construction engineering were performed by San Joaquin County under the direction of L. H. Bradley, Director of Public Works. C. W. Hedstrom was resident engineer for both the bridge and road projects, and I feel did an outstanding job on a difficult project.

On November 5, 1959, dedication ceremonies were held. Many county, state and City of Tracy officials participated, including Supervisors Bruce McKnight, W. R. Ruggles, Edmond Heinbockle, and C. B. Bull, without whose help the project would not have been possible.

Thus, at a cost of about $700,000, the barrier between the Tracy area on the south, and the island area and the City of Stockton on the north, had been broken.

So ends another chapter in the history of the "Grant Line."

Visitors

Foreign Engineers From Many Nations Study L.A.'s Freeways

By MILTON C. STARK, District Information Officer

THE State of California, with its 7,500,000 motor vehicles use 14,000 miles of state highways and freeways, has become a world leader in highway development. It is, therefore, only natural that many countries wishing to improve their transportation facilities would seek information here, where modern highway and freeway construction has been pioneered and developed.

District VII of the State Division of Highways has in this respect been a popular meeting ground for foreign engineers from many countries. Within the space of a single month the district has been host to engineers from Japan, Switzerland, Australia, New Zealand, Denmark, Sweden, Viet Nam and India.

A team of Japanese engineers, headed by Dr. Kiyoharu Utsumi, President of the Japan Construction Mechanization Association of Tokyo, visited District VII on September 14 and 15, on one leg of an inspection tour that takes them through the United States to observe techniques in the heavy equipment field. The team was traveling under the auspices of the International Co-operation Administration of Washington, D.C. Accompanying the 12-engineer team was Ramsey Stobie of Training Within Industry, Incorporated, and Mr. Howard Christensen of the U.S. Bureau of Public Roads.

The engineers were briefed on policies and procedures of the State Division of Highways by E. T. Telford, Assistant State Highway Engineer, in charge of District VII. Also on hand to discuss construction methods and equipment was Ike Brown, Assistant General Manager of the Associated General Contractors.

Freeway Tour

On September 15 the Japanese group toured District VII freeways, which included picture taking at the four-level structure, and a trip over portions of the Golden State Freeway, the Ventura Freeway and the Mulholland Cut on the San Diego Freeway.

Guides on the tour were Herb Belford of the Construction Department and Fred Fujimoto, Project Engineer of Design A who also acted as interpreter. Fujimoto served as interpreter for the United States Army in the Far Eastern Theater during World War II.

The Japanese engineers were impressed with the extent of the District VII freeway system and the enormous traffic loads it carries. They felt that their own traffic complex on the islands of Japan—1,700,000 motor vehicles on 6,000 miles of paved highways—could benefit from adoption of a highway and freeway program modeled after our own.

Following the Japanese delegation came engineers from Australia, New Zealand, Denmark and Sweden. The more numerous Swedish group arrived in the district office on October 5 and spent two days discussing and touring local freeways, aided by guides James McMahon, Southern Area Bridge Engineer, and Bruce Gentry, Construction Engineer.

As acutely interested in freeway progress as their Japanese forerunners, the Swedish group shot film and took candid shots of the four-level structure in the Civic Center, later making an inspection trip over portions of the Santa Monica, Golden State, Santa Ana and Harbor Freeways. The engineers took on-the-spot notes on port-

Bruno Wildermuth, Swiss engineer (center) views an aerial photographic map of the Greater Los Angeles Freeway System with District Engineers L. R. Gillis (left) and A. L. Himelhoch (right).

A. K. Aga (left), chief town engineer for Jamshedpur, India, confers with E. T. Telford, Assistant State Highway Engineer (Los Angeles Times photo).

A group of engineers and officials from Japan visit the four-level grade separation in downtown Los Angeles. Standing at right is Ramsey Stobie of the Training Within Industry Corporation of Cleveland, Ohio, who led the group on their tour.

able wire recorders for later transcription.

New Technique Used

McMahon found that the visitors were very much interested in bridge building, design and construction, particularly in our use of single column bents, box girders and prestressed concrete and that these techniques were in use in their own country. A unique bridge building procedure used in Sweden is the construction of reinforced concrete bridges by cantilevering out from concrete piers balancing the successive pours. This practice is not prevalent in the United States for reinforced concrete bridge construction, although it is common procedure for structural steel bridges.

Swedish concern with bridge building is occasioned by growth of highway transportation and the fact that many of their roads must pass over deeply indented shore lines, rivers and islands.

On October 13, 1959, a Swiss engineer from Zurich, Bruno Wildermuth, called at the district office, culminating an 18-month stay in the United States, during which he was employed by American engineering firms and attended engineering courses in New York City and at the Institute of Transportation and Traffic Engineering at Berkeley, California.

Wildermuth came to the United States, and especially to California, to research transit and transportation problems and relate them to freeway development. According to Wildermuth, Switzerland, too, is facing growing traffic problems and will require an expanded network of mainline highways to bolster its present overtaxed system which is handling an estimated 600,000 motor vehicles. He noted that the trend in transporting persons and goods is via the highways, and that the metropolitan street car lines and the railways increasingly are occupying a secondary place; hence, the necessity for freeway or expressway planning in Switzerland. The Swiss driver pays 85 cents per gallon for his gasoline, 80 percent of the tax revenue from which is used by the Swiss government for construction of the national highways that are built by both cities and cantons to uniform standards, as with our own interstate highways. Swiss automobiles are all imports, fueled by petroleum products from the Near East, yet cost of gasoline in Switzerland is less than in any other neighboring country.

Viet Namese Road Builders

Even distant South Viet Nam, the Far Eastern country bordering the South China Sea and formerly known as French Indo China, is giving its attention to a new road building program to meet the demands of a growing economy. It is a country of some 11,000,000 inhabitants occupying a land area of approximately 700,000 square kilometers; it has 14,000 kilometers of paved and unpaved roads extending through mountainous terrain. South Viet Nam's 100,000 motor vehicles, 30 percent of which are trucks, pay 40 cents per gallon for gasoline.

Here in the United States on a 2½-month tour to study road construction techniques were two Viet Namese, Nguyen Van Dinh, Director General of Public Works, and Nguyen Huu Tuan, Bureau of Foreign Aid, Ministry of Public Works.

The Vet Namese officials, who arrived in Los Angeles on October 16, said that Viet Nam was constructing 200 miles of new roads per annum with American financing and technological assistance. Their purpose in visiting District VII was to study road construction, maintenance methods and equipment.

At the conclusion of their visit they were taken on a field inspection trip over portions of the Angeles Crest and Pearblossom Highways by Howard Christensen of the U.S. Bureau of Public Roads.

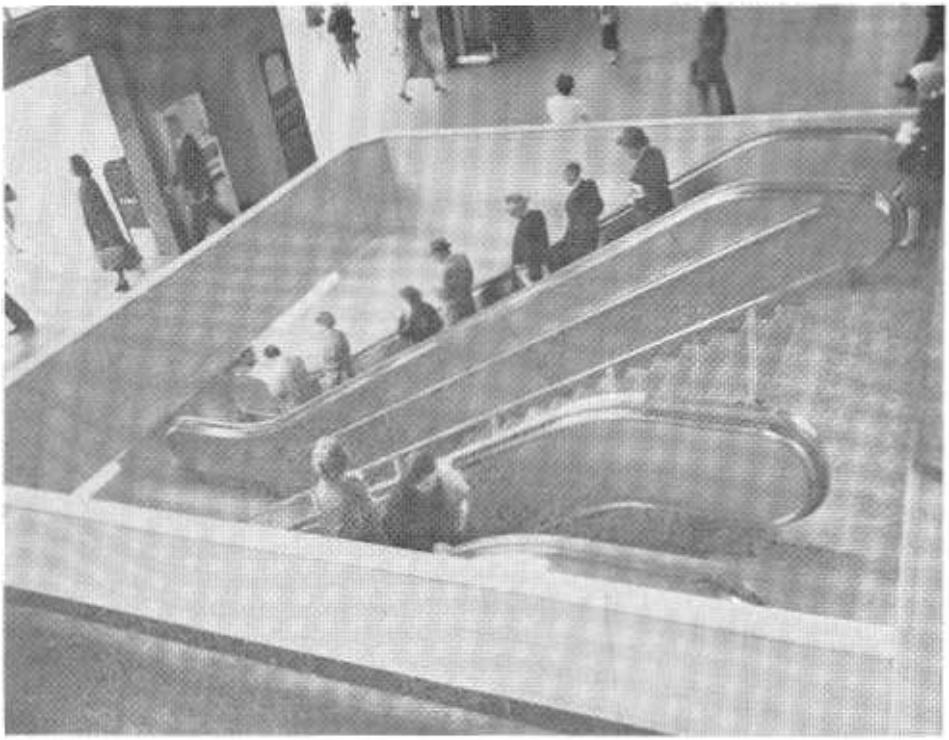
A. K. Aga, Chief Town Engineer for the City of Jamshedpur, India, conferred with engineers in the District VII Office and was taken on an inspection tour of Los Angeles freeways during the week of October 19.

Aga said that the rapidly expanding City of Jamshedpur now has need of a freeway to handle the growing numbers of motor vehicles. A 280-foot right-of-way carrying two lanes of traffic each way and centered by some sort of railway is planned. There will be another slight difference between the Jamshedpur freeway and ours: It will have to have some provisions for bicycles.

WARLOW ELECTED

The California Highway Commission has elected Chester H. Warlow of Fresno its vice chairman to succeed James A. Guthrie, San Bernardino, who has served as vice chairman for the past year.

REMODELING OF S.F. TRANSIT TERMINAL CONTINUES



Included in the remodeling of the Transbay Transit Terminal in San Francisco was the installation of a new stairway flanked on both sides by escalators leading from the lobby to the mezzanine level.

Included among the improvements planned by the Division of San Francisco Bay Toll Crossings in connection with the reconstruction of the San Francisco-Oakland Bay Bridge is the rehabilitation of the Transbay Transit Terminal. A ruling of the Public Utilities Commission ordered the abandonment of train service across the bridge and into the East Bay, which became effective April 20, 1958.

The elevated track area from the San Francisco Anchorage which faces Beale Street in San Francisco, around the Terminal Loop, and through the building, has now been repaved and the 14 motor coach lines of the Key System Transit Lines are now operating out of the terminal, thus relieving the city streets of this traffic.

Since the abandonment of train service, the transit terminal has been operated by the State. A program providing for the general rearrangement of the various services in the building and the refurbishment of both the interior and exterior of the structure has been started.

Included in this remodeling was the construction of a new stairway to the garage area below the street level, the installation of fluorescent lights in the main waiting room and on the mezzanine floor, the opening of various previously closed areas for freer movement of pedestrian traffic throughout the building, the constructing of a new ticket office, and the installing of a new stairway flanked on both sides by escalators, leading from the lobby to the mezzanine level.

The escalators are 48 inches wide and transport 135 passengers per minute at slow speed, and 180 passengers per minute at fast speed. The direction of the moving stairway can be changed to accommodate peak traffic flow in either direction. All possible safety devices have been incorporated in their installation.

The terminus with its new facilities and the improved transit service to the East Bay should induce a larger number of persons to use public transportation. With buses transporting an average of 22 passengers per trip, compared with less than two persons per car, the traffic congestion on the bridge, particularly during the peak periods, would be somewhat relieved.

Chemical Engineer E. D. Botts Retires

Dr. E. D. Botts, Senior Chemical Testing Engineer, retired on January 1, 1960, after 10 years of service with the Materials and Research Department and a total of 25 years in state service.

DR. D. E. BOTTS

Botts is widely identified with the excellence of paints used by the Division of Highways for improved traffic striping and the protection of structural steel. In recent years he has pioneered the use of epoxy resins as binders and adhesives and has received national recognition for his work.

He was born in Missouri in 1893. He attended schools in Missouri and Oregon and later received his Ph.D. degree at the University of Wisconsin.

Botts served in the U.S. Army during World War I. In 1924 he became chief chemist for American Marine Paint Co. in San Francisco. From 1928 to 1944 he was a professor of chemistry at San Jose State College. Subsequently he acted as a technical adviser to the Small War Plants Corporation and the U.S. Department of Commerce at Los Angeles. He also served for two years as research chemist with the Veterans Administration at the Birmingham Hospital in San Fernando Valley.

In 1950 he came to the Materials and Research Department as Senior Chemical Testing Engineer, a position he has held until his retirement.

Botts was married in 1929 to Gretchen Kroncke. He and Mrs. Botts have left Sacramento on a three-month tour around the world after which they expect to resume their residence in Sacramento.

BILLION MARK PASSED

A summation of the Division of Architecture's construction program over the 20-year period 1941 through 1960 (including projects under consideration for the 1960-61 Budget) totals over $1 billion.

Freeway Benefits

Madera Freeway Reduces Accidents, Congestion, Recent Survey Shows

BASED ON a recently completed comparison of accidents before and after it was opened to traffic last year, the new Madera Freeway can be credited with a large reduction in traffic accidents and persons injured and killed.

E. W. Taylor, District VI Traffic Engineer, reports that during the last year when all U.S. 99 traffic used the former F Street route through Madera, there were 154 accidents reported by the California Highway Patrol and the Madera City Police Department in the 3.7 mile section that was later superseded by the freeway. The freeway was opened to traffic on October 1, 1958, and during the one-year period until September 30, 1959, there were only 33 accidents on the former route, now designated as "U.S. 99 Business," and 15 on the freeway. This total of 48 represents a 79 percent decrease.

The number of persons injured and killed also showed a marked decrease to less than half the former number, it was reported by Taylor. During the last year before the freeway was opened, there were 49 persons injured and one killed on the F Street route, while only 15 were injured on the old route and seven on the freeway during the year ending September 30, 1959, a total of only 22. No fatalities have occurred on either the business route or the freeway since the latter was finished.

In terms of the number of accidents in relation to the volume of traffic, the comparison indicates the pronounced effect freeway construction has on accident frequency, even on a superseded route. During the last prefreeway year, the accident rate was 7.9 accidents per million vehicle miles of travel on the former route. This dropped to 6.5 accidents per million vehicle miles for the portion remaining on the F Street route for the smaller amount of traffic it carried after the freeway was opened. The freeway rate is a very low 0.9 accidents per million vehicle miles, lower even than the statewide average of 1.2 for all California freeways.

Recent traffic counts show that the average daily traffic on the freeway is now about 12,700 vehicles, with an additional 4,300 a day using the Business 99 route. The sum of these is a 2 percent increase over the 1958 average volume carried by the F Street route.

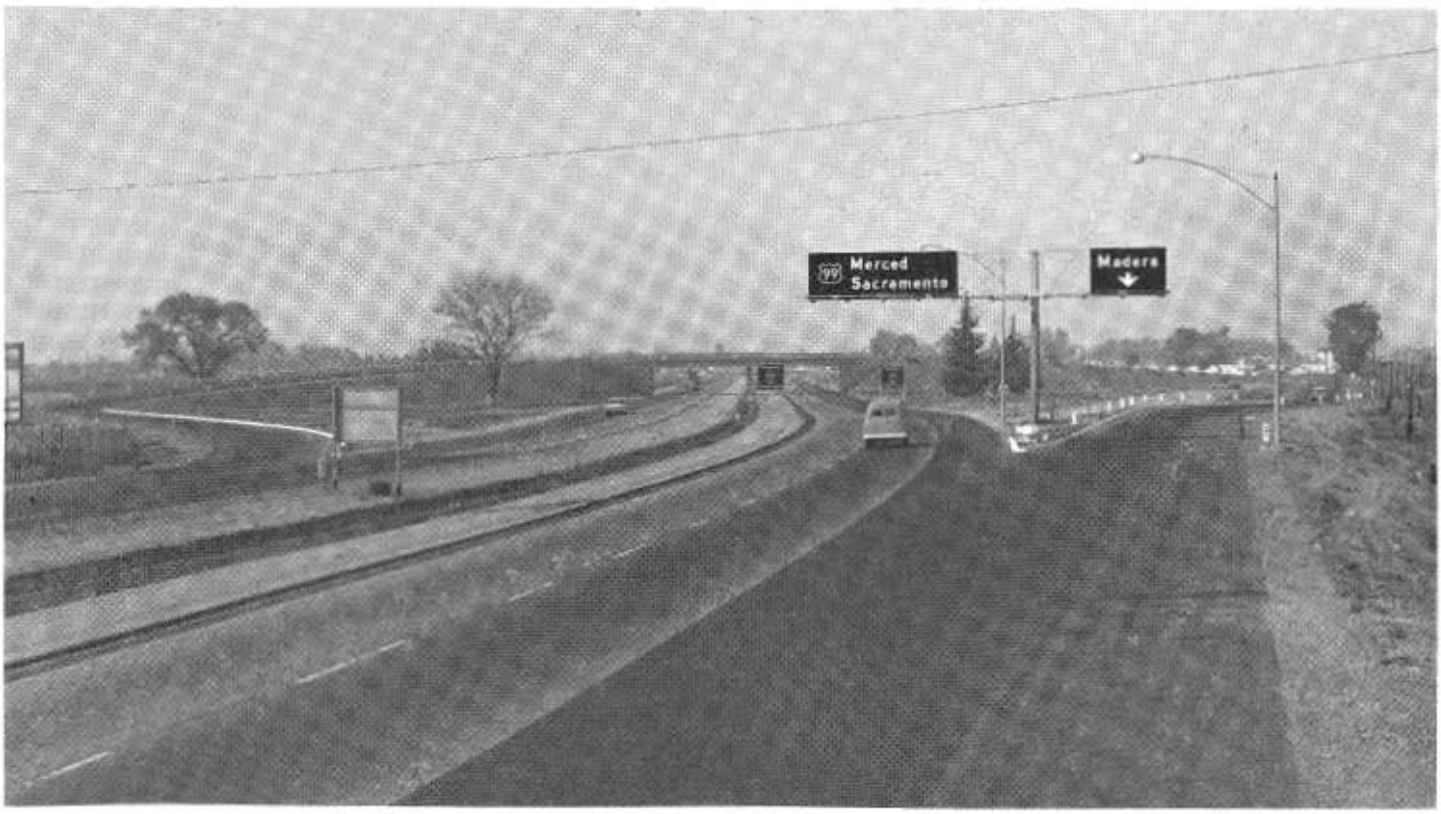
Other advantages accruing since the freeway was opened were outlined in the following editorial entitled "Some Freeway Hindsight" from the Madera *News-Tribune* of November 27, 1959:

> It has been over one year and two months since Madera's new freeway opened (September 1958). As a result, there has been considerable adjustment for many F Street businesses. After the initial loss of traffic, it seems a reasonable amount has been regained.
>
> We notice a good flow of customers at the principal restaurants. Readers will recall that experts predicted an immediate loss of business for all those dealing with through highway traffic. They said this would gradually readjust with a gainback of through traffic stopovers and better local use because of improved traffic conditions. Whether the previous peak would be reached could not be assured, because it depended on quality of service and proper advertising.
>
> We feel this has been fairly well accomplished. At least northbound traffic has an easy ingress to the city via F Street. It is harder for southbound traffic to get off the

. . . Continued on page 62

A view of the Madera Freeway looking north at the Fourth Street overcrossing. Landscaping of the freeway includes the planting of oleanders along the dividing strip and pyracantha on the slopes.

A low-lying species of pyracantha was planted on the slopes of the Madera Freeway to give an effective yet attractive ground cover.



A view of the Madera Freeway showing the turnoff for local traffic at the south end of the city.

FREEWAY BENEFITS

Continued from page 60 . . .

freeway, due to the overpass necessary. This, at least, doesn't look as inviting to the travel as the south entrance.

Service stations, naturally, have suffered the most. Some have just closed up and taken other locations. Grocery stores, lumber yards and other retail businesses have profited the most. Their businesses are more easily accessible than before. Who can forget crossing F Street in the midst of noisy truck and tourist traffic, plus local cars and trucks. It was hazardous, to say the least.

At any rate the depressed freeway on old H Street seems to have been accepted. Cross-town traffic has been improved and access to Highway 99 certainly from Fourth Street and Olive Avenue, is simple.

In keeping with its promise, State Division of Highways has landscaped the depressed section sides. When the plants mature, a park-like effect will be for all to see who pass through Madera. Local residents also, we are sure, will view with pride the total effect.

Sign Fee Increase Is First Since 1933

A revised schedule of permit fees for advertising signs along California's highways and county roads will be in effect in 1960.

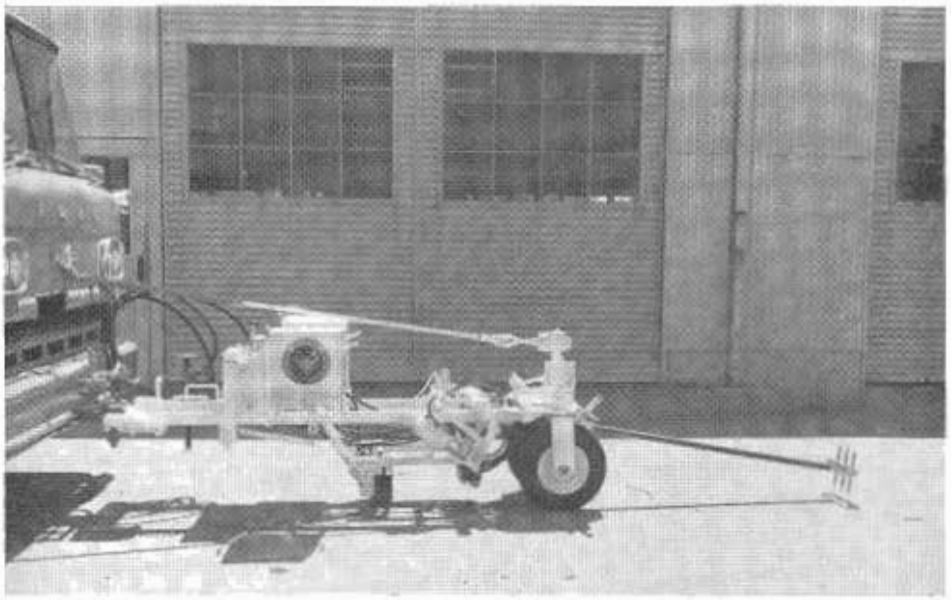
The 1959 Legislature increased the fees for permits and licenses issued under provisions of the California Outdoor Advertising Act, which regulates the placement and design of signs and billboards along state highways and county roads outside incorporated cities.

The fee increases are the first since the act was adopted in 1933. The money from permit and license fees, approximately $125,000 a year, is used by the Division of Highways to pay the cost of administering the act.

According to this statute, signs must meet minimum state requirements so as to have no adverse effect on traffic safety or highway efficiency. Signs must also conform with local land use and zoning ordinances independently administered and enforced by many of the counties.

Sign permits are issued by the State on a calendar-year basis and must be renewed each year.

NEW STRIPER MODEL OPERATED FROM TRUCK CAB



Experimental model of new traffic striping unit developed by the Equipment Department at its headquarters shop in Sacramento. This model will replace the unit that requires the operator to ride in the sulky (See photo below).

The Equipment Department has long recognized the advantages of moving the traffic line striping machine operator out of the sulky, pushed by the striping truck, and into the truck cab. This change will be advantageous from both safety and economy standpoints, and will result in a more simplified striping unit.

To attain these advantages, the Equipment Department has developed a traffic striping machine that is completely controlled from the cab of the paint truck. The new unit has been completed and is now operating on a test basis. The results of this actual operation will give the department additional information necessary to further the usefulness and productivity of the new machine.

Many states and foreign countries use the same general type of striping equipment developed by the Equipment Department years ago. Many of these states and foreign countries have expressed interest in the new unit. It is estimated that this new unit will cost less to manufacture, and will paint more stripe at less cost per mile with more safety for the operator.

The unit was designed, constructed and is being tested under the supervision of Associate Equipment Engineer James J. Keleher of the Equipment Department.

Current model of traffic striper used by the California Division of Highways. This model, developed by the Equipment Department, is in use in many other states and many foreign countries. The unit will be replaced by the new self-contained unit that is operated from the truck cab (See photo above).

Upon final completion and testing, details and photos of construction and operation will be presented in this publication.

INTERSTATE PROJECTS

From July 1, 1956 (the start of the Interstate Aid Highway Act of 1956), to December 31, 1959, 83 interstate contracts totaling $286,085,500 had been awarded in California.

'Tempus Fugit' Corner

Twenty-five years ago. The following items appeared in the January and February 1935, issues of *California Highways and Public Works.*

NO "DEATH CURVES" HERE

Views of the completed 3.5-mile improvement of the northern section of the famous Ridge Route (between Fort Tejon and Grapevine Station) show that the former dangerous curves and narrow roadway have been replaced by a fine, safe three-lane modern highway.

GAS TAX CONTINUES DOWNTREND

In spite of ideal weather conditions, improved roads, and normal summer and fall prices, sales of gasoline have been decreasing steadily since May of 1934 with the exception of October. With only the returns for December to come, it appears that the total assessments for 1934 will fall slightly below the figure for 1933, with a probable total for the year of $39,000,000.

SOUTHLAND ROUTES BEING MARKED WITH NEW STATE SIGNS

Rapid progress is being made by sign-posting crews of the Automobile Club of Southern California on erection of the new-type numbered route signs on main state highways. Seven thoroughfares are now being signed and two more will be posted within the next few weeks.

"OFFICIAL STATE HIGHWAY PLEDGE" Urged by Women's Community Service Auxiliary Committee of L.A. Chamber of Commerce

"I pledge devotion to the Highways of our Country, to the preservation of their existing natural beauty and to the intelligent development thereof; that our highways may serve not only as arteries of the nation's commerce, but through their beauty bring *peace and joy* to those who travel them in their hours of leisure."

UNEMPLOYMENT RELIEF

The Division of Highways program to speed the advertising of construction projects which are financed from the 1935 federal grant of the Hayden-Cartwright Act has the entire state highway organization keyed to a high pitch in order that all projects shall be under contract by July 1 * * * this program is one of the primary factors in the *relief of unemployment* in California today.

BIENNIAL BUDGET

The *biennial* state highway budget for the 87th and 88th fiscal years, July 1, 1935, to June 30, 1937, shows total amount for major project construction throughout the State will be *$26,498,980.*

Earl Malkson Retires In San Bernardino

Gilbert Earl Malkson, Maintenance Engineer of District VIII, with headquarters in San Bernardino, has retired from state service. He joined the Division of Highways in 1928.

EARL MALKSON

His first division job was as a survey party chief in District VIII. Later he was assigned to the construction department as resident engineer on a highway construction project in the Mojave Desert.

In 1940-41, Malkson was resident engineer on one of the first cement soil stabilization projects in District VIII on U.S. Highway 60-70-99, between Banning and Whitewater.

In 1943 he was transferred to maintenance duties as a highway superintendent. He was promoted to his present position in 1947.

Malkson was born in Snohomish, Washington, in 1893 and attended public schools there and in Lake Stevens, Washington. His first engineering job was as a construction foreman and hydrographer in 1913 with the Central Oregon Irrigation Company, where he remained until 1920. He spent two years with the City of Redmond, Oregon, as water and street superintendent. Before coming to the California Division of Highways he was employed eight years as a locating engineer with a private civil engineering firm in Bend, Oregon.

IN MEMORIAM

Headquarters Office

Harry B. Milner, Supervising Highway Engineer; Sam Osofsky, Highway Economist; John W. Vickrey, State Highway Engineer.

District I

Wallace L. Chapman, Assistant Right-of-Way Agent; Eugene Meyer, Associate Highway Engineer; LaVern M. Robinson, Highway Foreman.

District III

Helen Laaste, Highway Engineering Technician; Edward J. Nunes, Assistant Highway Engineer.

District IV

Gabriel Flaviani, Laborer; Grace Modica, Intermediate Typist-clerk.

District V

Paul H. Tarbox, Engineering Aid II.

District VII

Lawrence P. Friel, Senior Right-of-Way Agent; Paul C. Gibbons, Stock Clerk; Albert Martinez, Laborer.

District VIII

Clarence R. Cox, Laborer.

District IX

Irven D. Hartley, Highway Leadingman.

Bridge Department

Leonard M. Flannigan, Intermediate Clerk.

Materials and Research

George D. Ralph, Assistant Highway Engineer.

Bay Bridge

Joy D. Wade, Toll Collector.

OLD ISSUE WANTED

A copy of the April 1924 issue of *California Highways,* forerunner of *California Highways and Public Works* magazine, is needed to complete a set for binding. If you have one to spare please send it to the editor.

L. V. Campbell

Lawrence V. (Pat) Campbell, retired Division of Highways engineer, died on December 21 after a short illness.

In April of 1953, he retired as engineer of city and co-operative projects of the division after 33 years of service.

Campbell was born in Louisville, Ky., in 1888. He attended high school in Louisville and graduated from Rensselaer Polytechnic Institute of Troy, N.Y., in 1910.

He started his career with the State in 1915 but left to serve as a second lieutenant in the Army engineers during World War I. Before returning to state service in 1922 he was employed by Sacramento County, the Nevada Highway Commission and the Montana Highway Commission. Campbell served as office engineer of the division for 11 years before his appointment to the city and co-operative projects post.

Campbell was a member of the American Society of Civil Engineers and the honor engineering society, Tau Beta Pi. He was also a member of the Golden Empire Council of the Boy Scouts of America and one of the founders of cub scouting in Sacramento.

He was active in obtaining a retirement system for state employees.

He is survived by his wife, a daughter, Mrs. Eugene M. Gray of Sacramento and a son, Lawrence Pike Campbell II of Paris, France.

TOSS OF COIN DECIDES

It required a coin toss to determine the "low bidder" on a project for 1.3 miles of fencing on U.S. Highway 101 in San Luis Obispo County.

Anchor Post Products, Inc., and the San Jose Steel Company, Inc., submitted identical low bids of $18,237.40.

The two firms broke the tie in the time-honored manner. Anchor Fence Post won the toss.

Office Engineer H. C. McCarty of the Division of Highways said there have been identical bids submitted before, but they are so rare he could not remember when the last one occurred.

Department Submits New Palisades Study

Director of Public Works Robert B. Bradford has submitted to Governor Edmund G. Brown and the Legislature a report on measures proposed to control landslides along the Pacific Palisades in the Santa Monica area.

The report was prepared by the Department of Public Works in conjunction with the City of Los Angeles, Los Angeles County and the City of Santa Monica. It is based on a study made by the New York City consulting firm of Moran, Proctor, Mueser and Rutledge.

Remedial measures proposed in the report in general follow the recommendations of the consulting engineers, as announced last August. However, the State's engineers expressed some reservations as to how closely cost estimates may fit final plans. The consulting engineers estimated an overall cost in excess of $6,000,000 which would include installation of drains, the construction of berms or benches in some locations, and the partial filling of some canyons.

The recommendations cover 12 locations along the Palisades.

For East Pacific Palisades, the area of the "big slide" of 1956 and subsequent slides, it is proposed to intercept ground water by a 2,380-foot tunneled gallery and lateral drain system 40 to 60 feet below the surface in sound material and to regrade and drain the upper 100 feet of the material in the slide.

To reduce the hazard of a northerly progression of the big slide, it is proposed to grade the top of a steep intact promontory and build a bench at the toe to intercept small soil falls before they reach the highway.

The report stated:

"With reservation on applicability of cost estimates to final detailed plans, the proposal is recommended with confidence." The consultants' preliminary cost estimate was $933,900 for the East Pacific Palisades work.

The report was prepared under authorization of the 1957 Legislature, which made an appropriation of $300,000 from the State Beach Fund available for the study.

Division Announces Recent Retirements

District I

James J. Garfield, Highway Equipment Operator-Lab., 32

District II

John P. Carlton, Laborer, 23

District III

Owen E. Davies, Groundsman, 8

Perry R. Lowden, Supervising Highway Engineer, 34

District IV

Harry M. Paul, Highway Leadingman, 24

District V

Francis LeRoy Clayton, Highway Equipment Operator-Lab., 18

Walter S. Pratt, Highway Engineering Technician, 12

District VII

Walter E. Crooks, Highway Leadingman, 26

Sylver P. Dane, Senior Stenographer-Clerk, 28

Walter R. Waugh, Highway Landscape Supervisor I, 22

District IX

Loyd C. Jordan, Highway Leadingman, 13

District X

Russell J. Woodward, Assistant Highway Engineer, 13

Materials and Research Dept.

Elbert D. Botts, Senior Chemical Testing Engineer, 25

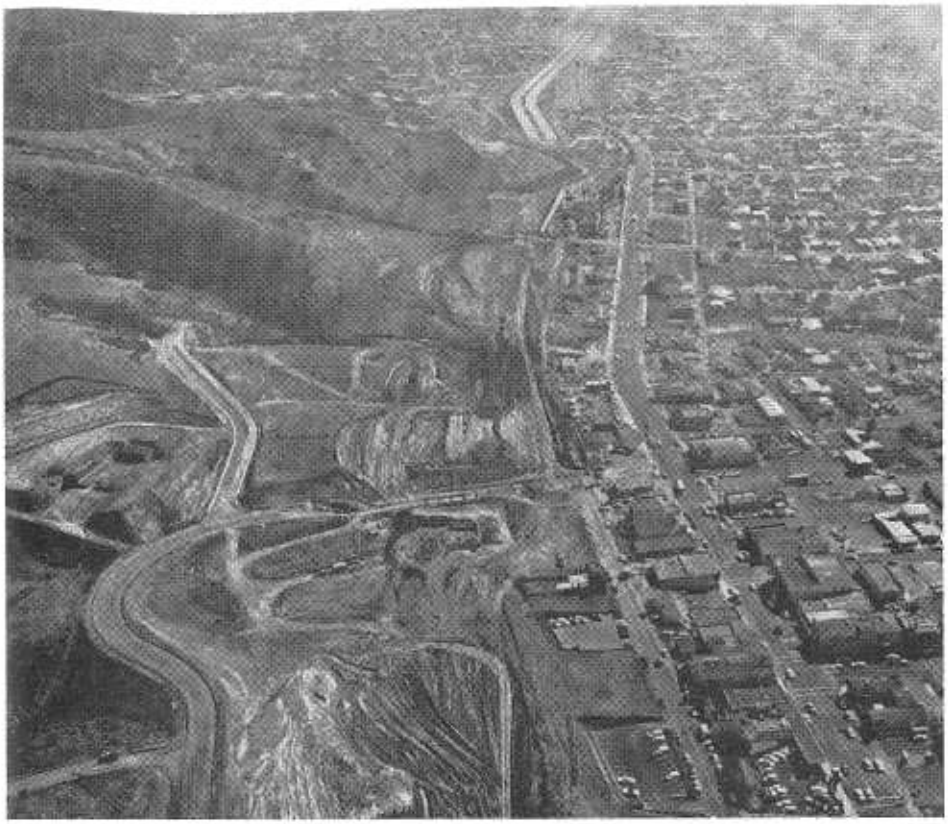
Headquarters Shop

Frank E. Furrer, Automobile Mechanic, 13

Anita Edna McEnery, Intermediate Account Clerk, 17

Shop 11

Roscoe I. Linn, Automobile Painter, 16



Looking southeast along construction on the San Diego Freeway skirting the City of San Clemente. A completed portion of the freeway can be seen in the background.

Continued from page 19 . . .

Route 19 Freeway

This route for 16.6 miles between the Santa Ana Freeway in Orange County and the Pomona Freeway in Los Angeles County, traversing as it does a portion of Brea Canyon, is sometimes locally referred to as the "Brea Freeway." It was declared a freeway by the Highway Commission in 1956. It traverses the Cities of Orange, Santa Ana, Placentia, Anaheim, Fullerton and Brea.

Preliminary designs are now in progress in the district office. The only expenditures to date have been those necessary in the acquisition of properties to protect rights of way. Expenditures to date for this purpose total $323,000.

Outlook for Future

One measure of the fiscal problems of the past year is that the total value of contracts under way has decreased from $88 million on October 20, 1958, to $85 million on November 20, 1959; and of the construction under way on November 20, 1959, only contracts with a total value of about $51 million will remain uncompleted on March 20, 1960. To this we hope to add new contracts to bring the total of work under way to a value of about $70 million as of March 20.

The spring of 1960 is obviously going to be a lean period for construction. Following that, we anticipate that it will be possible to place work under contract at an average rate of somewhat more than $10 million per month.

Based on our best estimates, it appears that the following portions of the freeway system may be opened to traffic in 1962:

Golden State Freeway—Complete within the City of Los Angeles.

San Diego Freeway—Jefferson Boulevard in Culver City to Burbank Boulevard in San Fernando Valley and from Long Beach Freeway to 174th Street.

Santa Monica Freeway—Santa Ana Freeway to Hoover Street, including Harbor Freeway Interchange.

Newport Freeway (Orange County)—Santa Ana Freeway to Riverside Freeway.

Freeway through City of Ventura (US 101)—Telephone Road to northwest of Ventura River.

We have had a serious construction delay during 1959 and a substantial reduction in the interstate highway program amounting to $70 million statewide in the 1960-61 fiscal year. This is regrettable but the program that now appears possible on the basis of existing federal and state laws offers the possibility of sound progress for the future. It is to be hoped that no changes or unforeseen obstacles develop.

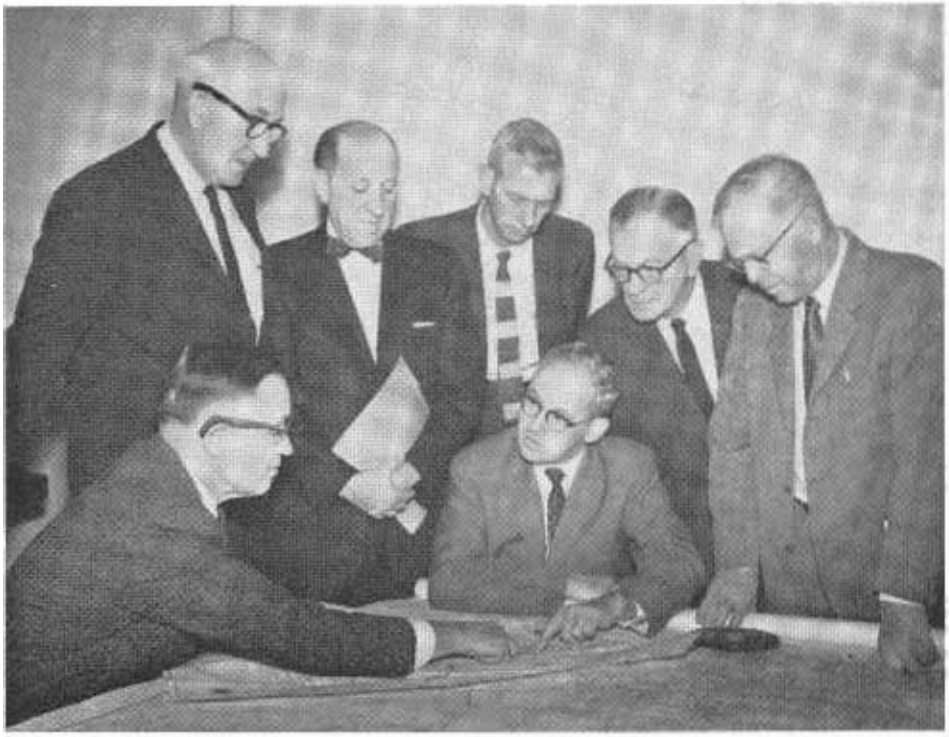
Resident Engineer Retires February 1

William T. Rhodes, long-time resident engineer for the State Division of Highways in San Diego, retired February 1, 1960. Rhodes, who was employed by the State for 39 years, acted as the State's representative on numerous construction projects both in the central as well as the southern portion of the State. During his career he developed a number of aids to highway engineering. Among them the "Rhodes arc," which rapidly calculates the relationship of horizontal to slope distance for surveyors, is the widest used. Other innovations have been "Rhodes ready reckoner," for determining pavement depth during construction, and "Rhodes temporary striping," consisting of white-painted tar paper which is glued to new paving with asphalt binder to delineate traffic lanes through new construction.

Rhodes, Dekema said, has probably participated in highway development and growth during its greatest period of change. He has supervised construction projects ranging from two-lane desert highways to the complex US 80 freeway between Grossmont Summit east of La Mesa to Chase Avenue in El Cajon.

Rhodes and his wife, Marguerite, plan an extended trailer tour. They will maintain their residence in San Diego.

A.A.S.H.O. COMMITTEE STUDIES STATE'S FREEWAYS



George M. Webb, Traffic Engineer for the State Division of Highways and a member of the special AASHO committee (seated left) points to something of interest on the map to other members of the committee which includes (seated right) C. W. Prisk, Director of Highway Safety Studies for the U.S. Bureau of Public Roads, and (standing, left to right) T. S. Huff, Chief Engineer of Design, Texas Highway Department; Joseph Barnett, Deputy Assistant Commissioner of the Bureau of Public Roads; J. D. Lacy, Chief of the Plans Analysis Branch of the Bureau; E. L. Sherertz, Engineer of Design for the Illinois Highway Department; and H. W. Griffin, Chief Road Engineer of New Jersey.

A COMMITTEE of freeway experts, representing the American Association of State Highway Officials, spent several days in California in the course of a nationwide study to examine freeways in operation in the Los Angeles and San Francisco metropolitan areas.

The committee began its visit to Los Angeles on November 9, with a conference at the District VII Office of the Division of Highways. City and county engineering and enforcement officials, and motorists organization representatives were invited to participate. Inspection tours of various Los Angeles freeways followed.

The same pattern was repeated in the San Francisco area, on November 12.

The committee, which is designated as the Special Freeway Study and Analysis Committee, was established by the A.A.S.H.O. a year ago at the suggestion of Federal Highway Administrator B. D. Tallamy.

The job of the committee, as spelled out in A.A.S.H.O. proceedings, is to study freeways in operation in various states and to "study the various geometric designs involved and their relationship to operational difficulties and accident patterns, and to make recommendations to A.A.S.H.O. on those features of design that should be encouraged and those that should be avoided in designing future highways."

Chairman of the committee is R. R. Bartelsmeyer, chief highway engineer of Illinois and immediate past president of A.A.S.H.O. (he was represented on the California study tour by E. L. Sherertz, engineer of design for the Illinois Highway Department). The secretary is Joseph Barnett of Washington, D.C., Deputy Assistant Commissioner of the U.S. Bureau of Public Roads.

The committee also inspected freeway operation in the New York, Detroit, Chicago, Houston, and Dallas areas.

U.S. Travel Miles Exceed 664 Billion

Total motor-vehicle travel in the United States in 1958 amounted to 664.7 billion vehicle-miles, an increase of 2.7 percent over the 647.0 billion figure for 1957, according to figures released by Bertram D. Tallamy, federal highway administrator. The travel data were compiled by the Bureau of Public Roads, U.S. Department of Commerce, from information supplied by the state highway departments and toll authorities. For 1959, total travel is estimated at 696 billion vehicle-miles, based on reports for the first three-quarters of the year.

Of the 1958 travel, 40 percent was performed on main rural roads, comprising 14 percent of the nation's total of 3.5 million miles of roads and streets. Another 46 percent of the travel was on urban streets, which comprise only 11 percent of the total mileage. Local rural roads, which make up 75 percent of all mileage, accounted for only 14 percent of the travel.

Passenger cars represented 83 percent of the vehicles and performed 82 percent of the travel in 1958; trucks and combinations accounted for 16 percent of the vehicles and 17 percent of the travel; similar figures for buses were less than 1 percent.

The average motor vehicle traveled 9,658 miles in 1958, almost half of it in cities, and consumed 776 gallons of fuel at a rate of 12.44 miles per gallon. The changes from 1957 were too small to be considered significant.

The average passenger car traveled 9,494 miles in 1958, an increase of 1.1 percent over the 9,391-mile average in 1957, and consumed 664 gallons of fuel in 1958 as compared with 652 gallons in the previous year. The average passenger-car fuel-consumption rate of 14.30 miles per gallon in 1958 was 0.7 percent lower than the 1957 rate of 14.40, but the difference is not statistically significant. Fuel consumption rates of buses and trucks remained virtually unchanged from 1957 to 1958.

APPOINTMENTS

Continued from page 2 . . .

sign), and the American Society of Photogrammetry. He is a member of the Commonwealth Club and of the Elks.

He has been for the past few years a member of the transportation committee for the VIII Winter Olympic Games in Squaw Valley.

Womack has twice been called on as a consultant in highway planning for foreign countries. In 1953 he served as consultant on a study of highway deficiencies for the Government of Haiti. He was retained by the Japanese Government to make a route study between Tokyo and Kobe in 1954 and prepare a report on construction and bond financing for a road which is now under construction.

Womack is married and has two sons. His home is at 2653 13th Street, Sacramento.

Murphy Promoted

Murphy has been Assistant State Highway Engineer (Administration) since October 1957. He has been an employee of the Division of Highways for nearly 30 years.

A native of Pittsburgh, Pennsylvania, Murphy came to California as a child and grew up in Bakersfield. He attended the University of California at Berkeley, receiving his degree in civil engineering in 1930.

The same year he began his career with the Division of Highways as a construction inspector in District III (Sacramento-Marysville). He remained with District III until 1938, when he moved to Headquarters Office in Sacramento as assistant to the federal aid engineer.

During World War II Murphy was a Marine Corps officer, with service in the South Pacific. During the later months of the war he was Division Engineer Officer of the Second Marine Division. He held the rank of major upon separation from active duty.

He returned to Sacramento after the war, and was appointed Construction Engineer of District V (San Luis Obispo) in 1947. The following year he returned to the Marysville Office as Assistant District Engineer, and in 1950 transferred to Headquarters Office as a principal highway engineer in charge of public relations. Responsibility for personnel management and related functions was added to his duties in 1955.

G. A. Hill

Early in 1957 he was transferred to the position of Advance Planning Engineer for the Division of Highways, and served in that capacity until his promotion later that year to Assistant State Highway Engineer.

Murphy and his wife Dorothy live at 5812 Wymore Way, Sacramento. They have two children, John and Dorothy.

Gillis, who succeeds Murphy as Assistant State Highway Engineer (Administration), was District Engineer (Planning) for District VII in Los Angeles.

Gillis Appointed

A native of Walla Walla, Washington, Gillis moved to California as a youth and completed high school in Sacramento. He received his civil engineering degree from the University of California in 1938, and has since been with the Division of Highways except for military service during World War II and the Korean Conflict.

His first three years in highway work were spent on the planning survey staff in Sacramento. In 1941 he moved to District IV (San Francisco) and moved steadily up the promotional ladder in that district, with experience in traffic, utility relocation, construction, and design.

Early in 1956 he was appointed District Engineer in District VII, first in charge of operations and then planning. For the past two years he has been responsible for the location and design of freeways and other highway improvements in Los Angeles, Orange and Ventura Counties, along with budgeting and other related functions.

Gillis, who is married and has two daughters, has made his home in Arcadia. He is the son of Ridgway M. Gillis of Sacramento, who retired in 1955 as Deputy State Highway Engineer.

His wartime military service was in the Navy Civil Engineer Corps. He holds a World War II commendation from Fleet Admiral Chester Nimitz. During the Korean Conflict he was in charge of design and contract construction for the 12th Naval District.

Hill to L.A.

Hill, who succeeds Gillis, has been chief assistant to the Engineer of Design in the Sacramento Headquarters Office of the division. Born in Oakland, he graduated from Fremont High School and received his degree in civil engineering in 1937 from the University of California. He joined the Division of Highways the same year and served most of the next nine years in District VI (Fresno), except for military duty with the U.S. Army Corps of Engineers in Alaska and the Pacific during World War II.

In 1946 he went to Yale University for a year's graduate study in traffic engineering. Upon his return he was assigned to District IV (San Francisco), and served there until 1953 in construction, traffic analysis and planning functions. He was in charge of analyzing the first major origin and destination survey of the home-interview type, which was conducted in the Bay area in 1947-49.

In 1953 Hill was promoted to supervising highway engineer rank and transferred to the design department in Division Headquarters Office in Sacramento. Since 1955 he has been chief assistant engineer of design.

Hill, his wife and son have lived in Davis. He is a member of the Institute of Traffic Engineers and of the Forum Toastmasters Club of Sacramento.

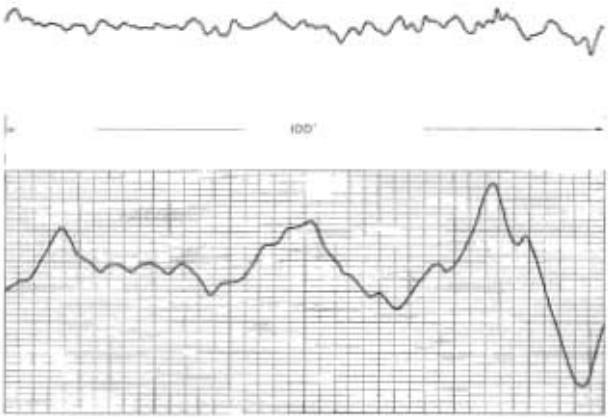


Figure 14. A comparison between a record from the AASHO slope recorder (top line) and one made by the Michigan Profilograph (lower line).

Figure 15. A photo of the Michigan Profilograph unit modeled after a California design.

Continued from page 52 . . .

1. Plotting a profile from level notes taken at frequent intervals along the pavement with rod readings to the nearest .001 foot.
2. Measuring deviations from a straightedge laid on the surface of a pavement in which the reference plane corresponds to the average of the two highest spots within the length of the straightedge.
3. Profile records plotted by the movements of a center wheel in a three point contact system. In other words, a beam equipped with a single wheel at either end and with a recording wheel in the center free to move in a vertical plane.
4. Recording vertical oscillations of a wheel with reference to a suspended weight or mass; for example, movements of the front axle of an automobile or movements of a wheel in a specially constructed device such as the U.S. Bureau of Public Roads road roughness indicator (Figure 3).
5. Devices in which the reference plane represents the mean of a number of points of contact with the road surface in the vicinity of the point being recorded.
6. Devises to mark the pavement to delineate either high or low spots as desired. The most elaborate of this type known to the author is the "Marking Viagraphe" developed and used in France. This machine, instead of examining a single line, marks a considerable width of pavement in one operation (Figure 6).
7. A novel device developed by the staff on the A.A.S.H.O. test road is equipped with two wheels nine inches apart in tandem with electronic means for constantly measuring the slope of all inequalities on the road surface. This device does not give a direct picture of the road profile but it is stated that the data could be interpreted to give a profilogram if desired (Figures 11, 12, 13, 14, 15).

TWENTY-FIVE-YEAR AWARDS

Employees who received twenty-five-year awards since those listed in the July-August edition of *California Highways and Public Works*

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Alton D. Cromwell
Harry D. Hicker

District II
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Harold E. Goode

District III
Abraham Salgado

District IV
Leroy R. Cardwell
Wilder G. Morey
J. F. O'Brien

District V
Russell A. Adams

District VIII
David R. Henderson
Francis Royal
Joe R. Solomon

District IX
Robert L. Pruett

District XI
John A. Hoffman
James D. McCain
Raymond L. Potts
Richard F. Anderson (Dec. 1958)

Headquarters Office
Ohla C. Hinton
Ferdinand J. Volkert

Bridge
Lawrence E. Crayne

Bay Bridge
Georgia Max
H. C. Snead
Rollin H. Taylor
Martin G. Van

Shop 7
Edward A. Lavery

DIVISION OF CONTRACTS AND RIGHTS-OF-WAY
George C. Hadley

Index of California Highways and Public Works

January to December 1959

SUBJECT INDEX

INDEX OF AUTHORS

Paper Cites Human Factor in Freeway Crashes

The following editorial, under the title "Soon: Tall Double Line," appeared in the Palo Alto *Times* for December 21, 1959:

Two persons were killed and four severely injured a few days ago when an automobile careened across the dividing strip of Bayshore Highway at Candlestick Point and hit an ice cream truck. Occupants of the car had been drinking, its owner said.

The tragic collision left four children fatherless and three motherless only a few days before Christmas. But tragedy alone did not explain the prominent news display that a similar crash on the old Bayshore Highway a decade ago never would have gotten.

Newspapers hit the story hard because such collisions are so rare on the freeway. The coverage was a testimonial to the effectiveness of the divided freeway in reducing the frequency of "across the double line" smashups.

State highway engineers are close to making freeways even safer by perfecting barrier fences for installation in the center strips of freeways throughout California.

Two barrier models are undergoing final tests. The one considered most likely to be selected has cables interwoven in a chain link fence. It is designed to stop a vehicle whose driver is intoxicated, ill, asleep or intent upon suicide from crossing the dividing strip and colliding with oncoming traffic. At the same time, it is engineered so an automobile hitting it won't bounce back into the lanes from which it came.

As long as a human factor remains in driving, the engineers probably won't be able to make us completely safe. But we are grateful for each highway terror they abolish.

The letter below was sent by the State Highway Engineer to the editor of the *Times* following the appearance of the above editorial:

Editor, Palo Alto Times
Palo Alto, California

DEAR SIR: Your editorial of December 21, entitled "Soon: Tall Double Line," emphasizing the safety engineered into modern freeways, was most gratifying to the Division of Highways for two reasons.

One reason, of course, is that we appreciate any mention of our continuing efforts to make freeways as near fool-proof as possible. The freeway safety picture is clear from statistical records—the fatality rate on freeways is about one-third the rate on the other highways—but the spectacular headlines on the occasional spectacular freeway tragedy make an understandably stronger impression on most people than do the statistics. This is particularly true of cross-median accidents on freeways, which account for less than 20 percent of all freeway accidents that result in fatalities. Your editorial helps to put this picture in its proper perspective.

Our other particular interest in your editorial stems from your constructive emphasis on the "human factor" in traffic safety. This is also brought out by statistics—about 90 percent of all accidents involve a violation of the Vehicle Code—but it needs constant reiteration to build it into the consciousness of the individual motorist, whose prime responsibility for the safety of himself and others on the road cannot be delegated to the engineers or anyone else.

Sincerely,

J. C. WOMACK
State Highway Engineer

A.A.S.H.O. ELECTS WOMACK

State Highway Engineer J. C. Womack has been elected to the executive committee of the American Association of State Highway Officials, to fill the two-year term originally held by the late J. W. Vickrey.

EDMUND G. BROWN
Governor of California

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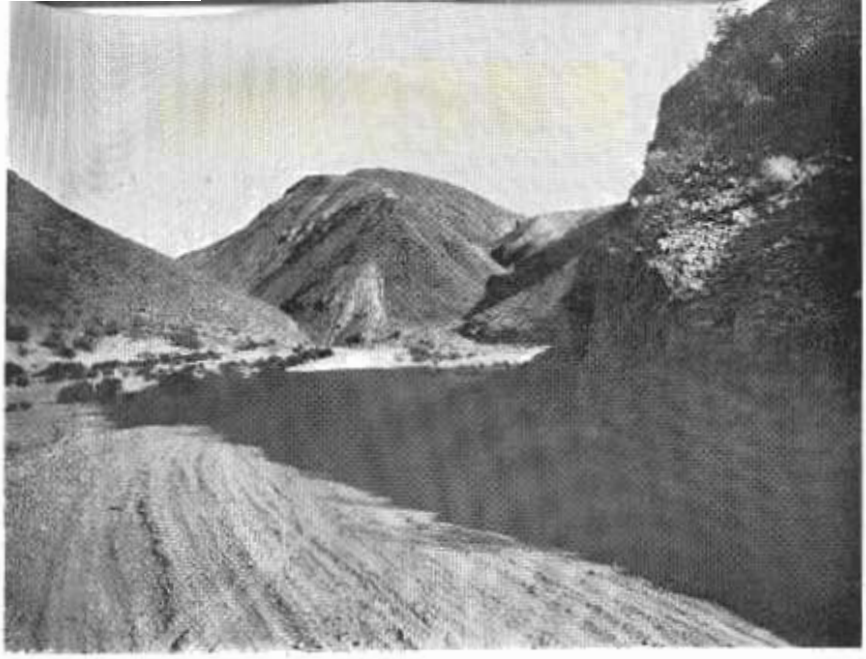


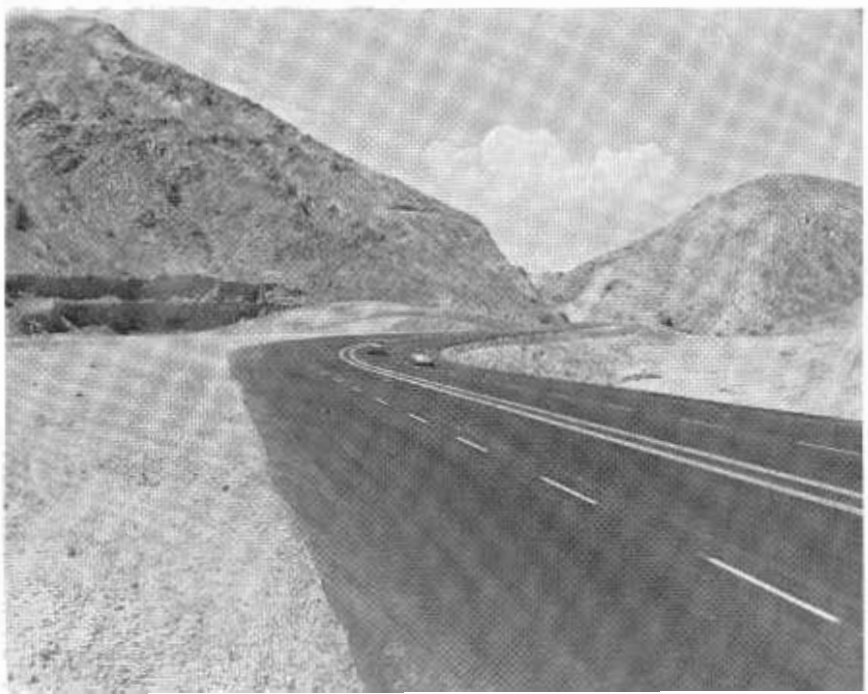
1929

In February 1931 a large group of motorists gathered in Red Rock Canyon, eastern Kern County, to dedicate a new section of highway. They came in their Fords, Buicks, Chevrolets, Dodges, Essexes, Maxwells and Chandlers from Mojave, San Bernardino, and even drove the long miles from Los Angeles to celebrate completion of the final contract of the many required to build a serviceable road between Mojave and Bishop.

Orators included two members of the California Highway Commission and the District IX Engineer, F. G. Somner. In his speech Mr. Somner said, "The completion . . . of the contract . . . sets at rest forever the terrors of Red Rock Canyon, the greatest barrier to travel within District IX, owing to the old road having occupied the floor of the canyon, subjecting travelers to the dangers of being caught in the roaring currents from periodical cloudbursts originating within a vast drainage area at the head of the canyon."

This optimism was somewhat premature. Although the construction of 1930-31 elevated the highway about 15 feet, flash floods continued to be a maintenance problem. Last year the road was once again modernized with increased bank protection and wide, four-lane roadway. The photographs show the road as it was when it followed the stream bed, and as it is now.

1959



The Mulholland Summit Cut on the San Diego Freeway in Los Angeles (right portion of the above photo) is already approaching in size the Big Cut of the Carquinez Project. The curving four-lane highway approaching the tunnel is the existing highway (Sepulveda Boulevard). The roadway through newly excavated ground above it is Mulholland Drive. (See "Report From District VII," this issue.)

Construction of the first phase of the future Santa Monica-Harbor Freeway interchange (the bridges across the Harbor Freeway) is now completed. The full eight-lane detour around the construction site, which carried 190,000 vehicles a day, has now been removed. This will be a part of the freeway loop around downtown Los Angeles now under construction. (See "Report From District VII," this issue.)