

# CALIFORNIA HIGHWAYS AND PUBLIC WORKS

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# California Highways and Public Works

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CALIFORNIA HIGHWAYS AND PUBLIC WORKS  
P. O. Box 1499  
Sacramento, California

# Record Span

By NORMAN C. RAAB,  
Projects Engineer

## Richmond-San Rafael Bridge About Ready for Traffic

# New Crossing

THE RICHMOND-SAN RAFAEL Bridge, one of the largest construction projects in the San Francisco Bay area, is to be opened to highway traffic on September 1, 1956. This structure, although it does not lay claims for any outstanding features, can, however, be classified as one of the world's largest bridges as shown on the accompanying chart.

### Dedication Plans

Elaborate plans for the opening of the Richmond-San Rafael Bridge are being developed by the Department of Public Works and the citizens of Marin and Contra Costa Counties.

On Friday, August 31st, at 11 a.m., official dedication of the bridge will take place at the toll plaza. Governor Knight will deliver the dedicatory address and will unveil a bronze tablet containing an historical record of the project.

Following the dedication ceremony, the structure and buildings will be open for public inspection until 6 p.m. No automobile traffic will be allowed on the bridge during this inspection period.

At 12:01 a.m., Saturday, September 1st, the first vehicle will pass through the toll lanes and the bridge will be opened for business.

Plans are being completed for civic participation and celebration as a part of the opening ceremonies.

On July 10th, the California Toll Bridge Authority adopted the following toll schedule for the bridge:

No.	Classification	Toll
1	Automobile, motorcycle, tri-car, light delivery automobile, ambulance, hearse, housecar, noncommercial truck, station wagon, and taxi	\$0.75
2	Commutation book (for Class 1 vehicles except light delivery automobile and noncommercial truck) *	18.75

3	Class 1 vehicle drawing a 1-axle trailer	1.25
4	Class 1 vehicle drawing a 2-axle trailer	1.50
5	Truck, 2-axle	1.25
6	Truck, 3-axle	1.75
7	Truck, 4-axle	2.50
8	Truck, 5-axle	3.00
9	Truck, 6-axle	3.50
10	Truck, 7-axle	4.00
11	Bus, 2-axle	1.50
12	Bus, 3-axle	1.75
13	Vehicles not otherwise specified	5.00

\* Book to contain 50 one-way tickets each good for a single passage at any time during the two consecutive calendar months, or fractional part thereof, for which sold.

f A truck shall include a truck-tractor, or any combination of truck, truck-tractor and trailer or semitrailer.

Preliminary work was started July 1, 1950, under an appropriation by the State Legislature in the amount of \$200,000 for an engineering report as to the feasibility to finance and construct a vehicular crossing connecting Contra Costa and Marin Counties. A favorable report on the project prompted the 1951 Session of the Legislature to appropriate an additional \$750,000 to be used for further studies and the preparation of plans and specifications for the major contracts. The project, in general, consists of a four-mile overwater crossing with a short piece of highway approach in Marin County and a somewhat longer approach in Contra Costa County.

### Two Important Events

In December of 1952, two important events took place to bring the project closer to a reality:

1. The California Toll Bridge Authority authorized the sale of not to exceed \$72,000,000 of Richmond-San Rafael Bridge toll bridge revenue bonds; however, it was stipulated that the initial issue of Series A bonds should not exceed \$62,000,000.

2. Bids were opened on the two major contracts for the construction of the substructure and the superstructure work; and the low bids were found to be, in each case, below the engineer's estimates. In February of 1953, revenue bonds in the amount of \$62,000,000 were sold, and the two major contracts were awarded. The following month work was started on the scheduled 3½-year construction period.

### Bond Issue Money

The money obtained from the bond issue for the completion of the upper deck for highway traffic was distributed as follows:

Construction fund	\$50,000,000
Current interest fund	10,000,000
Construction reserve fund	2,000,000
Total	\$62,000,000

The construction fund of \$50,000,000 was further budgeted as follows:

Construction contracts	\$45,000,000
Right of way	1,600,000
Salaries and wages	2,000,000
Equipment	100,000
Operating expenses	1,500,000
Insurance	600,000
Appropriation repayments	800,000
Interest on unexpended funds	-1,600,000
Total	\$50,000,000

The interest on the \$62,000,000 bond issue is payable from the current interest fund of \$10,000,000 during the 3½-year construction period and for six months thereafter. Any money remaining is to go into the bridge reserve fund.

The construction reserve fund of \$2,000,000 could be used in the event the \$50,000,000 was insufficient to complete the construction and open



This aerial view of the Richmond-San Rafael Bridge is looking toward the City of Richmond on the Contra Costa County shore.

the bridge to traffic in the allotted time. This \$2,000,000, along with any surplus in the construction fund, is to be placed in the reserve fund within six months after the bridge is in operation. There is to be accumulated and remain in the bridge reserve fund the sum of \$5,500,000 during the period in which bonds are outstanding.

The work performed under the construction fund was divided into 15 different contracts in order to allow similar work to be performed by one

contractor and so as to complete certain phases of the project prior to the work of others. Construction could not interfere with Richmond-San Rafael Ferry traffic or the operations of local industries.

The contracts under the construction fund were as follows:

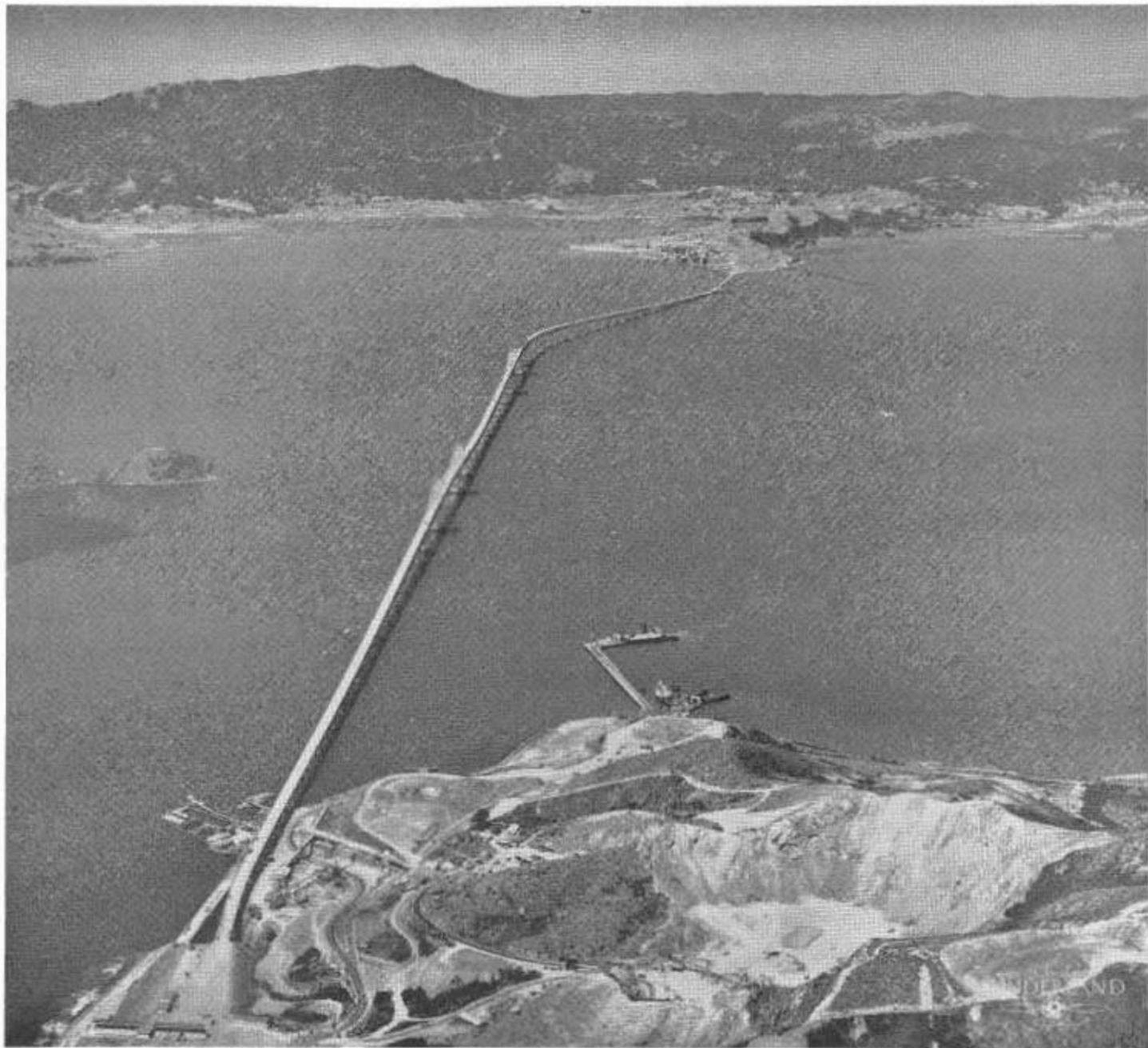
*Contract*

No.	Title	Amount
1003	Substructure	\$14,700,000
1004D	Superstructure	24,400,000
1005	Mole fill	250,000
1006	Paving	460,000
1007	Trestle approach	190,000

1008	Richmond approach	870,000
1009	San Rafael approach	210,000
1010	Buildings and toll plaza	360,000
1011	Electrical work	1,100,000
1012	Toll collection equipment	480,000
1015	Separation structures	650,000
1018	Traffic stripes and signs	20,000
1019	Girder spans	830,000
1020	Pier backfill	220,000
1022	Maintenance facilities	260,000
	Total	\$45,000,000

*Governor Knight Interested*

On October 26, 1954, Governor Goodwin J. Knight issued a statement that it would be advantageous to the State and to the motoring public if



This aerial view of the new northbay crossing is looking toward San Rafael on the Marin County shore.

the construction of the lower deck of the bridge were not delayed.

It was estimated that additional funds of \$6,000,000 would be required to provide for an ultimate six lanes of traffic. The estimated traffic figures were reviewed; and it was the opinion of the department's consultants on traffic, financing, and revenue that this additional liability could be repaid from the bridge revenue.

The State Legislature, by Chapter 159, Statutes of 1955, authorized a loan

from the State School Land Fund. These funds became available for expenditure as of September 7, 1955.

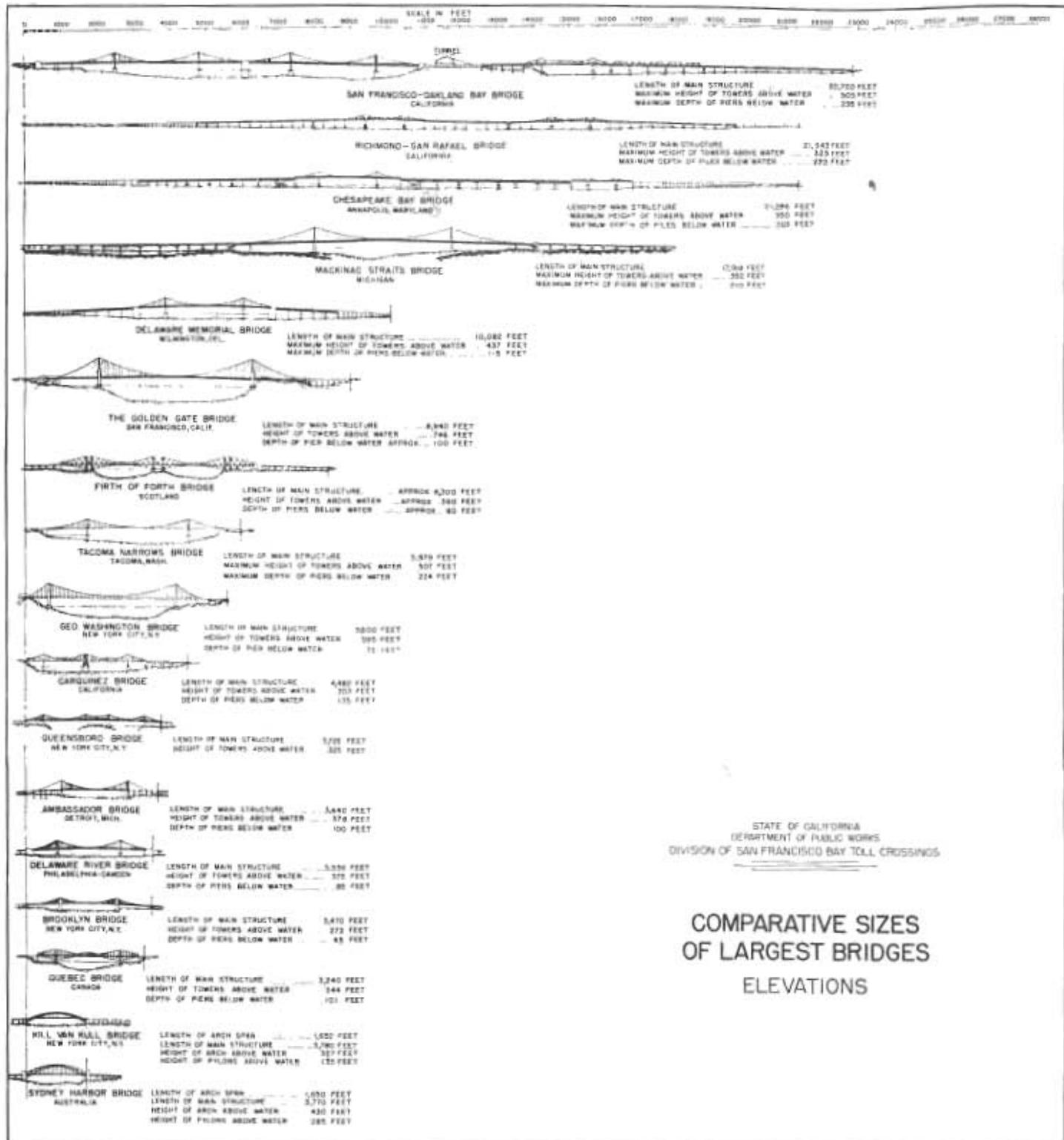
#### Five Contracts

Five contracts were prepared for the completion of the project, and at present the following contracts have been awarded:

Contract No.	Title	Amount
1014	Highway lighting	\$260,000
1017	San Quentin approach	2,920,000
1018A	Traffic stripes and signs	20,000
1021	Lower deck paving	1,140,000

When this work is completed, the structure will then provide two 36-foot roadways; three 12-foot lanes of traffic on the upper deck to San Rafael and the same provision on the lower deck to Richmond.

The quantities of materials used in the construction are here listed for phases I and II. The latter is for the completion of the lower level of the bridge for an ultimate six lanes of traffic.


**STRUCTURAL MATERIAL**

Standard concrete	Light-weight concrete	Reinforcing steel	Structural steel
c. y.	c. y.	ton	ton
Phase I	101,270	16,560	6,010
Phase II	11,110	23,140	2,990
Totals	112,380	39,700	9,000

**PILING**

Phase I	Concrete I. F.	Timber I. f.	Steel I. f.
Phase II	53,000	000	558,170
Totals	53,000	201,000	566,100

**MISCELLANEOUS**

2½" Pipe	Cable	Timber	Paint
I. f.	I. f.	M. B. M.	gallons
Phase I	45,400	251,900	1,100
Phase II	13,500	64,600	000
Totals	58,900	316,500	1,100

*...Continued on page 22*

# Freeway Traffic Flow

By GEORGE M. WEBB, Traffic Engineer, and  
KARL MOSKOWITZ, Assistant Traffic Engineer

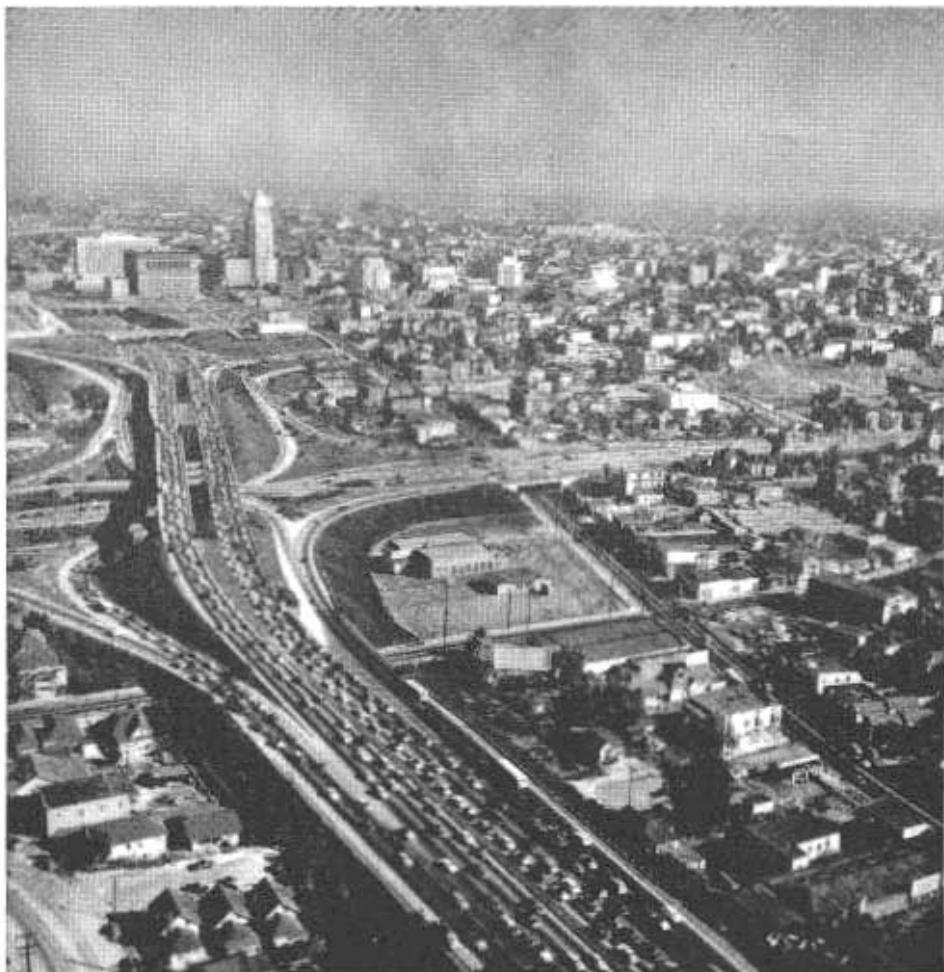
THE INCREASE in California population ( $3\frac{1}{2}$  million in 10 years) and vehicle registration (also  $3\frac{1}{2}$  million in 10 years) has been reflected in a tremendous increase in traffic volumes throughout the State and particularly in the metropolitan areas of Los Angeles and San Francisco.

To accommodate this traffic, an increasing program of freeway construction is being carried on by the California Division of Highways and more is being planned. Because of the large sums of money expended on this program, a constant re-evaluation of design standards is essential to assure that the greatest possible traffic service is provided for each dollar.

Opinions based on casual observations of traffic movements are not sufficiently reliable for the important decisions required in the design of these projects. To gain factual information for the designer, numerous counts of traffic flow on freeways have been made since the first ones were opened to traffic. The most recent of these counts was a carefully planned study begun in the San Francisco and Los Angeles areas in 1955. An analysis of these data, together with tentative conclusions, is presented in "Freeway Capacity Study of 1955," published by the California Division of Highways.

Because of the increasing evidence of public interest in this subject, this article will point up some of the facts contained in the report, which runs to 41 typewritten pages and 61 graphs and figures. The full report is available on request.

The field work basically consisted of counting and classifying traffic by type of vehicle in five-minute intervals and in each lane; measuring and recording speeds, and keeping a descriptive record of the type of operation, i.e., free-flowing, smooth but crowded, or congested. Motion pic-



At a four-level traffic interchange which can carry up to 20,000 vehicles per hour, a demand of 23,000 vehicles per hour has the same result.

tures were also made for the purpose of illustrating, better than words can, the type of flow experienced at various volume levels and as affected by design features. These films are primarily for training and instruction of division personnel.

## FINDINGS OF STUDY

Some of the facts found out in the study are:

1. The highest one-way volume observed during one hour was 8,082 ve-

hicles southbound on the five-lane weaving section of the Harbor Freeway immediately south of the four-level interchange in Los Angeles. Some other high hourly volumes were as follows (all figures are one-way traffic in the direction of heavier flow):

Four Lanes One Way (Eight-lane Freeways)	
Hollywood Freeway westbound from four-level interchange	7,793
Hollywood Freeway westbound at Vermont	7,548
Hollywood Freeway westbound at Mulholland	6,419
Bayshore Freeway southbound at 22d St.	6,002



UPPER—Congestion is relative. At an intersection of two-lane highways with a capacity of 1,600 vehicles per hour, 1,800 vehicles per hour produced congestion.  
LOWER—At an intersection of three-lane, one-way city streets, capacity 2,000 vehicles per hour, an additional 100 vehicles per hour produced congestion.

#### **Three Lanes One Way (Six-lane Freeways)**

Hollywood Freeway eastbound at Highland	6,630
Pasadena Freeway northbound at Ave. 35	5,268
Eastshore Freeway northbound at 19th St.	4,270

#### **Two Lanes One Way (Four-lane Freeways)**

Santa Ana Freeway westbound at Florence	3,962
Eastshore Freeway southbound at Hegenberger	3,020

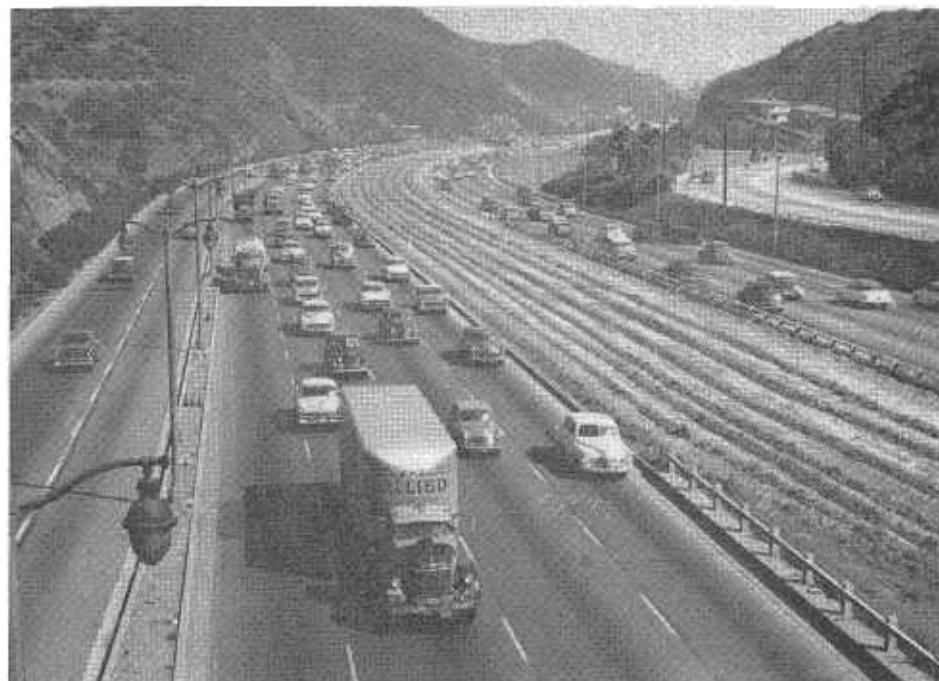
2. Freeways in large metropolitan areas (1,000,000 and more persons) carry an hourly volume up to 25 percent higher than hourly volumes on freeways in less populated areas (under 500,000) with no greater momentary degree of congestion. This is because of the sharp peak demand which lasts less than an hour in smaller metropolitan areas. In the large metropolitan areas, the peak flow which causes this particular degree of congestion will last much longer.

3. As most regular users of freeways must have noted, freeway traffic at high volumes is not evenly divided by lane. The shoulder lane (except at ramps) never carries nearly as much traffic as the other lanes, even with no trucks. For this reason, a three-lane roadway (one-way) will carry a somewhat greater average volume per lane than a two-lane roadway.

4. A three-lane roadway (one-way) was observed to be capable of carrying more traffic per lane than a two-lane one-way section by comparing the two sections at ideal operating conditions. There is no four-lane one-way roadway available for observation which has as ideal a combination of geometrics and demand as this three-lane section, but it is believed that under the same conditions a four-lane roadway will in turn average more traffic per lane than a three-lane section. The highest volume observed on a four-lane roadway was 7,793 in an hour (westbound on the Hollywood Freeway immediately west of the four-level interchange).

#### **Undesirable Congestion**

5. Undesirable congestion is usually experienced when traffic volumes increase to the point where operating speeds are reduced to 35 miles per hour. At this speed, traffic is practically bumper to bumper; there are very few normal gaps available for lane-changing, and there is noticeable



UPPER—Even slight upgrades significantly reduce capacity when truck volumes are appreciable. Note uneven distribution of traffic by lanes. LOWER—Another view of the four-level structure showing normal midday operation.

driving tension even for short rides. Also, at this speed stoppages can occur quickly even from a single driver's faulty maneuver or hesitation. And finally, when congestion reduces speeds to 35 miles per hour it means that the lanes nearest the median are carrying 2,000 vehicles or more per hour. Expressed another way, this gives an interval between vehicles of only 1.8 seconds.

*It is believed that volumes which result in an average freeway speed of 45 miles per hour should be considered the practical capacity of the freeway. At an average speed of 45 miles per hour the traffic in the shoulder lane will average about 40 miles*

*per hour and traffic in the median lane will average near 50 miles per hour.*

6. Upgrades as small as 2 percent significantly reduce capacity when truck volumes are appreciable. On downgrades of significant length, average volumes of 2,000 vehicles per lane per hour can be carried with no congestion.

7. The comfortable operating volume for one direction of an eight-lane freeway (based on a 45-mile-per-hour minimum average speed) at an average location with undulating grade lines in a large urban area with 200 to 250 trucks and busses per hour is about 5,500 vehicles per hour, distributed as follows:

	v.p.h.
Lane 1 (next to shoulder)	800
Lane 2	1,100
Lane 3	1,800
Lane 4 (next to median)	1,800
	<hr/> 5,500

The foregoing indicates that for a typical urban four-lane roadway (one-way) and about 3 percent trucks (up to 200 per hour) a round figure of 1,500 vehicles per lane per hour may be considered the practical capacity for eight-lane freeways. Four-lane freeways with an equivalent percentage of trucks have a considerably lower average capacity per lane because of the inefficient use of the outside lane.

8. Determination of maximum volume which can enter a freeway at one point is more dependent upon the sum of the ramp volume and the adjacent lane volume than it is upon the length of the merging area (acceleration lane and taper).

#### APPLICATION OF TRAFFIC STUDIES TO DESIGN

When the Pasadena Freeway was designed more than 15 years ago, it was a pioneer in its field. There were practically no similar facilities in existence anywhere upon which predictions could be made as to operating characteristics or volume. But shortly after it was built, traffic counts and

observations were made on it and, as the years went by, similar counts were made on other facilities which were gradually coming into existence in other parts of the United States.

The results of these various counts were made available to the engineering profession through technical journals such as the magazine "Public Roads" and the "Proceedings" of the Highway Research Board of the National Research Council, and these formed the basis for design of later freeways.

Finally, in 1949, the Highway Capacity Committee of the Highway Research Board (which had the active cooperation of the California Division of Highways, and on which the division has been and is represented) thought that enough data had been collected to produce a manual called the "Highway Capacity Manual." Later counts, including the study mentioned at the beginning of this article, have confirmed with remarkable agreement the findings published in the Highway Research Board Manual.

#### Evolution in Design

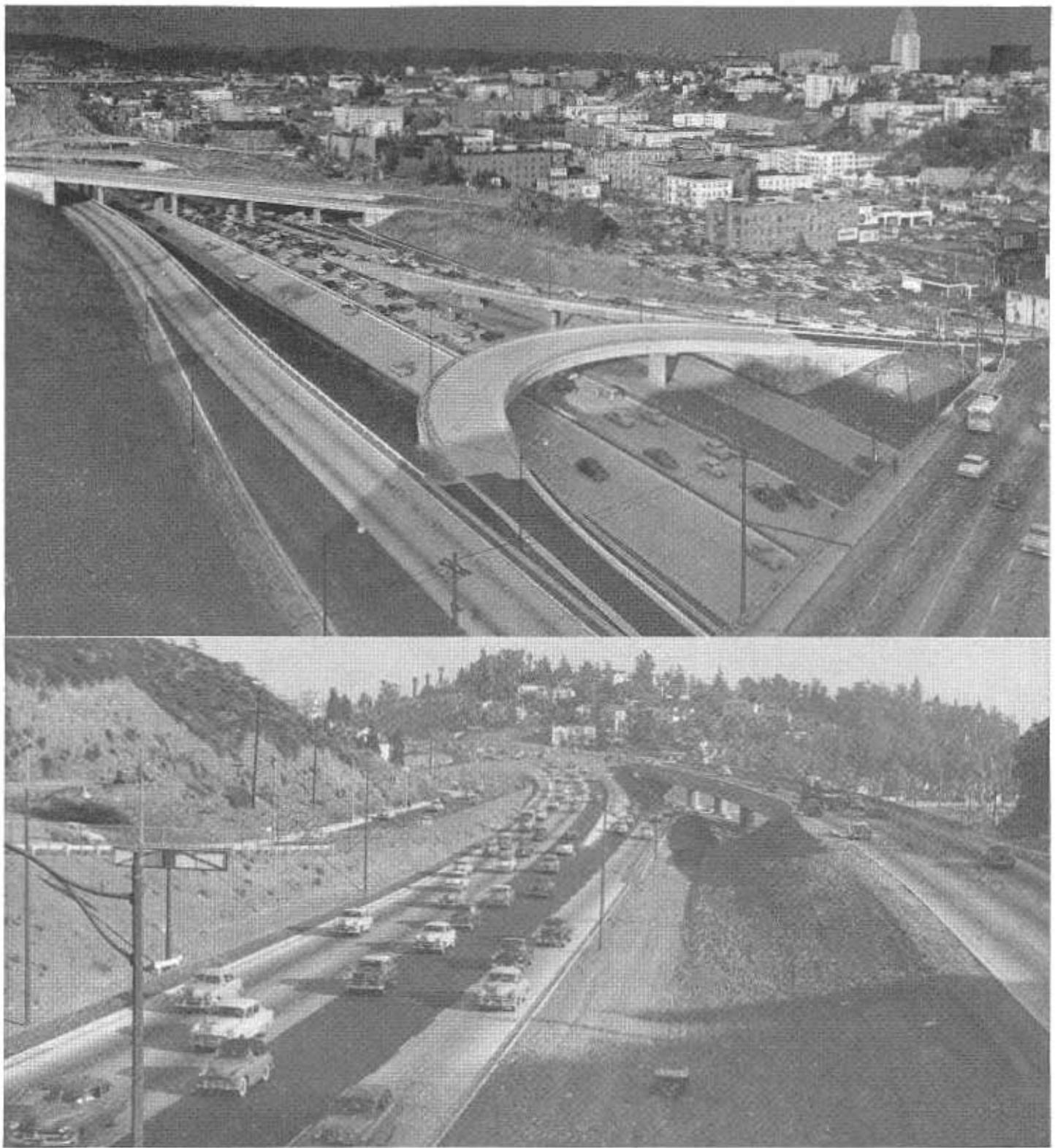
By comparing the Pasadena Freeway with the Harbor and Hollywood Freeways, the evolution in freeway design which has taken place as a result of traffic studies is obvious.

A few of the more important changes are listed here:

1. Metropolitan freeways are now designed for eight lanes instead of six.
2. Inlet ramps are provided with acceleration lanes.
3. Easier curves have been provided, primarily to decrease accidents in the off-peak hours rather than to increase speeds.
4. Lane widths have been increased from 10 or 11 feet to 12 feet.
5. The taper lengths at merging areas have been increased.
6. "Escape hatches"—i.e. merging lanes beyond the exit noses at points where the freeway drops a lane, are provided.
7. The median separation has been widened to 22 feet and an emergency refuge area provided on the inside as well as the outside. This change is just now being noted in actual constructed freeways; it was on the drawing boards some time ago.
8. Signs have been made much larger, more legible, and positioning has improved. Signs have now been designed which will provide greater advance notice for drivers to move to proper lanes well in advance of freeway exits.

*Another view of merging traffic from left-hand entry*





UPPER—Harbor Freeway in Los Angeles. Everyone starts home at once. LOWER—Hollywood Freeway in Los Angeles. Highway Avenue on-ramp. Note merging movement from left, with contrasting pavement in merging area.

Freeway operation under peak-load conditions is extremely sensitive. Hasty, ill-advised changes in design or traffic control devices could be

very detrimental to the safe, orderly movement of traffic. Furthermore, changes and additions are costly. For these reasons, the Division of High-

ways must proceed carefully and then only after thorough study. A very large initial and continuing operating expense could be incurred by plac-



Merging traffic from left-hand entry, as it looks to the driver

ing electrical control devices in, or "gadgeteering" existing freeways. The benefits, in terms of reduced congestion, are doubtful; the only certain result of such a program would be to divert funds from construction of additional needed freeways.

#### FREEWAY CAPACITY AND TRAFFIC CONGESTION

It must be clear that even freeways have a capacity; that is to say, a limit to the volume they will carry. By its very definition, capacity is the volume of traffic that can be handled without congestion. If the demand exceeds the capacity, there will be congestion. This is just as sure as the fact that if you pour a gallon of water in a one-half gallon container, it will overflow.

At the present stage of development, there are several places on metropolitan freeways in California where the demand exceeds the capacity for about an hour every day in each direction.

There is one point in Los Angeles where more than 23,000 vehicles pass through the intersection of two freeways in one hour every weekday evening. Nine thousand of them make either right or left turns. This is a fantastic volume of traffic to go through

a single intersection in one hour. As long as the demand remains less than 20,000 cars an hour, traffic keeps flowing smoothly. This facility has tremendous capacity without backlogging, but whenever *that* capacity is exceeded somebody has to wait.

#### SOLUTIONS TO CONGESTION ON FREEWAYS

1. *Additional Traffic Lanes.* The first and most obvious cure for congestion is to provide more traffic lanes. This can be accomplished either by adding lanes to the existing freeways or by construction of additional freeways in different locations.

When existing freeways are eight lanes already, or when they feed into eight-lane freeways, the better way of bringing demand and capacity into balance is to build additional freeways which lie closer to the desired travel lines of many of the present freeway users. To illustrate this, consider the case cited above where the demand is 23,000 vehicles per hour. More than a quarter-million trips a day go through this point; this amounts to one of every eight cars in the entire Los Angeles area (or one in every 16 cars twice a day). It is certain that this many people do not go through this one point because they have busi-

ness right there; they do it because, so far, it is the best way to get where they want to go. When there are shorter or straighter or quicker ways, they will use them instead. Increasing the capacity of a freeway beyond eight lanes would postpone the day when additional freeways become available. It would also put a concentrated strain on the city street feeders that would be very difficult to overcome.

2. *Modifications in the design of existing freeways* are made whenever it is found practicable to do so and when it is believed that they will help. Examples of this are to be found where exit lanes have been widened at the connections with city streets to prevent backing into the freeway and where off-ramp locations have been redesigned. In some instances, additional pavement delineation by means of asphalt (for the purpose of warning traffic that a lane is to be dropped) or diagonal arrows have been used to better inform motorists what channels they should follow.

3. *Improved Signing.* Although California freeways from the beginning have had larger signs and more advance signing than any other state highways and as much as any modern roads anywhere, the problem of ade-

quate signing is continually being reviewed and changes are being made to meet the challenge of freeways carrying far more than the designed capacity. Specifically new signs have now been designed to tell drivers sooner what lane to use for the next exit and to give distances to succeeding exits. (Latest signing practices were described and illustrated in the May-June, 1956, issue of *California Highways and Public Works*.)

**4. Traffic Control.** The importance of adequate traffic control for the purpose of keeping traffic moving and taking action with regard to stoppages occasioned either by disabled vehicles or collisions must be recognized.

The removal of disabled vehicles from the traveled way is extremely important when traffic flow is at saturation volumes. One lane blocked for 10 minutes under such conditions will cause a stoppage which backs up and does not totally dissipate for 90 minutes. By that time, of course, although the traffic on the freeway is all moving again, the tail end of the jam has

moved back to include the on-ramps and even the downtown streets. As many as 10,000 cars can feel the effects of such a stoppage. This is essentially an enforcement problem.

**Speed Limits.** The capacity of a freeway lane is about three times that of a lane in a city street. The ratio depends on the amount of control imposed on the city street traffic and the time intervals between vehicles. During long intervals, or "gaps," the traffic flow is zero. Intersections, signals, and other controls create these gaps. In order to make full use of all freeway lanes, traffic must be allowed to fill up the gaps between vehicles. This means that variable speeds are necessary, and lane changing is essential. Imposition of controls which would freeze speeds or prohibit lane changing (provided that they could be enforced) would be certain to reduce capacity and increase delay.

It has been found that when hourly volumes are such as to permit comfortable driving on a freeway, i.e. 1,500 vehicles per lane, the average

speed for all lanes is 45 miles per hour. More than half of the cars are going faster than that, and half of the cars in the median lane are going more than 50 miles per hour. When speeds are reduced to where the faster cars are going only 45 miles per hour, congestion has set in. When volumes reach the point where traffic is slowed down to 35 miles per hour, it is virtually impossible to "speed," and cars are so close together that driving becomes tense.

Imposing a low speed limit other than the basic speed law now in the statutes, which requires reasonable, prudent speed, could have only these effects: it would make law violators out of a high percentage of the off-peak drivers; it would create "lane-block" barricades of three- or four-abreast drivers proceeding at a frozen speed; and it would cause a large number of drivers to be watching their rear-view mirrors at times when they should be watching the car ahead. A speed limit during periods of congestion would, of course, be mean-

Hollywood Freeway, with traffic from the Pasadena Freeway merging. This is what a peak-hour flow of 7,800 vehicles per hour in one direction looks like.



ingless because nobody is going more than 40 miles per hour anyway.

#### MECHANICAL DEVICES

Many ideas have been advanced for elaborate control measures, including electrical and mechanical devices, almost all of which cost very large sums of money, both for initial installation and for continuing operation. In most instances, the effects of such devices have not been adequately studied or considered.

For example, suggestions have been made that electric signs to be actuated by various means be installed for the purpose of advance warning of stalls and wrecks on freeways. Some of the technical problems to consider before adopting such signs are these:

1. In multiple collisions, the vehicles involved are following *immediately* behind the first car which gets in trouble. There is no place where warning devices could be installed, and no particular instant at which they should be activated, to warn cars that the fellow 100 yards ahead is about to have a collision.

2. For the purpose of warning the more distant traffic of congestion ahead, it would be necessary to rely on motorists at the scene to find the proper button and push it. Generally, no one (unless personally involved) even gets out of his car at the scene of an accident.

3. A very elaborate electrical detecting device might possibly be invented, which would automatically illuminate signals to the rear when traffic slowed down beyond a certain point, say 25 miles per hour. (It would not be possible, of course, for presently available electrical devices to tell the difference between stopped traffic and no traffic at all. Either condition would indicate the same to a detector in the pavement.) The design would have to be such that no false alarms would be turned in, or it would soon be worthless. A system which would accomplish the desired results has not been devised to date. Additionally, even simple lane control signals at periodic intervals would cost several hundred thousand dollars per mile, including the complicated electrical circuits, structures to support the lights, and so on.

A few people have suggested traffic signals on freeways. It does not take much imagination to visualize the chaos that would result from such a measure. Enough unfortunate experience has been had with traffic signals on relatively low-volume expressways to state categorically that the number of collisions at each signal during a



*At saturation volumes, even minor collisions will cause a back-up of traffic, which will take several minutes to dissipate.*

year would be enormous. And, of course, the congestion resulting from stoppage, and the effect it would have on capacity, are obvious.

#### TELEVISION

An eastern city is considering the installation of television on several miles of freeway for the purpose of keeping traffic under surveillance at all times from a central location. Representatives of the Division of Highways have discussed this installation with officials of the city and manufacturers of equipment.

In considering television, one must not lose sight of the fact that this provides only a method of seeing what traffic is doing and does nothing directly to reduce accidents or congestion. Television could indirectly provide means for rapid dispatching of emergency vehicles and in this way reduce delay due to wrecked or stalled vehicles. At the present time, it is the thinking of Division of Highways engineers that the cost of such an installation on California metropolitan freeways would exceed the benefits obtainable from it. In other words, the sum of money required for the initial installation (several hundred thousand dollars) and subsequent operation (several hundred thousand

dollars per year) of a television system would provide greater benefit to highway users if spent to provide additional freeways.

#### SUMMARY

1. Very high volumes of traffic are being carried on metropolitan freeways in California.

2. When the volume exceeds the capacity, delay results.

3. Many improvements in design have been made as a result of research and experience.

4. Solutions to congestion lie primarily in providing more travel lanes, mostly on new alignments which are closer to desired travel lines. In addition to this primary solution, modifications are being made in design and directional signing is being improved.

5. Extreme caution is required in the contemplation of restrictive control devices on freeways. The fundamental difference between freeways and ordinary streets is the lack of restrictive control devices. The result of this removal of controls is safer operation, higher speeds, and greater capacity.

6. In spite of the congestion, the existing freeways are, to date, the safest, quickest ways available for motor vehicles to get from one point to another.

# Informative Study

Report on Open Graded  
Plant-mixed Surfacing

By W. C. CARROLL, Assistant Engineer, Construction

THE FOLLOWING report is a discussion of facts about open graded plant-mixed surfacing, which have been established by the experiences of highway construction personnel in the field. Because the use of a thin top course of O. G. PMS has been restricted to a certain few areas of the State, the number of field engineers experienced in this type of bituminous pavement mixture is necessarily limited. Therefore, the principal aim of this exposition is to present all available information about this material to other interested field engineers.

To start with, the material should be defined. Generally speaking, open graded PMS is a bituminous mixture in which the grading of the mineral aggregate is deliberately left open so that the voids of the coarse aggregate are unfilled by finer aggregates. A relatively higher asphalt content provides thicker asphalt films which bind the mixture together when maximum mineral aggregate surface contact is made.

In order to give greater meaning to this definition the following discussion of the specifications for mineral aggregate and bituminous binder is presented.

## MINERAL AGGREGATE

Open graded PMS is covered in Article (e) of Chapter II under Section 20, entitled "Plant-Mixed Surfacing" in the Standard Specifications. Mineral aggregate (which must be either broken stone or gravel or natural material having essentially the same qualities of angularity or surface irregularities and roughness as broken stone), shall be tough, durable, sound and free from vegetable and other deleterious substances. This is much the same as the requirement for the dense graded mineral aggregates.

The combined mineral aggregate when tested shall conform to the following requirements:

Sieve sizes	Comparison of Mineral Aggregate Grading Requirements				
	Percentage passing sieves				
	Type A PMS 1/2" max.	Type B PMS 1/2" max.	Type B PMS 3/8" max.	Type C PMS 1/2" max.	Open graded PMS
3/4"	100	100		100	
1/2"	95-100	95-100		95-100	100
3/8"	75-90	80-95	95-100	80-95	90-100
No. 4	50-70	55-75	65-85	57-78	30-50
No. 8	35-50	38-55	47-65		15-32
No. 16					0-15
No. 30	15-30	18-32	25-39	21-34	
No. 200	4-7	4-8	5-12	4-9	0-3

Loss in Wet Shot Rattler Test \_\_\_\_\_ 37% max.  
Loss in Los Angeles Rattler Test (after 500 revolutions) \_\_\_\_\_ 40% max.  
Film Stripping \_\_\_\_\_ 25% max.  
Swell (test to be made on material passing No. 4 sieve) \_\_\_\_\_ 0.030" max.

The film stripping test is only made on mineral aggregates proposed for use in O. G. PMS and is a very important test. Borderline material in respect to this test specification should not be used.

Of the various mineral aggregate requirements, those for grading show the major difference. To illustrate this difference, let us compare open graded with dense graded mineral aggregate grading specifications.

From the table above, the decrease in the amount of material between the No. 4 and No. 200 sieves is clearly indicated; the voids are unfilled, resulting in exactly what the name implies, an open graded mixture.

At the hot plant the mineral aggregate for open graded PMS is separated into two sizes which are stored in separate bins. One bin contains that portion of the material retained on a No. 4 sieve, the other contains the remainder of the material which passes a No. 4 sieve. There are no other ad-

ditional requirements at the central mixing plant.

In some areas of the State excessive quantities of fines in the mineral aggregate stockpiled for use in open graded PMS necessitate the changing of screens on the plant.

Experience indicates that excessive fines will cause bleeding if the asphalt content has not been correctly computed for the specified open graded PMS mineral aggregate grading. Further, if the mineral aggregate is graded on the fine side of the grading specifications and the asphalt content is set too high, bleeding may result.

## BITUMINOUS BINDER

The specifications for the bituminous binder to be used in open graded PMS are the same as those used in dense graded PMS. The amount of bituminous binder added to the mineral aggregate is between 3 1/2 percent and 5 percent, by weight of the dry mineral aggregate.

On page 6 under Test Method No. Calif. 303-A in the Materials and Research Department Laboratory Manual of California Standard Test Procedures, it is stated that the formula used to determine the bitumen ratio for open graded mixes is  $1.5 K_c + 2.5$ . It is further stated that no correction need be applied for viscosity. The

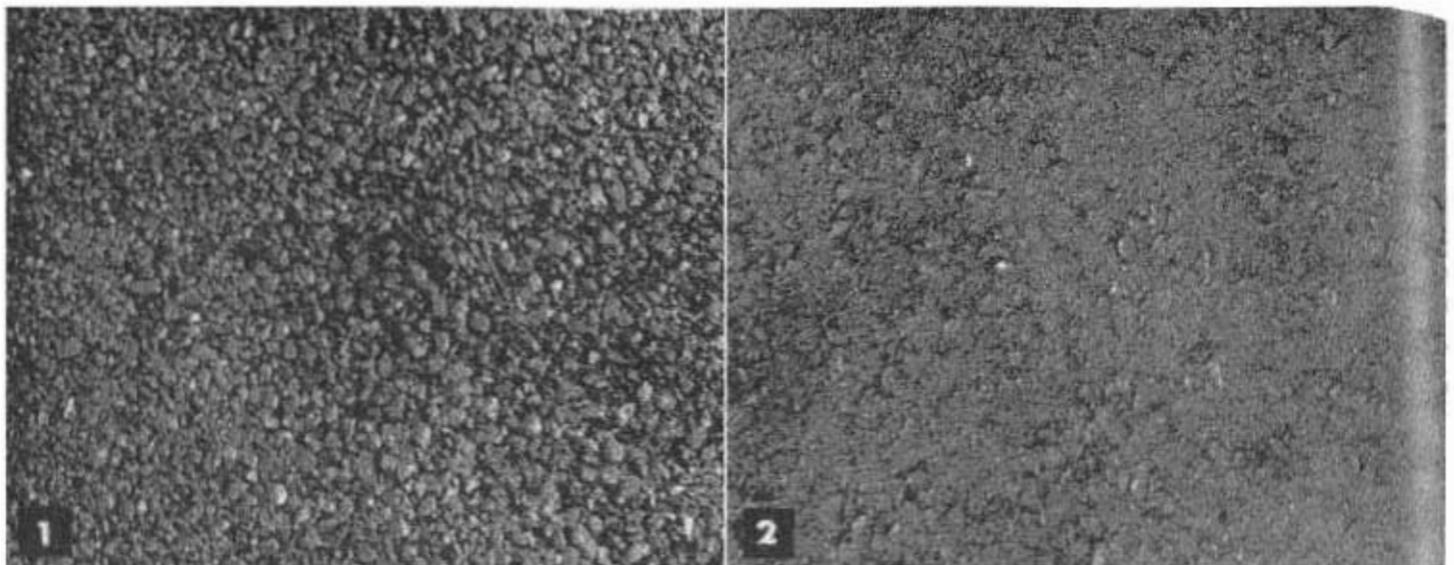


PHOTO No. 1. Close-up view of open graded PMS showing typical surface texture. PHOTO No. 2. Close-up view of dense graded PMS showing typical surface texture.

bitumen ratio computed from the above formula would be the same whether liquid asphalt SC-6 or paving asphalt, grades 150-200 or 85-100 was used.

It should be noted that open graded PMS appears over-oiled and has a very uniform surface texture. See photos No. 1 and No. 2. It is not necessary to apply a fog seal to a newly placed open graded PMS.

It seems logical to follow up our discussion of the mineral aggregate and bituminous binder requirements with a discourse on the various problems most frequently encountered in the manufacture and placement of open graded PMS.

#### HEATING AND TEMPERATURE CONTROL

Particular care should be taken during the manufacture of open graded PMS material to avoid overheating or "burning" the mixture. If borderline weather conditions exist, it is recommended that the paving of open graded PMS be halted rather than risking overheating of the mixture for the sake of handling and placement. Overheating very often accounts for raveling due to fact that the asphalt film thickness on the aggregate has been reduced below that which is required to maintain what cohesion binds the material together. Generally, it is recommended that the mineral aggregate be heated to not over 275 degrees F.

In connection with this problem of heating open graded PMS at the plant and reducing the loss of temperature of the mixture from the plant to the street, it has been found that the dump truck beds can be effectively heated before first loaded with open graded PMS in the mornings by using hot aggregate from the plant bins. All loads delivered during the day should be covered.

Any cold lumps of open graded PMS should be removed from the receiving hopper of the paver. If not removed, these lumps will cause dragging of the screed unit and probable failure by raveling.

#### UNDERLYING SURFACE CONDITIONS AND TREATMENT

It is very important that the surface upon which the open graded PMS is to be placed shall be clean, dry and tacked with a fog spray of asphaltic emulsion.

Experience indicates a fog spray of emulsion used as a tack coat is justified where open graded PMS is being placed on top of a dense graded PMS. The rate of application of the fog spray tack coat will generally vary from 0.05 to 0.10 gallon per square yard depending upon the surface conditions. A dusty surface on the dense graded PMS combined with the rapid cooling of the open graded PMS aids slippage failures.

All delays in handling and placing open graded PMS should be eliminated, the material should be placed as soon as it is received on the job site.

#### FEATHER EDGING

Because the open graded PMS is intended to be used as a wearing surface over the dense graded PMS structural section, feather edging of the open graded wearing surface at the edges in order to eliminate the sudden drop-off is necessitated. Open graded mixes have also been successfully feathered at the edge of PCC gutters.

It should be noted that several of the districts call for tapers at the outside edges of the open graded PMS blanket. These tapers, which vary from 4 inches to 1 foot in width are made using the hand rake or a diagonal strike-off plate extension fitted to the paving machine screed. This strike-off plate scalps off most of the  $\frac{1}{2}$ -inch and  $\frac{3}{8}$ -inch rock, leaving the fines along the tapered edge. This screed-attached, taper strike-off has one advantage of leaving the edge looking more uniformly aligned. However, in time, under traffic, the edge usually becomes slightly ravelled and appears much the same as the hand-raked tapered-edge. It is recognized that satisfactory rolling of a taper is something desired but seldom obtained. This sometimes incomplete and uneven compaction of the tapered

edge accounts for the ravelling due to lack of "set" of the mixture. Also, spotty tacking at the edges of the pavement to be paved over with an open graded PMS blanket will promote ravelling of the tapered edges.

It has been suggested that fine mixes be used to construct the tapered edges on the open graded PMS wearing surface blanket. This is not recommended if water will be trapped in the open graded PMS.

#### THICKNESS REQUIREMENTS

Open graded plant-mixed surfacing is usually placed as a blanket 0.05 to 0.10 foot in thickness. Although a  $\frac{1}{2}$ -inch thickness has been specified in the past, it is more common to find thicknesses from  $\frac{3}{4}$  to  $1\frac{1}{4}$  inches. Some of the districts have changed the grading requirements for open graded PMS mineral aggregate to require 100 percent passing the  $\frac{3}{8}$ -inch sieve. This change allows the spread of a slightly thinner blanket and makes feather edging easier. Since the placing of a thinner blanket is thought to provide a smoother surface, it is suggested that the thickness be that minimum which will just prevent dragging of the screed unit on the paver.

Further discussion of the minimum thickness of the open graded PMS blanket as affected or controlled by the maximum sized aggregate and degree of irregularity of the surface of the underlying pavement is necessary to establish another fact about this type of material which has been learned by practical experience.

The coarse aggregate in the open graded PMS material must be interlocked as much as possible. If the material is allowed to drag between the screed and a high point in an irregular underlying surface the coarser mineral aggregate will be spread out or "opened up," resulting in little or no surface contact among the various rocks. (This discussion deliberately avoids introduction of cohesion or stability values because of insufficient test data being available at this time.) A dragged section of the open graded PMS material will soon ravel away, since the thicker asphalt films are ineffective as a binder because of the

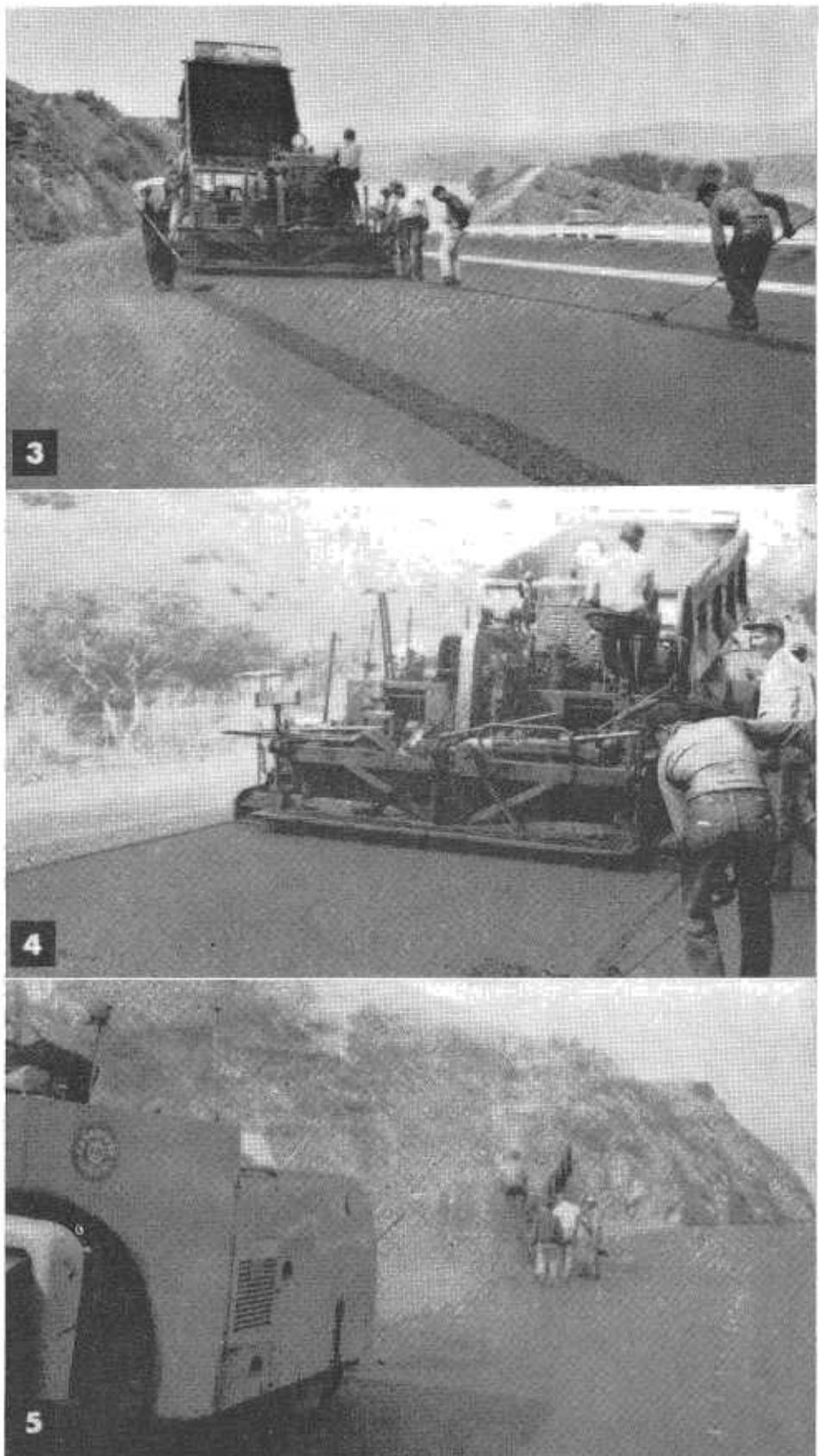


PHOTO No. 3. Here rakers are forming the one-foot taper section on the left and trimming the longitudinal joint on the right. PHOTO No. 4. Shows what a routine operation the paving of open graded PMS is. PHOTO No. 5. The breakdown roller doesn't have to delay getting onto fresh mat.

decreased interlocking and surface contact of the aggregate.

#### RECOMMENDATION

Therefore, it is recommended that the on-the-street thickness of the blanket be governed by the degree of irregularity of the underlying surface and the maximum size of aggregate. If a section of pavement does show signs of dragging immediately behind the paver, it has proven wise to blade off this faulty section and immediately replace it with a thicker and tighter knit mat. It follows that the more uniformly true the underlying dense graded PMS material has been paved, the closer the average thickness of the open graded PMS material will approach that shown on the typical section.

It is important that the major high points in the underlying surface be observed ahead of the paver, using a string line to determine approximate screed settings, and that these locations be marked outside the width of the working area. However, this suggestion does not intend to advocate "over-control" of the screed adjustments.

#### FINISHING AND ROLLING

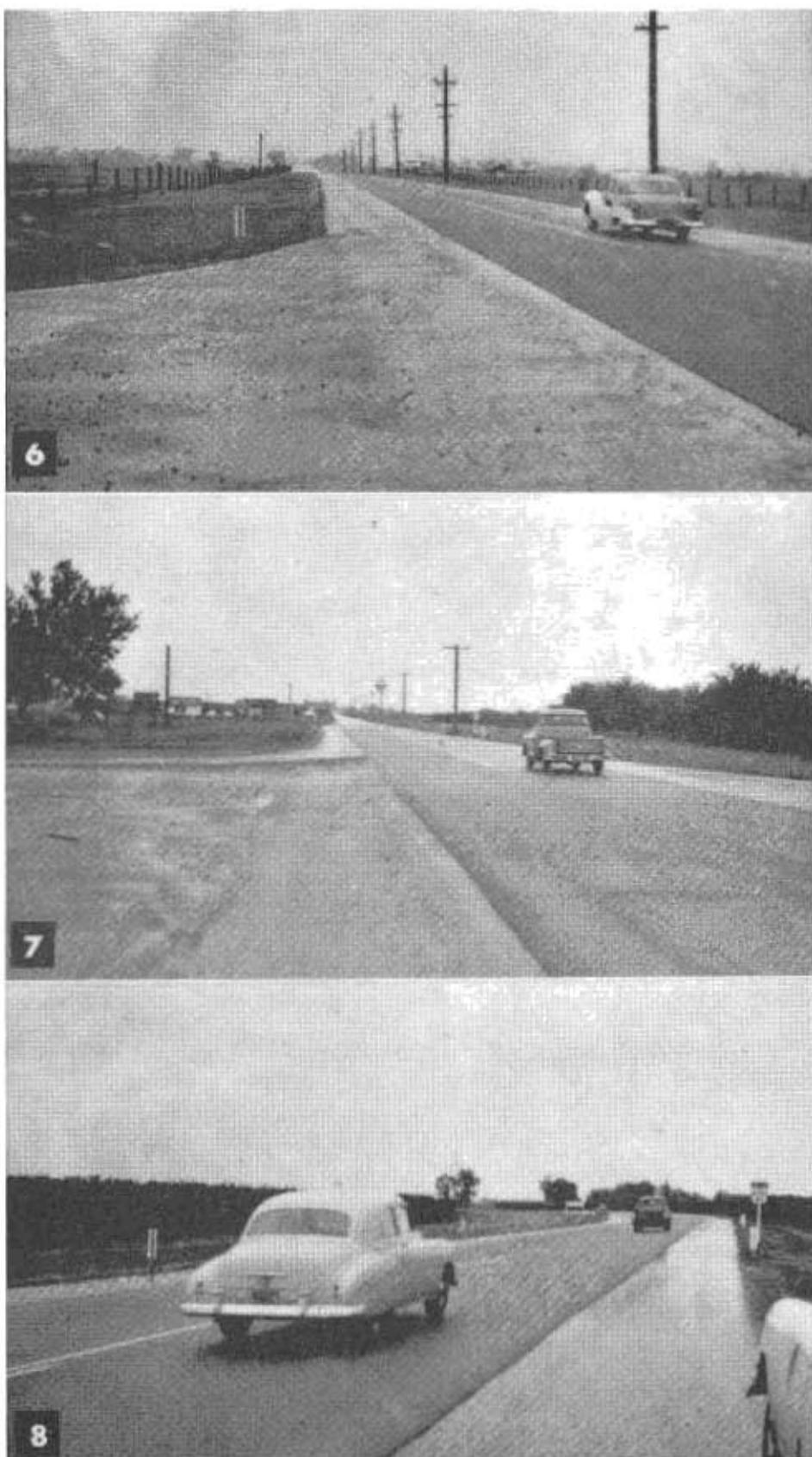
Because of its grading and relatively high asphalt content, open graded PMS used as a wearing surface is easily placed with any of the self-propelled mechanical spreading and finishing machines in use today.

Although the open graded PMS tends to cool much faster than dense graded PMS, no unusual rolling problems are incurred. However, it should be emphasized that care must be taken to avoid over-rolling open graded PMS. In most cases only one breakdown pass and/or one finish pass with the rollers are required. Excessive rolling will cause slippage failures. *Do not over-roll!*

#### PRODUCTION

Aside from local problems in providing sufficient quantities of properly graded mineral aggregates, open graded PMS is no detriment to plant production. (Note photos No. 3, 4 and 5.)

No unusual segregation problems have been encountered during the



PHOTOS Nos. 6, 7, and 8. These photos all illustrate the following advantages of an open-graded PMS blanket: TOP—surface dry condition during a rain, CENTER—Better delineation of E. P.'s. LOWER—Improved visibility of center stripe during a rain.

manufacturing or paving operations. When relatively thin blankets are to be paved, normal plant and street production has been maintained by using two pavers in tandem. No additional spreading and compacting costs are introduced.

#### ADVANTAGES

Now that we know about the mineral aggregate and bituminous binder requirements, and have been advised of problems we might encounter during the manufacture and placement phases of our dealings with open graded PMS, we will undoubtedly wonder why we are using this material; what advantages does this type of bituminous paving mixture have?

One of the important advantages of the open graded PMS wearing surface is its improvement of the riding quality of the pavement surface. The table below, which was compiled from records of roughometer reports made on various bituminous paving jobs throughout the State, clearly indicates this point of advantage.

It should be emphasized that this smoothness has two effects: (1), easier riding surface and, (2) reduction of impact loading, one of the principal factors which reduces the life of pavements. In addition, road noises caused by the vehicle tires operating on a rough surface are greatly reduced by this smoothness.

There are different theories which attempt to explain why the thin open graded PMS wearing course so effectively improves the riding smoothness of the bituminous pavement. (It has also been used to improve the smoothness of PCC pavements on bridges and in tunnels.)

One of these is based on the idea that any additional thin blanket course, whether dense or open graded, will remove a certain amount of roughness built into the course immediately below. This belief was definitely proven on a recent paving job in one of our southern districts where the 3-inch dense graded PMS was placed in three 1-inch courses. The roughometer index for this particular job was 6, which places this method of bituminous pavement construction in competition with that of adding an open graded wearing surface to a 3-inch

	Roughness Index (Inches per Mile)				
	Ben-Ali to Roseville Freeway	Waldo Grade on U.S. Hwy. 101 bet. San Rafael & Golden Gate Bridge	U.S. Hwy. 50 Clarksburg to Shingle Springs	Porterville Bypass	SSR #20 nr. Clear Lake
Dense graded PMS leveling course.....	13	No R.I. obtained	No R.I. obtained	14	16*
Dense graded PMS surface course.....	8	12	14 8	9	8*
Open graded PMS surface course (thin blanket-0.04' to 0.08' in thickness).....	4	5	7 5	5	4*

dense graded PMS pavement which has been constructed in two lifts. However, as can be seen from the table above, the open graded PMS still has a lower roughness index.

#### Leveling Action

In addition to the above theory there is the hypothesis ("something assumed for the purpose of argument") that all of the excess asphalt and most of the fine aggregate actually tends to flow within the lower section of the open graded blanket around and below the lower portions of the coarse mineral aggregate; this "leveling" action by the more plastic elements of the mix fills depressions while the more stable  $\frac{1}{8}$ -inch material above this plastic section is kneaded (by the rollers and vehicular traffic) until a relatively smooth surface results.

It should be mentioned that at the present time it is not feasible to test open graded PMS mixes for cohesion and stability. Further, our design criteria do not recognize open graded PMS as a part of the structural section. It is considered as being a type of seal coat. However, it is strongly felt that future laboratory studies of open graded mixes will change this classification.

Another important advantage of the open graded PMS used as a wearing surface is its relatively dry surface during wet weather. The well known fog spray which a moving vehicle whips up from the wet pavement and

throws back onto the windshield of the following vehicle and so on, ad infinitum, is greatly reduced.

(See Photos Nos. 6, 7 and 8 which illustrate the surface dry conditions during a rain, delineation of edges of pavement and improved visibility of the center stripe during a rain.)

At one time open graded mixes were heralded for their attributes which provide a good nonskid surface. However, more recent tests do not entirely support this idea.

The following information was excerpted from a "Report on Trends of Skid Resistance Tests of Three Highways Pavement Surfaces" which was prepared by Ralph A. Moyer, Research Engineer, and Gale Ahlbom, Graduate Research Engineer, Institute of Transportation and Traffic Engineering, University of California.

#### OBJECT OF TESTS

"These results of skid resistance tests have been collected to show the history and trends of three types of pavement surfaces. The tests on these surfaces are not as complete and frequent as should be for a complete analysis, but the results do show some indications of the effect of age, season and traffic.

"The test results referred to are lengthy and difficult to incorporate in this report. However, the basic findings are as follows: Open graded PMS is generally smoother than other types of pavement but does not have as high a coefficient of friction. Gener-

ally, however, the friction values for a dense graded PMS with rounded gravel aggregate and a high percentage of fines, are lower than open graded PMS, especially in tests made using the smooth tread tires.

"The lowest friction values were obtained on a section of open graded PMS which was completed and opened to traffic on the same day. It is thought that the asphalt films covering the aggregate particle were slightly more oily when these surfaces were first opened to traffic than several weeks later and that this oiliness contributed to the lower friction values which were obtained near the end of the construction period."

#### Another Advantage

Still another advantage of open graded PMS is derived from the fact that the uniform surface texture of the open graded PMS wearing course clearly delineates the traveled way from the shoulder areas thus providing a well-marked and easily followed lane for vehicles in all kinds of weather. With the exception of rare instances when there might be snow on the surface, traffic stripes are always visible, rain or shine. (*The photos Nos. 9 through 18, inclusive, illustrate how open graded PMS wearing surfaces surpass seal coats for delineation purposes.*)

One minor advantage of open graded PMS which is worthy of comment results from the flexibility of this material. The very nature of the grading of the mineral aggregate and relatively high asphalt content used in the open grade PMS wearing surface minimize reflection cracking from underlying pavements. Since it is more nearly a flexible pavement course it "gives" or heals over failure cracks which occur in the dense graded PMS pavement underneath.

As in any discussion of a subject of this kind, there are exceptions to the above statements. However, in the majority of these exceptions the failure cracks in the underlying pavement were excessively wide and most probably should have been filled with a fine mix, asphaltic joint filler material, or slurry seal before the open graded blanket was placed. It follows that open graded PMS should

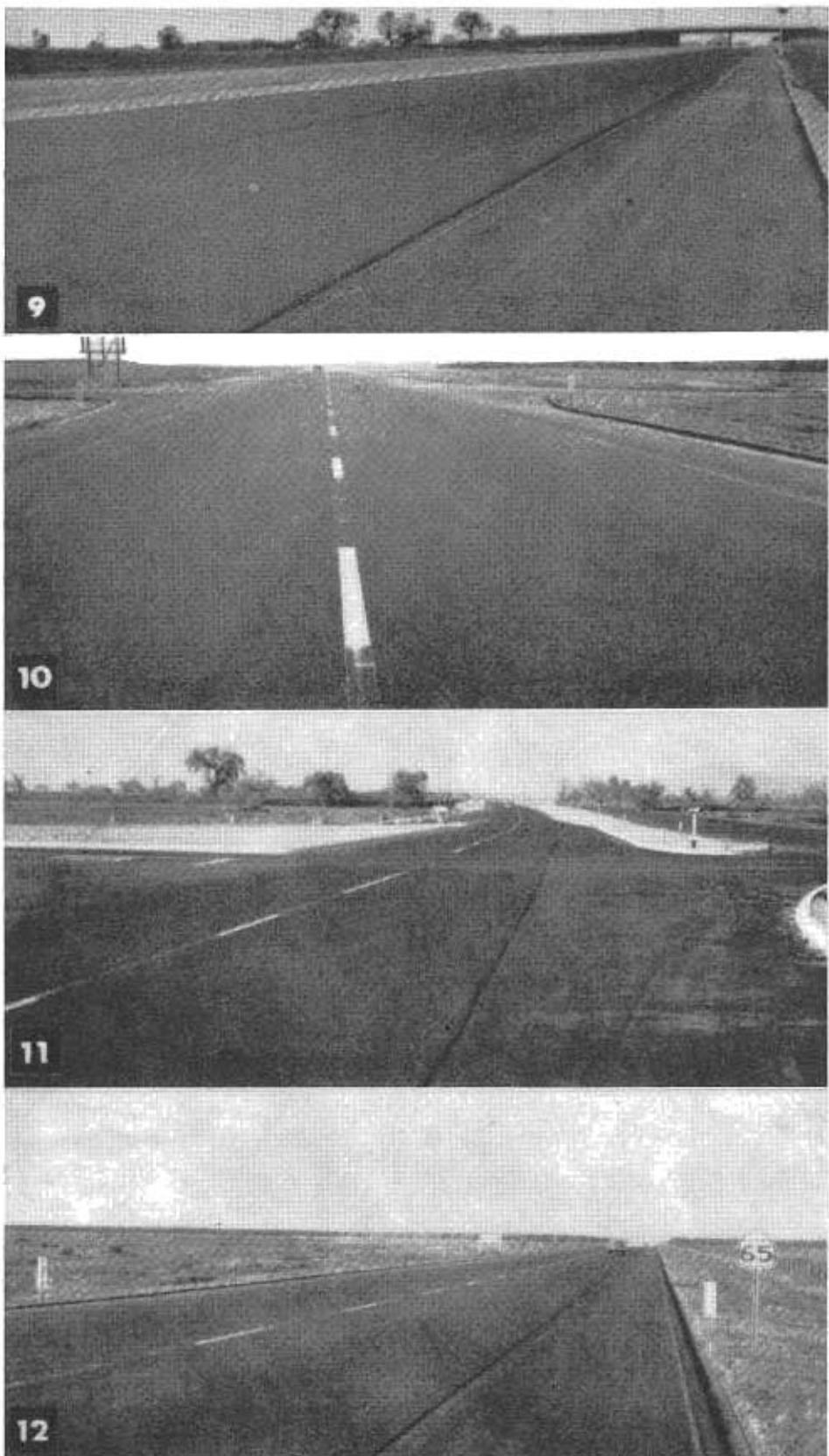


PHOTO No. 9. View of O. G. PMS blanket showing delineation characteristics—chip seal to be placed on shoulders. (No taper.) PHOTO No. 10. Question: Where are the E. P.'s? There they are! PHOTO No. 11. Here's what the O. G. looks like when carried through an intersection. PHOTO No. 12. Again the effective delineation of the open-graded PMS is clearly illustrated.

not be placed on a yielding base because the continuous flexure will definitely cause complete failure.

#### LIMITATIONS

As is true of all construction materials, there are limitations of usage which must be recognized and reckoned with when the use of open graded PMS is being considered. The next few paragraphs are devoted to acknowledging the known instances where open graded PMS should not be used.

In the northern districts where seasonal ice and snow conditions require the use of chains by vehicular traffic, it has been considered impracticable to use open graded PMS blankets. The expansive force of the ice exerted against the coarse aggregate combined with the cutting force of the tire chains erodes the coarse aggregate out of the mat. Also, the treads and blades of seasonal road clearing equipment damage the open graded PMS much more than they do the dense graded PMS.

However, there is one case in a northern district where this material was used on a road which is blanketed with as much as a foot of snow for short duration during the winter. In the two years that this open graded PMS blanket has been down there have been only slight failures—less than would normally be expected with dense graded PMS. Further, since there is less chance for ice to form on the open graded PMS surface, sanding operations were cut in half after the open graded PMS blanket was placed. (*Photos 19 through 21, inclusive, show the winding and steep graded mountain road on which the above-mentioned open graded PMS was placed.*)

#### Wearing Surface

In connection with our discussion of limitations of usage, there are a few examples of unsuccessful usage of open graded PMS as a wearing surface which should be mentioned to emphasize the need for proper utilization of open graded mixes as surface courses.

Among these is the case in a southern district where the structural section specified one inch of open graded PMS on top of two inches of dense



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PHOTO No. 13. Another illustration of delineation characteristic of O. G. PMS. PHOTO No. 14. A section of Highway US 101 south of Klamath at the Freshwater Lagoon where recent floods inundated this section. Still in good condition. PHOTO No. 15. Delineation characteristic of O. G. PMS shown again. This pavement is one of the best in the State for smoothness and appearance.

graded PMS and road mixed shoulders constructed flush with the edge of pavement grades on the open graded surface course. It follows that water shedding off the 2 percent slope within the one inch of open graded top course was trapped at the down slope edges and under existing heavy traffic conditions stripping of the asphalt from the aggregate was promoted during wet weather until raveling occurred at these outside edges. This was a clear case of misuse of the open graded PMS wearing surface.

Another case involved the use of a half-inch blanket course of open graded PMS and dirt shoulders. In wet weather the water shedding through the open graded PMS saturated the dirt shoulders making their use very hazardous. Damage to the edges of pavement resulted from loss of base support due to base saturation. This certainly would have occurred regardless of the type of pavement. However, the open graded PMS blanket provides such a surface dry appearance that the unwary driver was deceived into thinking that the surface of the shoulder was merely damp and would support his car.

There are other cases where open graded PMS was misused in much the same way. It is important that the nature of the material be recognized and provisions made to accommodate the surface drainage water in a practical manner. (*Inspection of the photos Nos. 9 through 18, inclusive, showing the various typical road sections with open graded mix as a wearing surface will illustrate this statement.*)

We have discussed the material, its manufacture and placement problems, its advantages and its restriction of use, as well as examples of misuse. Since we are trying to recognize all of the problems which arise from the use of open graded PMS, it is necessary that maintenance problems be discussed.

#### MAINTENANCE

In all fairness it must be admitted that open graded PMS is not easily patched. In fact, it is usually patched

with an SC-4 dense mix which promotes its own growth by trapping water in the open graded PMS on its up-slope side. It has been suggested that a hood and fire pot could be used to insure dry surface conditions in the area to be patched and that the open graded PMS could be hand mixed and placed at the patch area by maintenance crews trained in the technique of constructing open graded PMS mixes. The fear of promoting bleeding by the uncontrolled build-up of asphalt in the area to be patched provides the main argument against this method. This fear would be well founded if the mix were on the fine side of specified grading.

It has also been suggested that a small portable bituminous mixer capable of producing adequate and uniform open graded PMS material at the site of the failed area could be used successfully. This method has yet to be tried.

The maintenance engineer of one of our southern districts reports that a sizable stockpile of open graded PMS material using SC-4 has been manufactured and successfully used to patch failed areas. This is the first encouraging report of an attempt to improve patching methods where open graded PMS is involved.

#### COST

After all of the preceding discussions, we finally come to the subject of cost. Those readers who are familiar with the item bid prices for different types of seal coats, and for dense as well as open graded PMS will undoubtedly be familiar with the comparative costs in their respective districts.

Discussions of the comparison of costs of the chip seal and open graded PMS blankets often conclude that the open graded PMS blanket is too expensive to justify its additional cost. However, in the light of the many advantages noted above and considering the cost comparisons which follow, it is not thought that this is a fair conclusion.

The following is a comparison which has been made using the total of bid prices for the items of screenings (seal coat), and mineral aggregate (open graded PMS) and paving asphalt and asphaltic emulsion for contracts in 1954.

Total quantities were divided into total costs to arrive at average prices.

Next it was assumed that 5 percent of the total cost of open graded PMS is in the asphalt—and that one-third of the total cost of the chip seal coat is due to the asphaltic emulsion. These assumptions are based on figures extracted from *Contract Cost Date, 1954, Construction Department*. The following figures were removed from the same source:

Code 64, Paving Asphalt (PMS)  
90,500 tons at \$22.0972  
(call \$22.10) \$1,999,392.02

Code 73, Mineral Aggregate  
(open graded PMS)  
50,840 tons at \$4.5735  
(call \$4.57) \$232,515.25

Code 60, Asphaltic Emulsion  
(seal coat)  
10,503 tons at \$33.9099  
(call \$33.91) \$356,155.93

Code 68, Screenings, Seal Coat  
150,826 tons at \$6.0472  
(call \$6.05) \$912,074.56

1. Cost of open graded PMS:  
Pav. Asph:  $5\% \times \$22.10 = \$1.11$   
Min. Agg:  $95\% \times 4.57 = 4.34$

Average cost of open  
graded PMS per ton  $\frac{\$1.11 + \$4.34}{2} = \$2.725$

2. Cost of seal coat (using screenings):  
Asphaltic Emuls (seal coat)  
 $\frac{2}{27} \times \$33.91 = \$2.52$   
Screenings (seal coat)  
 $\frac{25}{27} \times \$6.05 = \$5.60$   
\_\_\_\_\_  
\$8.12 per ton

Again from the tonnage basis it can be seen that the open graded is cheaper than the chip seal.

It might be well to convert these figures to area comparison in order to remain impartial.

\* Based on .25 gal./S. Y. (or approx. 2 lbs.) of emuls. and 25 lbs. of screenings/S. Y.



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PHOTO No. 16. Showing delineation effect of O. G. PMS, also treatment of intersection areas as regards placement of O. G. PMS. PHOTO No. 17. Showing delineation effect of O. G. PMS on Highway US 101 north of Crescent City. PHOTOS Nos. 19, 20, and 21. Illustrations of the usage of open-graded PMS blankets on mountain roads where moderate winter weather conditions are experienced. Improved delineation is apparent.

1. Cost of open graded PMS:

Average cost = \$5.45 per ton using 6 lbs. per square foot of one-half inch thickness, the area covered by a ton is 320 sq. ft. or approximately 35.5 sq. yd.

Unit cost = \$0.15/ sq. yd.

2. Cost of chip seal:

Average cost = \$8.12 per ton using 27 lbs. of material (includes both asphalt and screenings) per square yard, the area covered by a ton is 74 sq. yd.

Unit cost = \$0.11/ sq. yd.

Another report on a cost comparison between the chip seals and dense graded PMS blankets in which the loss of rock screenings which have been paid for was taken into account has been prepared by Mr. Berndt Nelson, Assistant Construction Engineer,

Headquarters Construction Department, at the time he was Construction Engineer of District VIII:

"In this area PMS averages approximately \$5 per ton in place. This includes the cost of the mineral aggregate and the paving asphalt which are bid at the same unit cost although as separate items. The average cost of Class 'C' medium seal coat is \$5.50 per ton for rock screenings and \$38 per ton for asphalt.

"If we compare these two ways of rebuilding an existing surface on the basis of a square yard covered, we will arrive at the following cost analysis:

(1) CL 'C' Med. Sl. Ct.	
Asph. 0.25 gal./s.y. at \$38/ton or \$0.15833/gal.	\$0.0396/s.y.
Screen 0.20 lbs./s.y. at \$5.50 ton or \$0.00275/lb.	.0550/s.y.
Total	\$0.0946/s.y.
Call	\$0.095 /s.y.

"(2) PMS Blanket:

PMS ( $\frac{1}{2}$ " thickness) 6.25 lbs./s.f.  $\times$  9 s.f./s.y.  $\times$  \$0.0025/lb. = \$0.14/s.y.

"The comparison so far is based on the assumption that full benefit is obtained from the 20 pounds of screenings placed, which is decidedly not the case. Tests have been taken on the seal coat jobs placed this last season to determine the amount of screenings which stuck on to the pavement. The average is 13.3 pounds on the good jobs, indicating a waste of one-third of the screenings, even when only 20 pounds were originally placed. Therefore, no benefit was obtained from one-third of the screenings, although paid for; the cost of the quantity which did stick has been increased by this wasted amount.

"A comparison of the amount of material actually providing a wearing surface on the road will show the following results:

(1) Screenings and asphalt per sq. yd.	13.3 lbs. screenings 1.0 lb. asphalt
Total	14.3 lbs./s.y. at \$0.095/s.y.
Cost	\$0.0067/lb.
(2) Dense graded PMS blanket	56.3 lbs./s.y. at \$0.14/s.y.
Cost	\$0.0025/lb.

"Summarized, the Class 'C' medium seal coat in terms of quantity of material obtained cost 2.68 times as much as PMS material."

There are many cities throughout the State which are using the open graded PMS as a resurfacing material. One of these, Palo Alto, has kept good cost data records for the period of the last four years. After talking to Mr. I. T. Johnson, Public Works Superintendent of that city, the following information was obtained.

The average cost of resurfacing city streets with open graded PMS during the last four years is \$0.21 per square yard. The double course chip seal using mixing-type of asphaltic emulsion cost \$0.23 per square yard. From his records it is apparent that a chip seal of durability equivalent to that of the open graded PMS blanket is not any cheaper than the latter. Mr. Johnson further noted that the city has made a practice of sealing the open graded PMS in the gutters which cuts down considerably on raveling failures in the gutters during the rainy season.

Intangibles enter into this discussion of cost comparison between the chip seal and open graded PMS. Certainly the intended purpose of the seal as well as appearance or deliberate effect desired must enter into the de-

cision. However, it is hoped that the above-noted cost data will put the cost of open graded PMS material into a better perspective.

#### RECOMMENDATIONS

It is deemed necessary to clarify the recommendation for more widespread utilization of open graded mixes for thin wearing surface blankets. The open graded PMS wearing surface should be placed on top of dense graded PMS travel way pavements and paved shoulders with full recognition of its water shedding characteristic. It should not be used where water can be trapped within the open graded PMS. Open graded PMS should not be used to correct any deficiencies in the underlying base material or dense graded PMS.

#### CONCLUSION

In conclusion it is opined that a more state-wide utilization of open graded PMS wearing surfaces will provide many more miles of smoother riding and safer bituminous pavements and reduce maintenance costs. Any questions arising from reading the information set forth in this report should be addressed to the author at Construction Headquarters Office.

## RECORD SPAN

*Continued from page 4 . . .*

In the performance of the work under this project due credit is here given to the many persons engaged in the tasks of obtaining the various materials, the fabrication of these materials into bridge members, and the placing and erection of these members into the structure. Their accomplishments should be recognized by the multitudes this bridge will serve in the Bay area.

## COMMENDATION

6777 California Avenue  
LONG BEACH 5, CALIFORNIA

Division of Highways  
Stanton Division

GENTLEMEN: I wish to take this opportunity to commend your department, and to express my thanks to two of your employees in particular, Mr. Hazard and Mr. Allen, for the courteous and helpful service which was rendered to my sister and me when our car stalled in some deep water on Artesia Boulevard.

We were sitting there, at a complete loss, wondering what to do, while numerous cars were passing us by without a single offer of help, when Mr. Hazard and Mr. Allen came along. Not only did they push our car clear of the water and traffic, for which we were deeply grateful, but then they stopped and went to a considerable amount of trouble to get the car started again and this was no small matter since it had been so completely flooded by the backwash from passing cars. After getting us out of a difficult predicament and saving us a lot of trouble and expense, it was with a great deal of reluctance that they gave us their names.

As native Californians, it makes us very proud to know, from first hand experience, of the very fine public services performed by the Division of Highways.

Yours sincerely,

MRS. DORISE L. CLAESSEN

*California Highways*

# Topanga Canyon

Major Reconstruction Project on  
Sign Route 27 Is Completed

By K. D. LEWIS, Resident Engineer, and  
ROBERT W. AKIN, Assistant Resident Engineer

TOPANGA CANYON BOULEVARD, State Sign Route 27, extends from US 101-A, Pacific Coast Highway near Malibu, to US 101, Ventura Boulevard at Woodland Hills, thence across the west end of the San Fernando Valley to intersect with State Sign Route 118 at Chatsworth. Topanga Canyon Boulevard was taken into the State Highway System in 1933. From Pacific Coast Highway to Ventura Boulevard it traverses the Santa Monica Mountains.

On October 14, 1955, a contract to grade and pave Topanga Canyon Boulevard from 3.0 mile to 3.6 mile north of Pacific Coast Highway with three inches of plant mix surfacing over four inches of untreated rock base, along with drainage facilities, was awarded to Lowe and Watson, engineering contractors of San Bernardino. The contract allotment was \$220,000. The contract time was 100 working days.

The completion of this project has brought Topanga Canyon Boulevard

## GOOD IDEA

Woodland Hills

EDITOR: I have just finished reading, from cover to cover, the March-April issue of your most interesting magazine. You are to be congratulated on the recently added color illustrations on the covers as well as upon the content of the articles and their accompanying illustrations.

As a resident of the west end of the San Fernando Valley, who regularly uses Topanga Canyon to go to and from my work, I have watched with interest the project which is now nearing completion to straighten and improve the grade of the six-tenths mile which formerly was so tortuous. This is to express the hope that an article describing the problems and techniques used in accomplishing this project, and still keeping the route open to the working public, may appear in the next number.

HUGH B. MILLER

to a uniform standard of alignment and width for the entire length from Pacific Coast Highway to the San Fernando Valley. By improving sharp curves and providing ample roadway width and sight distances it is sincerely hoped that the accident rate will be lowered materially.

## Recreational Route

With the warm summer months the exodus of people from the San Fernando Valley to the beaches is under way and they will now find a safer and faster route between valley and ocean.

Topanga Canyon Boulevard has long served as a traffic link between the communities in the West San Fernando Valley and the recreational areas along the ocean beaches. Before the advent of World War II this area was considered a secluded retreat way off in the Santa Monica Mountains. Many retired people and members of the Hollywood movie colony built homes along or on top of the canyon walls.

These photographs show construction work on Topanga Canyon Boulevard reconstruction project



At the rim of the canyon Richard Dix, the one-time movie star, built a home with views that cover the full 360 degrees of the horizon. The panorama extends from Thousand Oaks in the northwest, out over the San Fernando Valley and the Sierra Madre Mountains to the north, the Santa Monica Mountains to the east, Long Beach, Palos Verde, Santa Monica to the south, and back up the coast to Point Dume in the west. Catalina Island and Channel Islands on a clear day seem to be just offshore.

After World War II others came and built homes along the canyon floor and along the walls. These people wanted quiet and seclusion for their homes yet they could not be too far away because they needed to earn the daily bread in the aircraft plants and other business enterprises in the San Fernando Valley or in the Santa Monica and Culver City areas. At present there are over 6,500 people living in this once isolated relatively uninhabited spot. There is a modern grammar school, stores, restaurants, a weekly newspaper and a United States Post Office flourishing in the canyon. New homes are being constructed continually and some day this once quiet canyon will doubtless be as thickly populated as similar canyons closer to Santa Monica and Hollywood.

#### Traffic Volume Increasing

As the San Fernando Valley has increased in population the traffic use of Topanga Canyon Boulevard has also increased proportionally. Many daily users of this important state highway live in the valley and commute to their jobs in Santa Monica and other points along the coast. In addition to the large increase in weekday traffic, the week-end traffic has increased even more. The present average daily traffic is 4,600 vehicles per day with a peak of 710 per hour in the area that has been reconstructed.

The records of traffic accidents in the project area show that the majority of the accidents involved single vehicles which apparently went out of control and ran off the roadway or struck roadside barriers. This was principally due to the sharp curves, having central angles of almost 180

degrees and the very narrow roadway. The existing traveled way seemed to hang to the near vertical cliffs above the creek bed nearly 200 feet below.

The existing grades on the project averaged 6 percent and the curving alignment might be described as serpentine. To effect a better alignment it was necessary to increase the grade on the first half of the project to 6.6 percent, while it was reduced to 2.6 percent on the remainder. The sight distances were also increased and the roadbed designed with maximum superelevation where possible.

#### Excavation Details

The major item in the contract was 80,765 cubic yards of roadway excavation. Due to the necessity of removing overhanging material on cut slopes and the fact that the roadway excavation did not swell as predicted, this quantity was increased to 98,873 cubic yards at the completion of the contract. The grading was carried out with four (4) crawler-type tractors and scrapers during the day shift and with a 2½-cubic-yard capacity shovel and three rear dump trucks on the night shift. A pioneer road was constructed along the top of the cuts. The Southern California Edison Company and the General Telephone Company placed a shoo-fly line around the project along this road. From this road the bulldozers started to bring down the sliver cuts. At times there was barely room to maneuver the equipment between the new and the existing cut slopes. The bulldozers would overcast the material to the existing roadway where the scrapers would pick it up and carry it to the embankment site. The new cut slopes rose as high as 150 feet above the roadbed, and the fill slopes extended very nearly the same distance below.

It was originally estimated that 60 percent of the total excavation would need to be done with powder. After starting the operation, however, it was found that practically all the excavation could be done with a heavy tractor cat equipped with a ripper. It was found that the rock was cracked and fissured to such an extent that in only one instance was powder needed to carry out excavation completely. This occurred in a through cut where

a dome of extremely hard sandstone was encountered. When the overhang was brought down the first holes were loaded with powder at approximately 0.3 pounds per cubic yard of material to be shot. This shot proved very ineffective. The quick-acting high percentage powder used lost most of its force in the cracks and fissures and only about 5 percent of the expected material came down. By changing to slower-acting bag powder, and a 20 percent to 40 percent stick-type with a slightly heavier loading, the results were more favorable. The quick acting powder was later used in the sandstone dome. Because of the fissures and cracks in the rock only about 20 percent of the total excavation needed to be shot.

#### Drainage Construction Problems

The drainage facilities for the project consisted of three large diameter reinforced concrete culverts to drain the canyons, the largest being 72 inches in diameter, and four small diameter culverts and six down drains to clear the roadway. An interesting problem arose when it came time to lay the 72-inch pipe as it was to be placed on a 32.5 percent grade and the site was inaccessible to a crane. The problem was solved, however, by the use of a nine-ton capacity fork lift. Extensions were constructed for the forks with a raised tip to prevent slipping. The extensions were then padded to lessen the possibility of cracking a section of pipe. Due to restricted storage facilities the pipe was stored near the end of the job; the fork lift would travel to the storage yard, pick up one of the eight-ton sections, and return to the culvert location. When the fork lift was in position at the top of the trench a heavy tractor cat with bulldozer was then attached to the rear of the lift by use of a short cable. This cable was attached to the back of the dozer blade, running under it to the trailer hitch on the lift. As both pieces of equipment proceeded down the trench the heavy tractor and bulldozer acted both as counterbalance and brake for the fork lift. Once the section of pipe was placed the joint was closed by using the tips of the extensions to apply pressure on the pipe at the same

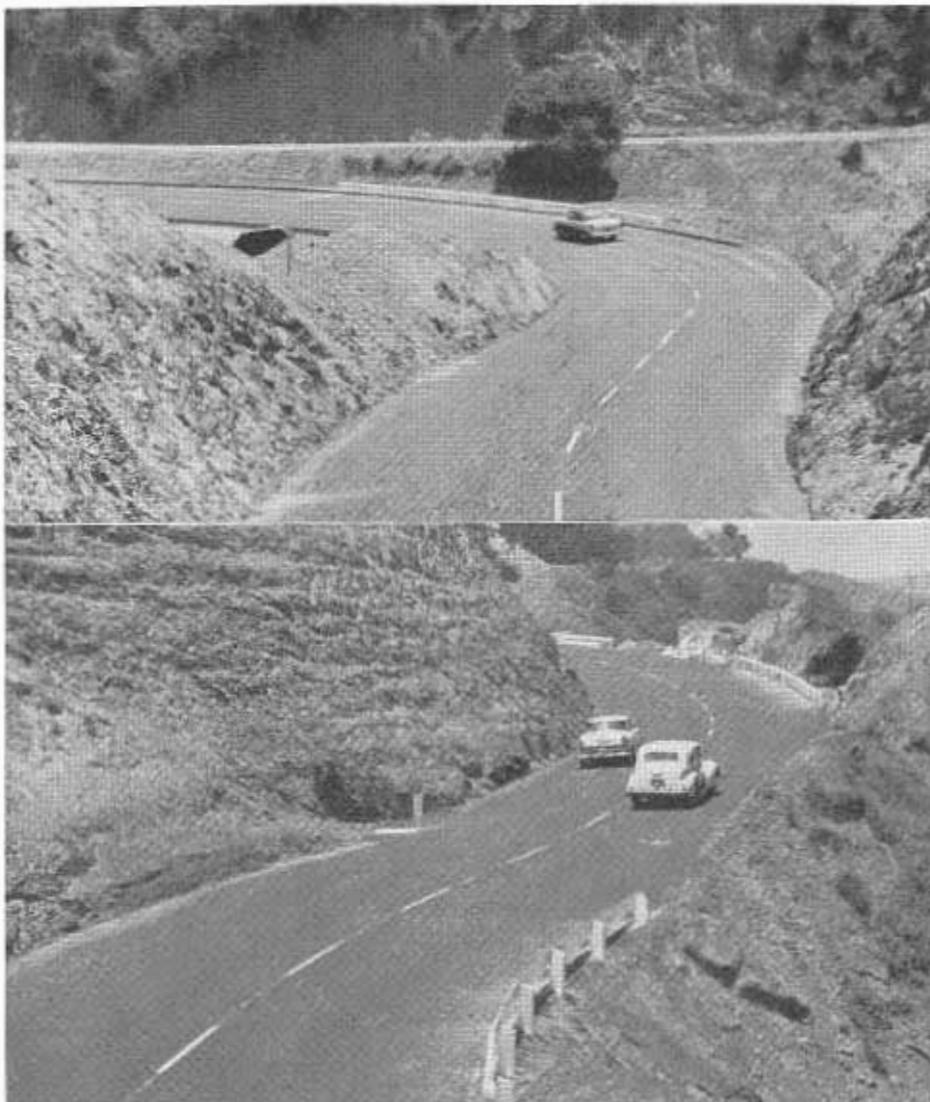
time adjusting the invert to the established line. This method of closing the joints proved highly satisfactory as it not only closed the joints to a maximum degree but, by having the previous section of pipe set true, the remaining sections followed with a minimum amount of adjustment needed to effect a good alignment.

#### Culvert Test Installation

One may wonder at the large sizes of these culverts but it must be remembered that this is a mountainous area with very steep terrain and a relatively large water shed above each culvert. Whereas the total yearly rainfall may not run much over 20 inches a single storm may bring as much as five inches, and the intensity may run over one inch per hour. Due to this high runoff rate and the large quantity of accompanying abrasive material and debris, the single 54-inch culvert near Station 66 was selected by the District VII drainage department as a test installation for a new process asphaltic lined corrugated metal pipe manufactured by a local company. A 16-foot length of the asphalt-lined metal pipe was installed at the outlet end of the 54-inch reinforced concrete pipe. In this way identical conditions of flow will provide direct comparison between the two types of pipe. By placing the test section at the outlet, should failure occur, very little expense would be entailed to remove and replace the experimental section.

#### No Detours Available

The major problem confronting the contractors Lowe and Watson at the beginning of the contract was the handling of public traffic. Due to the terrain no detours around the project could be established and the road could not be closed entirely. According to the special provisions the contractor was required to provide a minimum 20-foot width of traveled way during the hours of 6 to 9 a.m. and 4 to 8 p.m. on weekdays and full time on weekends and holidays. In effect, this cut the working time of the day shift to 6½ hours for which the men had to be paid eight hours. Preparing a roadbed for traffic caused some operations to be cut down by at least another hour. Only earthwork was



UPPER—Looking southerly along completed reconstruction on Topanga Canyon Boulevard showing old superseded roadway in background. LOWER—Looking northerly along section of completed reconstruction on Topanga Canyon Boulevard.

performed at night, and time for the night shift was also reduced by the time it took to cover the rough grade and to blade it smooth for use of public traffic. During each period of opening during weekdays the traffic would nearly reach the maximum peak as described above. "Notice to the Public" signs were placed at the entrances of each road leading into the canyon. These signs stated the hours during which the road would be open to traffic. However, human nature being what it is, several cars each day would drive merrily by them to suffer disappointment by being turned back at

the barricades. Most of these motorists were very cooperative.

In spite of the bad storms which caused so much damage throughout California this winter, the contractor lost only 13 days due to inclement weather. During three periods of bad weather it was necessary to close the road to all traffic because of slippery grade as well as the danger of falling rocks and slides. Closures of this type are nothing new to the users of Topanga Canyon Boulevard, as even before construction slides occurred that would close the road for several days at a time following heavy storms.

# Colton Underpass

*Is Answer to the Problem of Delays at Railroad Crossing*

By W. H. CRAWFORD, Senior Highway Engineer

OPENING of the Eighth Street Underpass project in Colton is the answer to the long-standing problem of traffic delays at the Southern Pacific Railroad crossing in Colton on US 395-91 and State Sign Route 18. The project, having a total cost of about \$1,000,000, is in the heart of the City of Colton, in San Bernardino County. The project begins at L Street and ends at existing Route US 99, also known locally as I Street.

#### Dedicate Underpass

Councilman Woodrow Miller presided over the dedicatory ceremonies, which were jointly sponsored by the City of Colton and the Colton Chamber of Commerce. A plaque was presented to Charles K. Dooley, publisher of the local newspaper, *The Courier*, in appreciation of the work by him and his committee, appointed by the city council, in obtaining the railroad underpass.

The ceremonies, witnessed by a large attendance of interested persons, were climaxed when State Senator James E. Cunningham cut a silk ribbon stretched across the roadway and State Highway Commissioner James A. Guthrie delivered the dedicatory address as the official representative of Governor Goodwin J. Knight.

#### Special Recognition

Many officials from the surrounding area, the Southern Pacific Railway, and the State Division of Highways, were on hand for the important occasion. Following a greeting by Harold Gridder, President of the Chamber of Commerce, they were introduced.

Among them were: State Senator James E. Cunningham; State Highway Commissioner James A. Guthrie; S. Wesley Break, Chairman of the County Board of Supervisors; Supervisor Paul J. Young; Raymond H.



State Senator James E. Cunningham, left, cuts ribbon formally opening the project to public use. He is assisted in this pleasant task by Highway Commissioner James A. Guthrie, center, and Charles K. Dooley, Chairman of Underpass Committee.

Gregory, Mayor of San Bernardino; Assemblymen Jack A. Beaver, 72d District, and Eugene Nesbit, 73d District.

E. E. Duque, President of the California Portland Cement Company, and Vice Presidents L. E. Bancroft, Archie D. McCall, and Richard A. Grant; H. Brand Atwood, Assistant Public Relations Manager of the Southern Pacific, and T. A. Purcell, Assistant Superintendent of the Yuma Division of Southern Pacific.

Also present was Allen R. Craigmiles, veteran employee of the Southern Pacific, who was the towerman who had operated the traffic-control gates at the Eighth Street grade crossing for the past 45 years.

From the Division of Highways were: Clyde V. Kane, District Engi-

nier, District VIII; Assistant District Engineer-Operations, E. G. Bower; District Construction Engineer, H. C. Prentice; and District Right of Way Agent, Ray E. O'Bier.

#### Dedicatory Talks

Representatives of the agencies which participated in the financing of the underpass project spoke briefly. They were: Mayor Alva Duke for Colton; Supervisor Paul J. Young for the county; District Engineer Clyde V. Kane for the Division of Highways; and W. E. Eastman, Superintendent of the Yuma Division of the Southern Pacific Company.

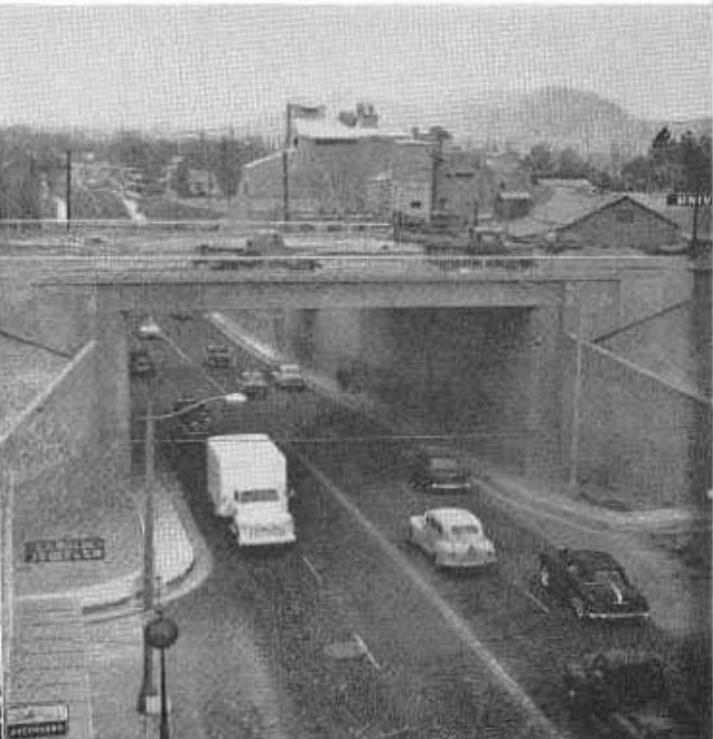
During the time the public was assembling for the program, a concert of favorite selections was given by the Colton Union High School Band.

#### **Eliminates Bottleneck**

Construction of the Eighth Street Underpass is an important step in the relief of traffic congestion in urban areas on US 395-91 and State Sign Route 18. Both routes in Colton follow the alignment of Eighth Street to its intersection with existing Route US 70-99 near the center of Colton. US 70-99 is presently being constructed to full freeway standards on new alignment one block south of its present location. This new location of US 70-99 will be a portion of the San Bernardino Freeway, which has its origin in Los Angeles. The freeway is adjacent on the north to the Southern Pacific Company's right of way for its main line and four other existing tracks leading to the Colton Yards.

The grade crossing at the Southern Pacific tracks, which was eliminated by this project, has been a bottleneck to vehicular traffic dating back to horse and buggy days. An article appearing in the Colton newspaper, dated October, 1891, states: "The people of the city, and particularly of South Colton, are subjected to a great inconvenience by the trains blockading the crossings at the Southern Pacific Depot."

*LEFT—Before construction. Looking southerly along Eighth Street, showing a typical traffic jam at the Southern Pacific Railroad crossing. RIGHT—After construction. View looking southerly along Eighth Street at junction with US 99.*



Vicinity map showing the location of the Colton Underpass and the relationship to other state highways in the area

#### **Heavy Train Movements**

Heavy train movements on the main line and switching operations on the other tracks made it necessary to install traffic-control gates in 1911. These gates, which were in continuous use for 45 years, were, in the last years of their service, lowered as much as 100 times daily and were down for about 4 hours out of every 24.

The present average daily traffic on Eighth Street at the underpassing is estimated at 18,000 vehicles, with a peak hour volume of 1,500. The peak hour occurs daily, Monday through Friday, and the traffic flow is approximately equal in each direction.

The project, which begins at L Street, follows the alignment of Eighth Street for approximately one-

fourth mile to I Street, passing under, in turn, the Southern Pacific Railway and the San Bernardino Freeway.

In general, the work consisted of the construction of three bridges, a graded roadbed, construction of cement-treated base, placing plant-mixed surfacing on the newly constructed base, and the construction of a graded detour with imported base material and plant-mixed surfacing. The three bridges are designated "Eighth Street Underpass," "J Street Off-ramp Undercrossing," and "Eighth Street Undercrossing."

The Eighth Street Underpass is a steel girder and concrete slab deck bridge 60 feet 6 inches long, consisting of one span supported on reinforced concrete abutments to carry the railroad tracks over Eighth Street. The bridge provides a clear width of 124 feet and a clear roadway width of 44 feet and two sidewalks each five feet in width for Eighth Street.

#### **Undercrossings**

The J Street Off-ramp Undercrossing is a reinforced concrete box girder bridge, 58 feet 8 inches long, consisting of one span supported on reinforced concrete abutments. The bridge provides a roadway width of 22 feet and two safety curbs for the off-ramp, and a clear roadway of 44 feet and two sidewalks, each five feet wide, for Eighth Street.

The Eighth Street Undercrossing is a reinforced concrete box girder bridge 60 feet long, consisting of one span supported on reinforced concrete abutments, to carry the San Bernardino Freeway over Eighth Street. The bridge provides for the freeway, two roadways each 46 feet in clear width, a median strip eight feet wide, and two safety curbs; and for Eighth Street, a clear roadway width of 44 feet and two sidewalks each five feet wide.

Reinforced concrete retaining walls were constructed joining the bridge abutments in a manner to form one continuous structure. Stairways were constructed on each side of Eighth Street near the north right of way line of the Southern Pacific Company, to provide pedestrian access to the railroad property and yards.

Continuous street lighting was provided for the entire length of the pro-



*Looking northerly along Eighth Street, showing in turn the Eighth Street Underpass, the J Street Off-ramp undercrossing, and the Eighth Street Undercrossing. Note completed embankment for the San Bernardino Freeway shown in right background.*

ject. A drainage pumping plant was also installed to remove runoff that will accumulate in the depressed portion.

#### **The Problem of Railroad Tracks**

The problem of constructing the underpass beneath the railroad tracks without disrupting the railroad's use of its facilities was accomplished by first constructing two shoofly trestles through construction to carry three tracks and routing railroad traffic thereon. This made it possible to construct approximately two-thirds of the underpass deck. Traffic was then routed over the permanent structure on temporary alignment until trestles were removed and last sections of the deck were placed. When the deck was completed in all respects, the original five tracks were returned to final location. The clear width of 124 feet between railings will provide space for future tracks to the north and to the south of existing tracks.

All of the track work and restoration of the railway tracks and ballast and removal of shoofly trestles and tracks was performed by the Southern Pacific Company's forces.

Agitation for the Eighth Street Underpass project was started in 1941, when a delegation from local organizations of Colton, San Bernardino, and vicinity met with the California Highway Commission and requested construction of a grade separation struc-

ture on Eighth Street at Southern Pacific Company's tracks. In 1944, the Colton Underpass Committee was appointed by the City of Colton and, headed by Charles K. Dooley, continued work on the project. In 1952, the advanced stage of development of plans for conversion of US 99 to full freeway standards made it both necessary and desirable to add to the original project the two undercrossing structures previously mentioned, to effect complete separation of the proposed freeway.

Work on the project was started January 14, 1955, bringing to a close 14 years of effort by its local sponsors for its construction.

This was a cooperative project financed jointly by the Southern Pacific Company, the County of San Bernardino, the City of Colton and the State of California.

The R. M. Price Company was the contractor, with R. M. Harris, Superintendent. Don Alden was the Resident Engineer for the State Bridge Department, and the District VIII Representative was B. D. Gilbert.

In Oklahoma City, Attorney Clarence P. Green told police a 10,000-pound bulldozer belonging to one of his clients had been "stolen or innocently misappropriated, depending upon your view of mankind."

# Delano Bypass

*Freeway Eliminates Bottleneck  
On US 99 in Kern County*

By O. R. ADAMS, Resident Engineer

AT 11:30 A.M. on June 22, 1956, the Delano Bypass Freeway extending from one mile south of the Delano Underpass to one-half mile north of County Line Road, a length of four miles, on US 99 in Kern County was opened to traffic and another bottleneck had been eliminated.

Immediately traffic on the old highway through Delano was reduced to a comfortable volume and, being of a local nature, assumed a leisurely pace. Use of the Delano Underpass, a hazardous spot on the old highway at the south side of the city, has been eliminated except for use by local traffic. Moreover, units of the city police and fire departments can now move across the city with a freedom not previously enjoyed. On the other hand, through traffic on the freeway

is able to traverse the city without reducing speed. Thus one more step is completed in the Division of Highway's plan to make US 99 a freeway from the Mexican border to the Oregon line.

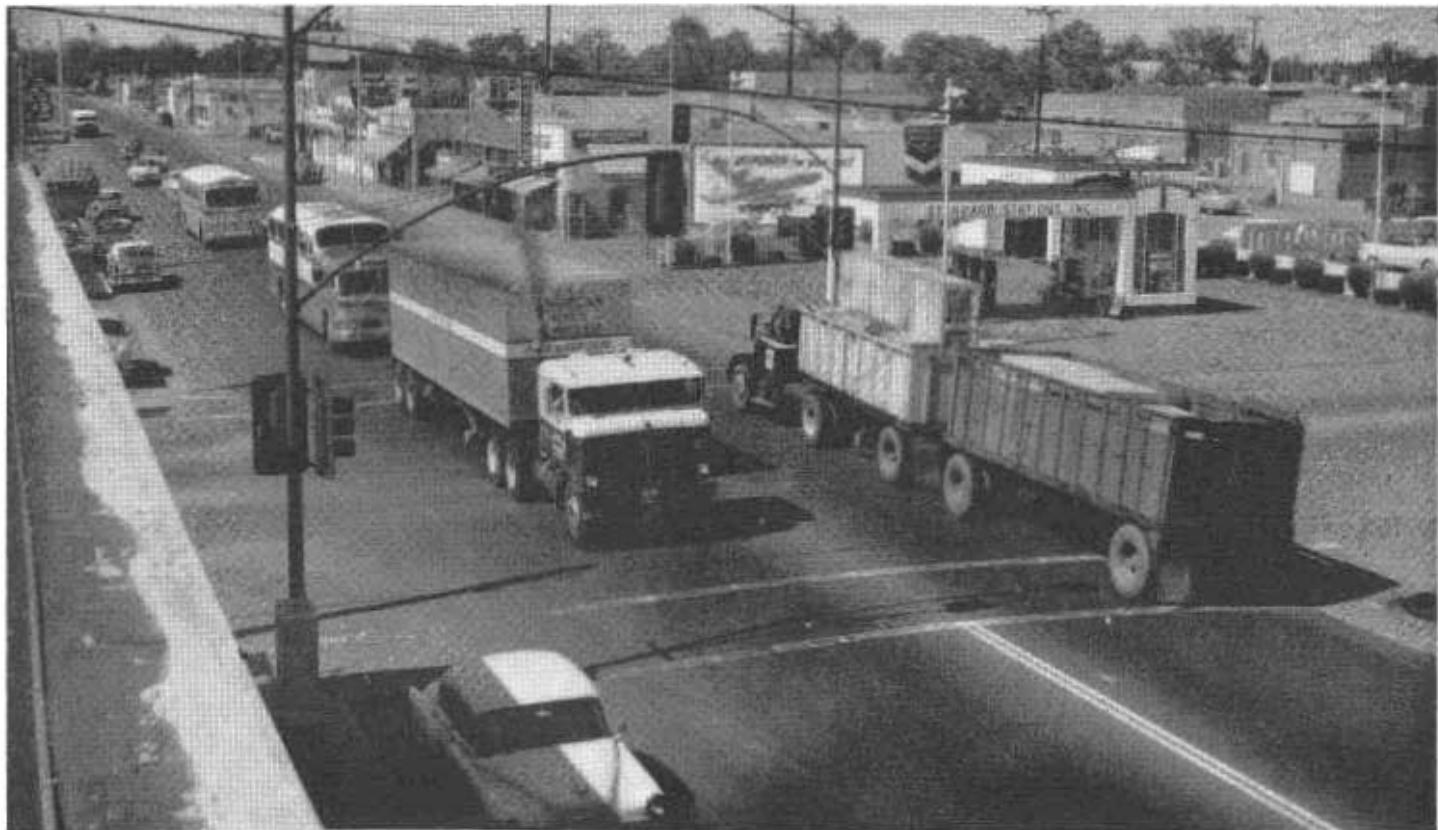
#### **Freeway Agreement in 1952**

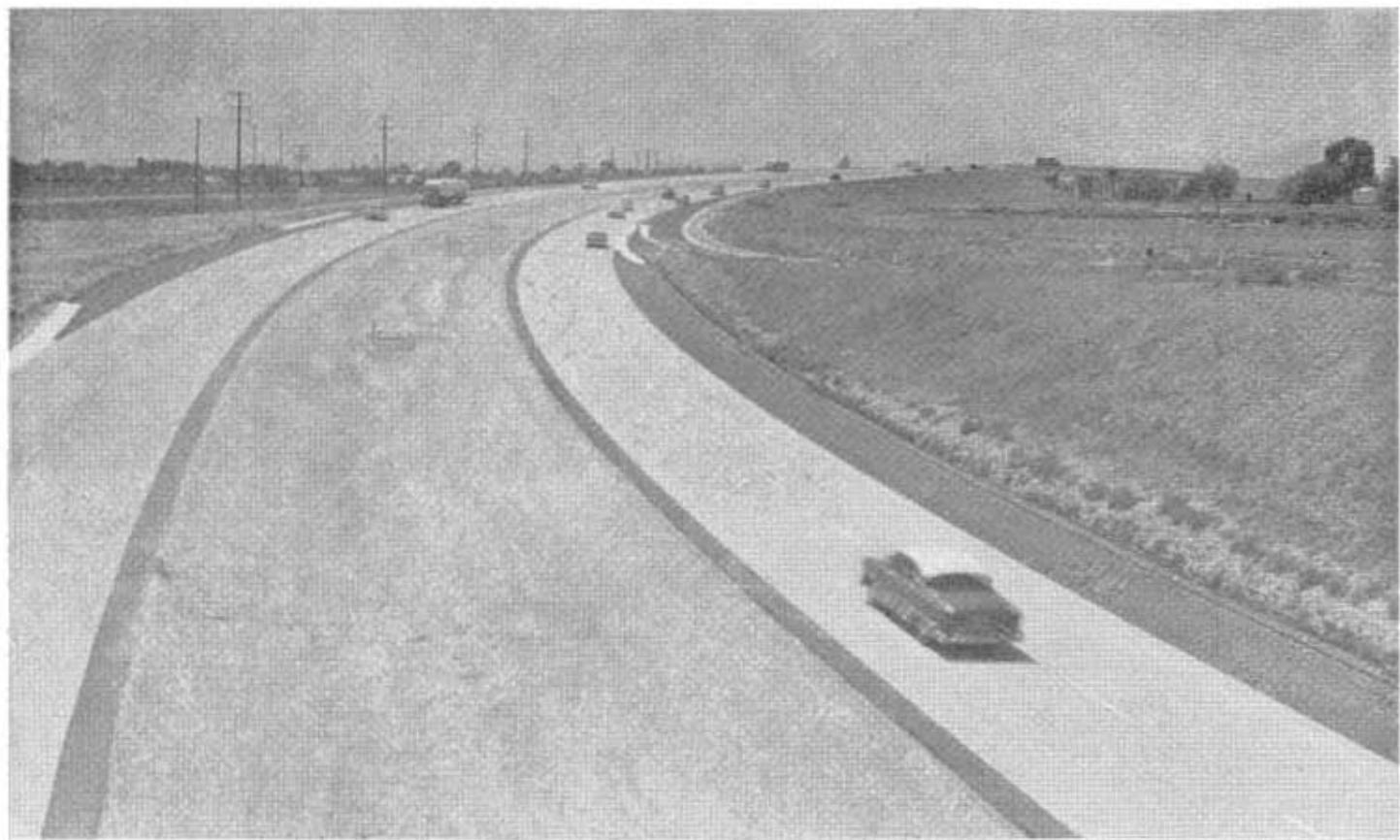
Negotiations with the City of Delano were completed and a freeway agreement signed in October, 1952, requiring the construction of an interchange at Airport Avenue, the south limits of Delano. Concrete paving at the Delano end of the construction project under way in 1952 between McFarland and Delano was terminated somewhat farther south than was originally planned for that contract, to permit construction of the interchange at the Airport Road

without the necessity for removal of any concrete pavement. In December of 1952, a freeway agreement for this proposed location was also completed with the County of Kern. Purchase of right of way and access rights was started soon thereafter. The contract for doing the construction work was approved December 16, 1954, with a contract time of 380 working days and an allotment of funds slightly in excess of \$2,000,000. The contract will be completed in about 365 working days at a cost of \$1,981,000, exclusive of engineering and right of way.

Traffic volumes on US 99 have increased steadily for many years until at present very few highways of such length in the Nation are as heavily traveled. On the old highway all of this traffic was confined to a two-lane

*Normal traffic through Delano before bypass improvement*





roadway which passed through the City of Delano, where speeds were necessarily restricted to 25 miles per hour. Traffic at intersecting streets each block through the city added to the congestion. Both the through traffic and the local cross traffic interfered with and delayed each other. Business properties of varying size and nature lined the highway. A few blocks to the west existed probably the least prosperous section of the city and in some cases the least desirable. Economics demanded that, if an adequate modern facility be provided, relocation was necessary.

#### New Alignment

The freeway, therefore, is on new alignment which, at the southerly end and through Delano, passes about one-quarter mile west of the former US 99 then veers northeasterly across the Southern Pacific Railroad tracks and the old highway on an overhead structure then northerly to the end of the project north of County Line Road.



UPPER—North Delano Overhead Crossing. In right background Southern Pacific Railroad and old US 99, looking northerly. LOWER—South end of project. Temporary crossing in foreground. View is looking southerly. Old south entrance to Delano in left center.



UPPER—Airport Road Overcrossing. View is looking southerly. LOWER—Cecil Avenue Overcrossing. This photo of freeway is looking southerly.

This project is the southerly one of three adjacent contracts all of which will be completed by early fall and which will provide an additional 18-mile section built to full freeway standards. Moreover, the divided highway aspect will be continuous from Los Angeles to a point a short distance north of Plaza (Visalia Interchange). This should be a welcome feature to tourists and truckers alike.

#### **Freeway Features**

General features of this contract are that two lanes of concrete pavement are provided in each direction, these being separated by a median width of 46 feet. If necessary, in the future, an additional 12-foot lane in each direction can be constructed within the median, yet retaining a 22-foot median width. On the median side the present pavement is bordered with two feet of plant-mixed surfacing and three feet of cement-treated base forming an all-weather shoulder. The outside shoulder has an eight-foot width of plant-mixed surfacing and an additional two feet of soil. Through cut sections the plant-mixed surfacing is extended beyond the eight feet to provide a paved gutter.

#### **Twenty Ramps**

Twenty ramps at various locations through the project provide for on and off movements of traffic. A frontage road and two connection roads are further service features. The frontage road serves local business; the first connection road is new construction of one block of city street to provide adjacent parallel streets to the freeway through town; and the second is a relocation of a street moved to maintain minimum standards for freeway ramps.

There are six grade separation structures, five of which are reinforced concrete box girder type construction with open type abutments. At these structures the freeway is in a depressed section passing beneath the transverse traffic movements. The sixth structure, a plate girder type with reinforced concrete deck, is really two similar but separate parallel structures which carry the new freeway over the Southern Pacific Railroad and the old highway.

#### **Construction Details**

The contractor lost no time in getting started with the construction of this balanced earthwork project. Excavation of County Line Road depressed section at the north end of the job and structure work at this location were started almost simultaneously on December 13, 1954. Four 20-cubic-yard scrapers completed the earthwork on the project by early June, 1955. Much of the time this equipment worked two shifts a day and on many days moved as much as 15,000 cubic yards of material. The earthwork operation was always directed at building the only major fill on the project to a high enough elevation to permit the start of work on the abutments for the North Delano Overhead structure.

A second objective was to provide a working place for the other structures at Airport Road, Fourth Avenue, Eleventh Avenue and Cecil Avenue as soon as possible. The footings for abutments and bents on all structures were set on cast-in-place piles. Thus, the first work at each structure location was the drilling of pile holes, placing the reinforcing steel cage and pouring the concrete for the pile. At several of the structure locations the abutments were nearly complete before the excavation of the depressed section for the freeway was started.

#### **Parallel Structures**

By the first part of May, 1955, when the plate girders for the North Delano Overhead structure arrived at a railroad siding in Delano, the contractor was ready to begin placing them. Each of the parallel structures at this location has six spans with three girders being required on each span. A single span in each structure crossed over the Southern Pacific Railroad and the placing of girders had to be coordinated with train movements. Another span of each structure had to be placed over the old highway and its traffic.

#### **Placing of Girders**

The individual plate girders are about 110 feet long, 6 feet high and weigh nearly 18 tons. Because of

the weight and bulk, one girder at a time was trucked from the railroad siding to the structure site. With a 30-ton truck crane, the girders were picked off the truck, turned about 90 degrees while being raised some 25 feet, then positioned and made secure. Placement of the first girder over the highway took 13 minutes, during which time the traffic was stopped as a safety precaution. Placing of each of the other five girders spanning the highway required a traffic stoppage of 10 minutes or less. Even the traffic that was inconvenienced by having to stop seemed not to be dissatisfied at being delayed by such a well-organized operation.

Other structures were started well before this and were completed, except for minor details by midsummer of 1955, at which time the tempo of work tapered off to a conservative pace, and during most of the next few months placing of curbs, cement-treating the base for ramps and placing the plant-mixed surfacing on them were the major items under construction. In January, 1956, concrete paving operations were started, and since this project and the one adjacent to it on the north were being undertaken by the same contractor, the paving operation moved from one project to the other in paving each lane. Daily production in this item was often above 4,700 lineal feet of concrete pavement 12 feet wide.

Some 48 mercury vapor type luminaires light the location of on and off ramps including many of the reflectorized permanent signs nearby. A large illuminated sign at the south end of the project with the words "Tulare" and "Delano" and the appropriate directional arrows is a guide for the northbound traffic. At the north end a similar illuminated sign reading "Bakersfield" and "Delano" serves the southbound vehicles.

Division of Highways Bridge Department representatives on the project were Mr. Loren L. Krueger, Mr. Walter J. Bedel, and Mr. Jack D. Norberg, in turn. The contractor was Gordon H. Ball and San Ramon Valley Land Company.

# Traffic Markings

Pasadena Experiment on  
Colorado Street a Success

By DOUGLAS C. MACKENZIE, City Engineer of Pasadena

THIS ARTICLE describes a unique application of traffic engineering to improve and expedite the safe movement of a very heavy volume of traffic on a primary business street through the heart of a city.

The street is Colorado Street in the City of Pasadena. It is the main business street in Pasadena, U. S. Highway 66, and California State Highway Routes 161 and 9.

Colorado Street has a right of way width of 100 feet and a traveled roadway width of 70 feet curb to curb.

It connects directly with the Colorado Freeway at the new Pioneers Bridge over the Arroyo Seco and extends easterly across Pasadena and into the fast growing business district in



DOUGLAS C. MACKENZIE

Los Angeles County area to the east of Pasadena.

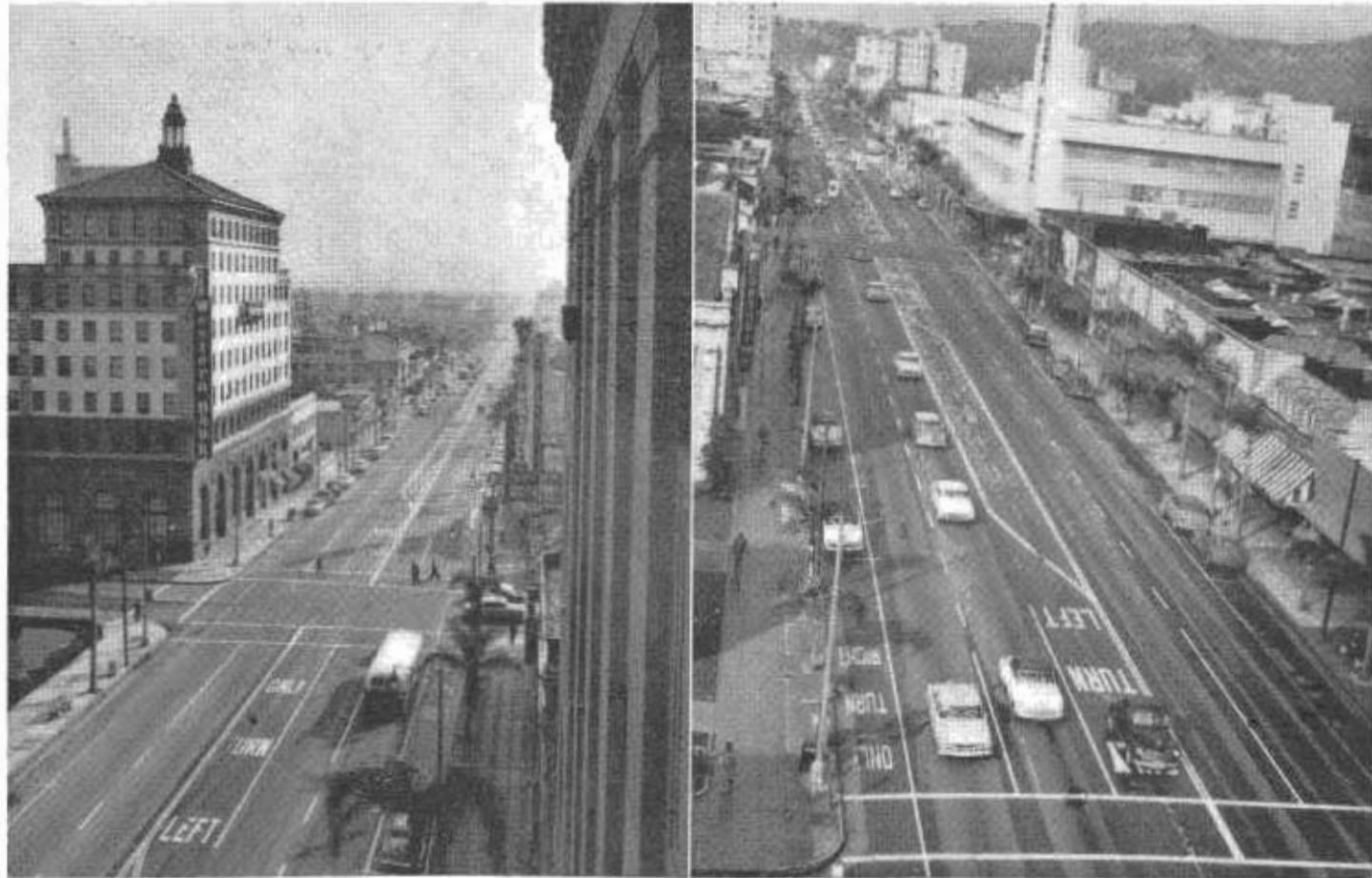
It is the main east-west truck route through Pasadena, carries local, intercity and transcontinental bus lines and a traffic volume in excess of 20,000 vehicles in a 12-hour period, 7 a.m. to 7 p.m., on an average day. There are heavy turning movements at many of the major street intersections.

All major intersections are signalized. The traffic signals are operated on a fixed time progression in both directions on Colorado Street.

#### Description of the Problem

As the 70-foot street width curb to curb is too narrow to accommodate three traffic lanes in each direction

*Traffic control markings on Colorado Street in Pasadena. Photographs by Pasadena Police Department.*



with a parking lane on each side of the street for many years it has been marked with a double center and two 13½-foot-width traffic lanes in each direction and an eight-foot parking lane on each side.

"Far corner" bus loading zones have been standard practice in Pasadena since prior to 1950. All bus loading zones on Colorado Street are "far corner" zones.

Traffic flow was continually interrupted at intersections by vehicles desiring to turn left or right, particularly in the lanes next to the center of the street by vehicles turning left; however, many times vehicles desiring to turn right were held up by heavy pedestrian traffic at the intersection and during these times blocked the movement of traffic in the traffic lane next to the parking lane so that vehicles in both traffic lanes would be delayed through an entire cycle of the traffic signals.

#### Description of How Street Was Remarked

All the traffic lane lines, except the parking lane lines were removed.

The street was remarked, as shown in the accompanying photographs, with a 10-foot width center island with "left turn" lanes, using double lane lines and pavement lettering reading "Left Turn Only." The length of the left turn lane pockets at the various intersections were tailored to accommodate the number of vehicles normally desiring to turn left during a traffic signal timing cycle as determined by traffic counts at all intersections—some are designed to accommodate three or four vehicles and some six, eight, ten or more vehicles.

Parking on the near corner was prohibited for approximately four car lengths to provide a "right turn" lane and pavement lettering was installed reading "Right Turn Only."

Traffic stripes were marked to provide two 11-foot-width traffic lanes in each direction.

The photographs on page 33 were taken in the morning when the traffic was very light so the markings can be more easily seen. The black vehicle in the photograph is in the left turn lane, the light colored vehicles are in the two east-bound traffic lanes, other vehicles are standing in the parking lane and the right turn lane is unoccupied.



Tournament of Roses Parade on New Year's Day, 1955. Photo by Pasadena Star News.

#### Raised Bars Not Used

Attention is directed to the fact that this traffic control design has been accomplished entirely by painted pavement striping, lettering and curb painting. Because Colorado Street is the route of the annual New Year's Day Tournament of Roses Parade it is not feasible to use raised islands, bars or other raised markers in the street.

The remarking on Colorado Street from Arroyo Parkway to Mentor Avenue, a distance of 11 blocks, approximately one mile, was done in March, 1954, after approval had been

granted by the California Division of Highways.

After the revised traffic control marking had been in operation for two and a half months during which time its effect on the movement of traffic was critically observed and studied and it was agreed by the California Division of Highways, the Board of Directors of the City of Pasadena, the Police Department and the Engineering Department that it had very materially improved the safe and expeditious movement of traffic on this portion of Colorado Street,

...Continued on page 36

# State's Loss

*George F. Hellesoe Retires  
As Maintenance Engineer*

**G**EORGE F. HELLESOE, Maintenance Engineer for the Division of Highways, retired on July 6th after nearly 31 years in state service.

Hellesoe's successor is Frank E. Baxter, formerly District Engineer of District IX with headquarters at Bishop.

E. R. Foley, a staff engineer in the division headquarters at Sacramento, was promoted to Baxter's post as head of the district office at Bishop.

## Testimonial Dinner

About 350 friends and associates of Hellesoe gathered in the Empire Room of the Hotel Senator on June 28th at a testimonial dinner. Some twenty former associates who preceded George in retirement were present to welcome him into their ranks.

Assistant State Highway Engineer Earl Withycombe acted as master of ceremonies. The honored guest and Mrs. Hellesoe were accompanied at the speakers' table by Director of Public Works and Mrs. Frank B. Durkee, District Engineer and Mrs. Alan S. Hart, George's successor, Frank E. Baxter and Mrs. Baxter, and Assistant Maintenance Engineer Nelson R. Bangert and his wife.

Director Durkee and Hart were the principal speakers, and the latter took George Hellesoe to task for the December, 1955, floods which disrupted the economy of the Redwood Empire. After the presentation by Bangert of a check representing contributions from a host of George's friends as a down payment on a station wagon for his projected tours, George handled the rebuttal to the lasting enjoyment of all present. In addition to the station wagon fund, George was presented with a beautifully bound book containing the signatures of about 3,000 employees of the department and other friends.

Hellesoe was appointed division maintenance engineer in 1949. Since then he has been directly responsible



GEORGE F. HELLESOE

for keeping the 14,000 miles of highway in the State Highway System in repair and open to traffic and for directing the expansion and intensification of the division's maintenance program necessitated by the tremendous increase in traffic during and since World War II. Under Hellesoe the present state-wide two-way FM radio setup between maintenance forces in the field and the Sacramento and district headquarters was developed to facilitate maintenance and other division operations.

Born at Jolon, Monterey County, Hellesoe began his engineering career in 1910 and for the next seven years was engaged in railroad construction, location, valuation and maintenance work which took him all over the western United States, Mexico and Alaska.

He first came to work for the Division of Highways in 1918 and stayed

*This photograph shows portion of crowd of well wishers that attended banquet in honor of George Hellesoe*





FRANK E. BAXTER

until 1920, with time out for military service.

From 1920 to 1927 he was with the U. S. Bureau of Public Roads, after which he returned to District III of the Division of Highways as locating engineer. The headquarters of District III at that time were in Sacramento.

He subsequently served as Maintenance Engineer of District I at Eureka, Construction Engineer of District II at Redding, and Maintenance Engineer of District IV in San Francisco. In 1946 he returned to District I as district engineer, a position he held until his appointment three years later as maintenance engineer for the entire division.

Baxter was born and raised in Los Angeles. An engineering graduate of the University of California at Berkeley, he came to work for the Division of Highways in 1930. The first 21 years of his career were spent in District VI at Fresno where he served as materials engineer, office engineer, and finally as maintenance engineer. In 1951, he was promoted to assistant district engineer in charge of operations of District II at Redding, where he served until his appointment in 1954 to District Engineer of District IX at Bishop.

Foley, also a native Californian, was born and raised in Nevada City. He



E. R. FOLEY

came to work for the Division of Highways shortly after his graduation in engineering from the University of California at Berkeley in 1932. From 1935 to 1950 he was assigned to the Bridge Department, first as resident engineer and later as assistant construction engineer. From 1942 to 1946 he served with the U. S. Navy and was in the South Pacific with the 46th Seabee Battalion. Since 1951 he has been in charge of the road inventory section of the division's highway planning survey.

### TRAFFIC MARKINGS

*Continued from page 34 ...*

authorization was given to extend the revised traffic control marking to the remainder of East Colorado Street.

#### In Operation Two Years

So in June, 1954, the marking was installed from Mentor Avenue to the east city limits, a distance of 31 blocks—approximately two and a half miles.

This traffic control marking has been in operation for two years. It has proven even more successful than was contemplated in improving the movement of traffic. Compliance with the painted markings by the motoring public has been very excellent and turning movement interference has

been eliminated to the extent that traffic may proceed in the two traffic lanes in each direction in accordance with the coordinated traffic signal timing system in effect on the street.

## Course for Traffic Engineers Planned

Designed for traffic engineers concerned with research, planning and signalization in cities over 300,000 population, counties, and states, and for instructors of traffic engineering, a two-week course on Simulation and Theory of Traffic Flow has been planned for next fall on the Los Angeles campus of the University of California.

Planned by the U. C. L. A. Institute of Transportation and Traffic Engineering and the Engineering Division of University of Extension, the course will be held September 10th to 21st, these dates having been selected to permit traffic engineers from distant points to attend the course on their way to the annual Institute of Traffic Engineers meeting in San Francisco the following week.

Instructional staff for the course will be composed of members of the U. C. L. A. ITTE staff, authorities from other universities and research agencies, and practicing traffic engineers. A detailed syllabus is being prepared as a text during the course and as a reference book after it is completed.

Persons interested in the course may obtain advance registration forms by addressing requests to the Institute of Transportation and Traffic Engineering, University of California, Los Angeles 24, California.

### PLAN HIGHWAY SAFETY GROUP

Public Works Superintendent Ben E. Nutter will attempt to form a "Citizens for Highway Safety," group in Hawaii. Mr. Nutter quoted statistics to show that such organizations on the mainland had helped to reduce traffic deaths considerably.

# San Bernardino Freeway

By LYMAN R. GILLIS, District Engineer

THE YEAR 1956 is a most significant one in the history of the San Bernardino Freeway in Los Angeles County. During this year four construction contracts, covering a continuous length of 15.3 miles from Rosemead Boulevard nine miles east of Los Angeles, through the cities of El Monte, West Covina, and extending to Pomona, will be completed. These four contracts with allotments totaling \$15,423,000 were started during the year 1954, and progressed simultaneously to completion.

On September 22, 1954, Governor Goodwin J. Knight officiated at the groundbreaking ceremonies that were conducted under the auspices of the El Monte Chamber of Commerce which started off the Peter Kiewit Sons' Company contract through that city. As this is written the estimated date for completion of this 3.9-mile unit of the San Bernardino Freeway from Rosemead Boulevard through the City of El Monte to the San Gabriel River, for which the con-



LYMAN R. GILLIS

struction allotment is \$6,400,000, is July 20, 1956.

#### Magazine Articles

Three stories have been published in *California Highways and Public*

Works about this freeway in the issues of September-October, 1951; January-February, 1952, and in March-April, 1953.

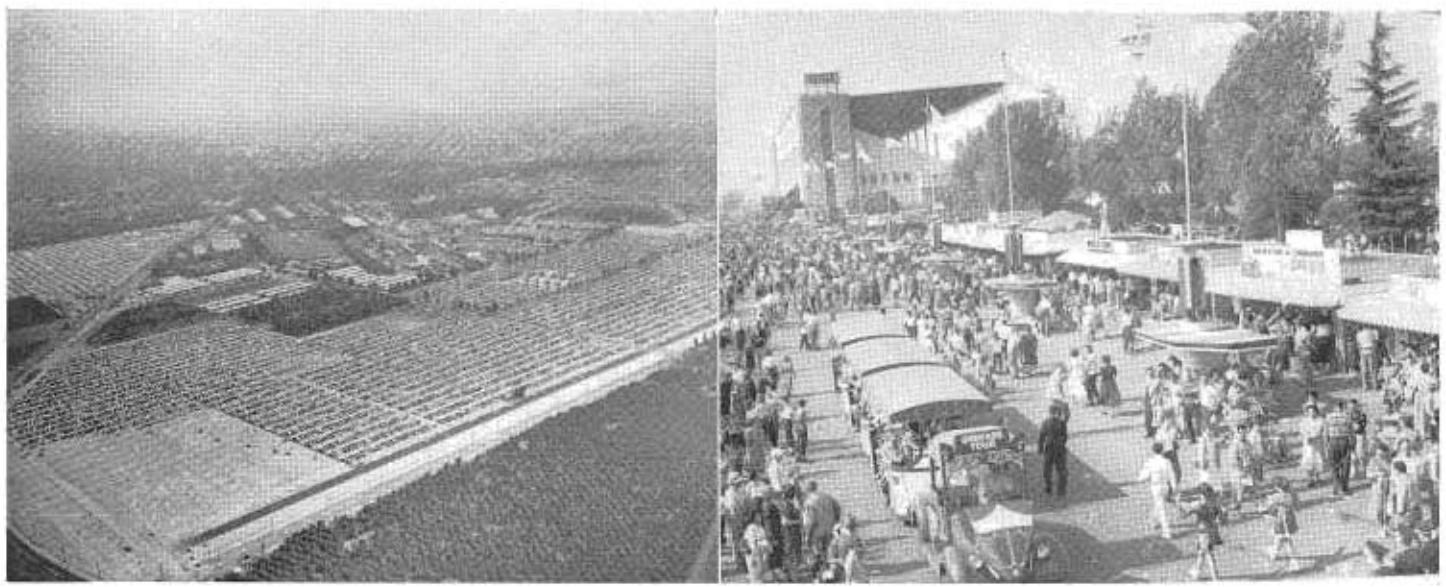
#### Old Ramona Freeway

It should be noted that these three stories referred to this freeway as the "Ramona Freeway." This was the local name that at that time was used to describe the part of this freeway in Los Angeles County. It took this name from the fact that a comparatively short length of the routing of this freeway followed along an existing street in Alhambra and Monterey Park that was called Ramona Boulevard. The name "San Bernardino Freeway" is a most logical one indicating the easterly terminus.

State Highway Route 26, that has now become the San Bernardino Freeway, was taken into the State Highway System by action of the State

LEFT—Looking easterly along completed San Bernardino Freeway through Alhambra and Monterey Park, showing Rosemead Boulevard (the beginning of newly constructed freeway) in the extreme background. RIGHT—Looking easterly from end of present construction operations showing completed San Bernardino Freeway approaching City of Pomona. Los Angeles County Fairgrounds shown background right.





*LEFT—Air view of 450-acre exposition park, home of Los Angeles County Fair in Pomona. The view gives a good idea of the space set aside for auto parking.  
RIGHT—Looking easterly along main promenade of the Los Angeles County Fair showing one of the familiar sightseeing trains in foreground, and the grandstand in background.*

Legislature in 1931. The State Division of Highways has since then undertaken a continuous program of construction that by the end of this year (1956) will provide a six-lane full freeway 30 miles long extending from Los Angeles to Pomona.

#### Famous Pomona Fair

The City of Pomona is the home of the Los Angeles County Fair which, starting in 1922 from small be-

ginnings, is held annually the latter half of September. It might be said that the Los Angeles County Fair and the San Bernardino Freeway have grown up together; both enterprises started from small beginnings, and both have now attained full maturity. From an idea to an annual exposition of national and even international acclaim within a comparatively few years, the Los Angeles County Fair serves as a gigantic display wherein the agricultural, industrial and cul-

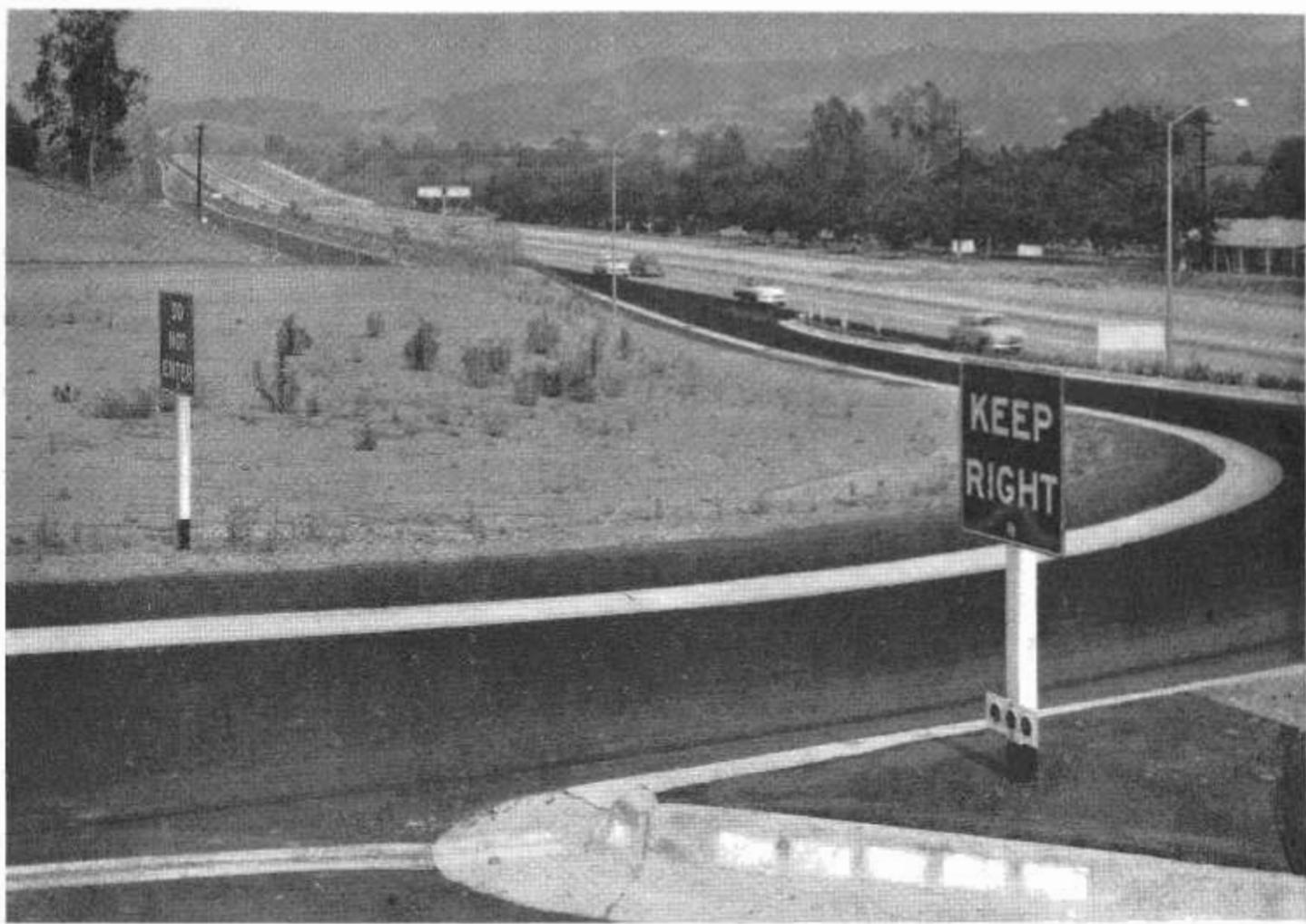
tural accomplishments of the Pacific Southwest are set forth dramatically in a panorama of infinite variety and appeal.

#### Fair Properties Total \$20,000,000

Highway development and the amazing increase in the use of the automobile provides an interesting chapter in the story of the county fair. At first parking was no problem. The comparatively few cars found ample space in the plot around the entrance,

*Looking northeast toward routes 158/26 separation structure on Rosemead Boulevard*





Looking easterly from Barranca Street Overcrossing under construction

This convenient situation did not continue for long. As attendance increased from a constantly widening area it brought a corresponding increase in the number of cars and the space set aside soon became inadequate. The management was quick to envision the future and meet the challenge.

#### Huge Parking Area

Thus it was that almost from the beginning, adequate parking had its place in the master plan of the fair. As more land was acquired for increased facilities, provision for the automobile was an important part in those facilities, until today some 260 acres are given over to surfaced parking areas capable of accommodating around 35,000 vehicles. Last fall 271,921 cars were parked. In the previous year there were 293,997. The peak single day in 1955 had 34,222 cars, and on the top day in 1954 there were

34,272 cars. The above figures do not include busses and other vehicles, nor does it take into account the large number of cars parked along approaching city streets and on private property.

Approach to the fairgrounds was greatly facilitated in 1949 with the opening of four-lane Ganesha Boulevard as a shortcut from the then Holt-Garvey highway, now the San Bernardino Freeway, to a main entrance gate where an underpass and overpass insures a steady traffic flow. There are now gates on all four sides of the grounds allowing convenient entrance from north, south, east and west.

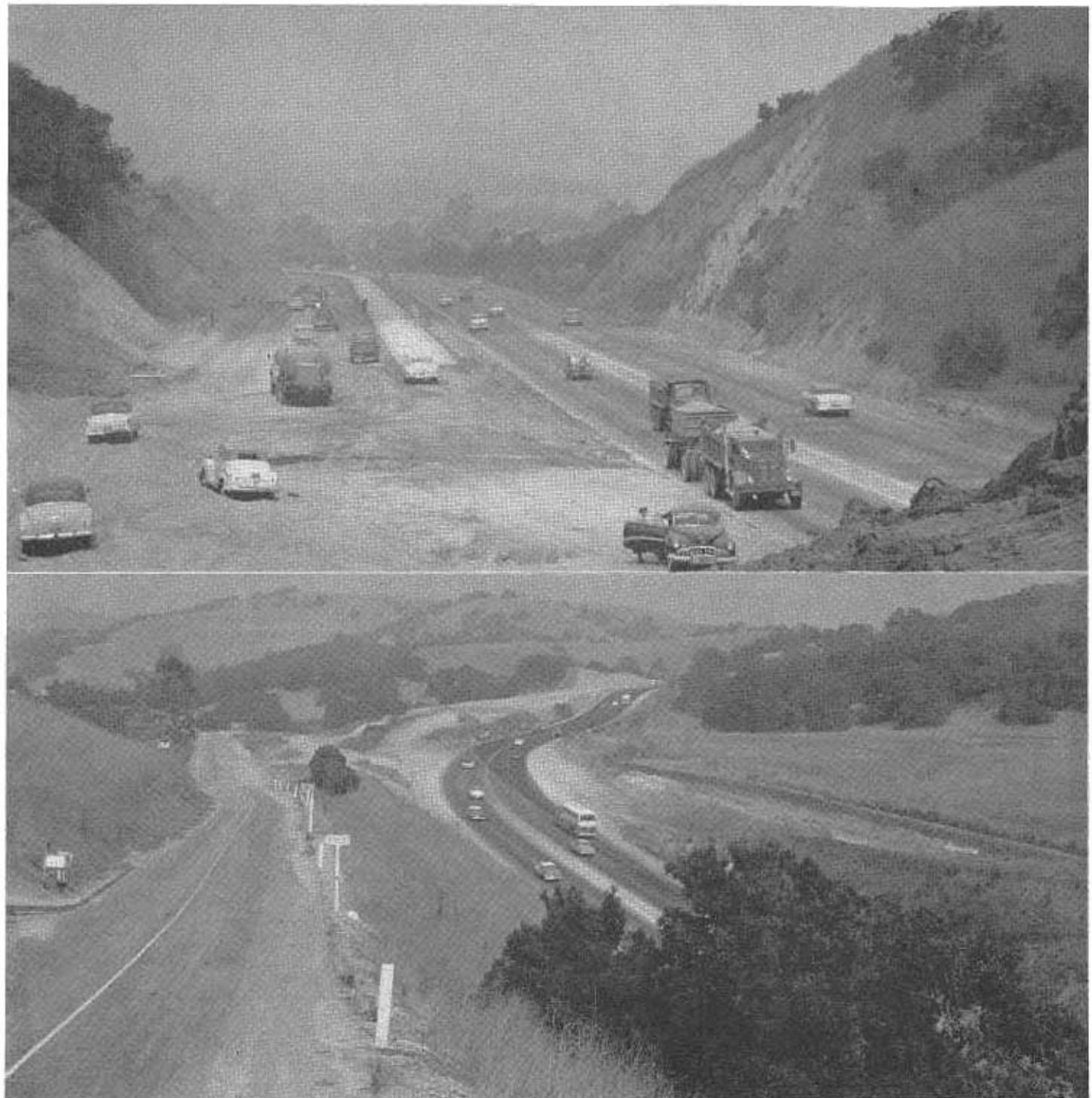
#### Freeway Benefits Fair

It is considered that the San Bernardino Freeway is the main traffic artery to the fairgrounds and it is estimated that 70 percent of the people attending the annual county fair,

of which there have been over 1,000,000 during each of the 1954 and 1955 seasons, come and leave by way of the San Bernardino Freeway.

#### Contract Completed in June

The contract for four miles of the San Bernardino Freeway carried out by Griffith Company, from the San Gabriel River to Puente Avenue at the west city limits of West Covina, was fully completed and opened to traffic on June 4, 1956. The completed grade separations on this section have eliminated signalized intersections at grade and have already greatly increased ease of traffic flow. Also the scheduled completion in July of this year of the four miles of freeway through the City of El Monte area from Rosemead Boulevard to the San Gabriel River, for which the contractor is Peter Kiewit Sons' Company, will also tremendously improve traffic flow conditions by the elimina-



*UPPER—Looking westerly from eastern end of paving construction. LOWER—Looking westerly showing grading between Pomona and West Covina.*

tion of many other busy signalized intersections.

Where construction is in progress from the west city limits of West Covina to Ganesha Boulevard under the two Winston Brothers contracts, conditions of traffic flow will be much improved during the coming Los An-

geles County Fair season than they are at the present time. The presently existing signalized intersections at grade at Orange Avenue and at Irwindale Avenue will have been eliminated by the grade separation bridges now under construction, leaving only two or three signalized intersections at

grade to slow up traffic for the entire 30-mile length of the San Bernardino Freeway between Los Angeles and Pomona.

#### **Fifty-three Bridge Structures**

The four current construction contracts on the San Bernardino Freeway

include all phases of highway and bridge construction. On this 15 miles of freeway there are 53 major bridge structures, many of which have been completed, with others still under construction.

I am indebted to James E. McMahon, Principal Bridge Engineer for the southern area of the State, and his Construction Assistant, George L. Laird, for the detailed information that they have furnished me relative to outstanding features of bridge construction on these four major contracts on the San Bernardino Freeway. The bridge construction is being reported in grouping the work into two units.

#### UNIT 1—ROSEMEAD BOULEVARD TO SAN GABRIEL RIVER

The bridge work included in this unit consists of 14 reinforced concrete box girder bridges, for reinforced concrete cored slab bridges, two reinforced concrete tee beam bridges, seven structural steel bridges, five reinforced concrete tunnel structures, six reinforced concrete cantilever retaining walls and a reinforced concrete pump house.

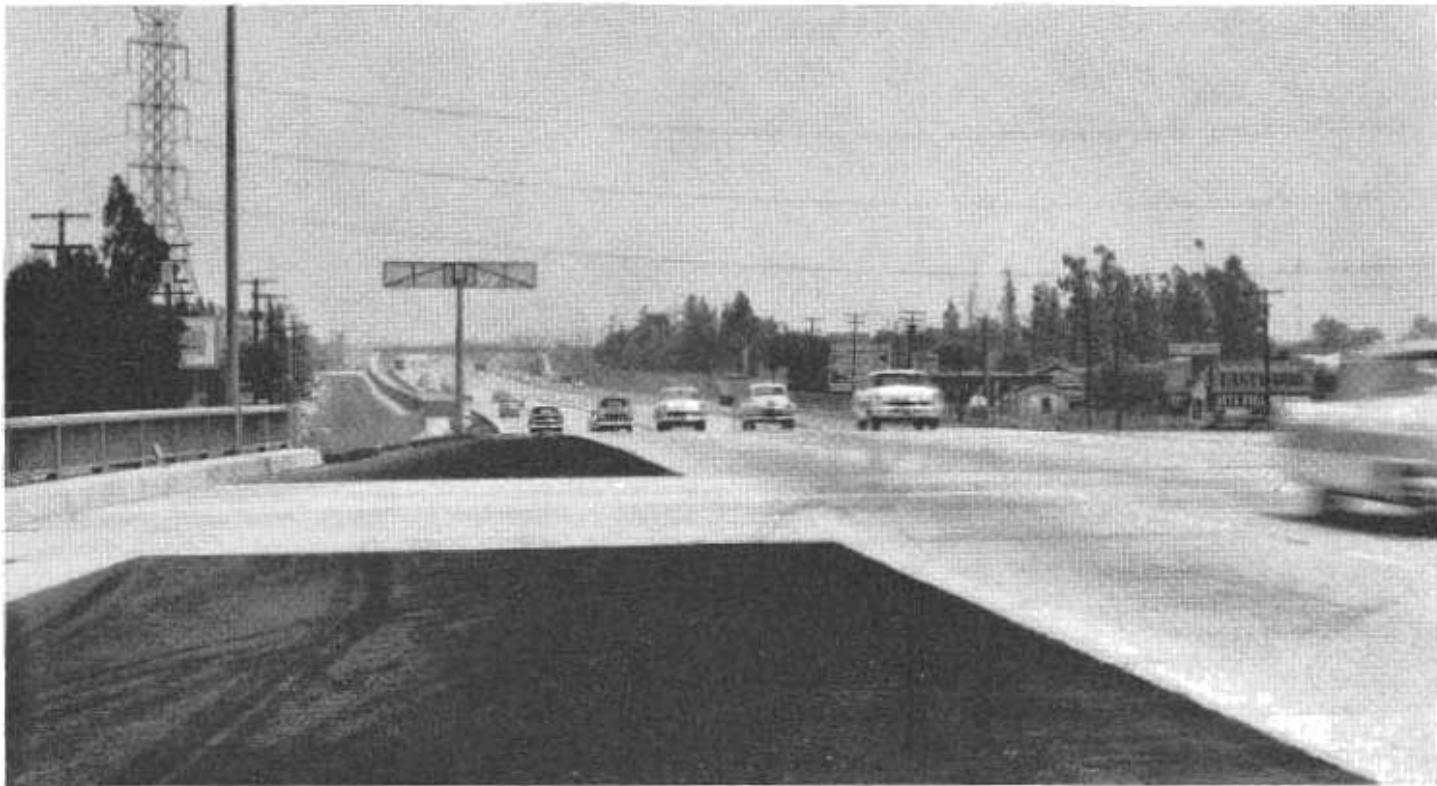
For these 39 major structures the principle items involved are 35,700 cubic yards Class A portland cement concrete, 1,368,000 pounds structural steel, 140,844 linear feet concrete piling, 5,778,000 pounds reinforcing steel

and 24,000 cubic yards structure excavation. The total bridge items aggregate a contract cost of \$2,987,-258.82.

One of the major items was the driving or drilling of the piles. The contractor decided to design and develop a unique method of drilling and pouring the piles. The specifications required that approximately one-third of the piles be driven to specified tip elevation and this was done by Raymond Concrete Pile Company as subcontractor. The contractor decided to drill the balance of the piles, approximately 3,000. The contractor felt that he could afford to experiment a bit and attempt to build a drill rig of his

*Looking southwest on Rosemead Boulevard, showing interchange and frontage road at routes 77/26 separation. San Bernardino Freeway running from left to right of photo.*





*Looking easterly from River Grade Road Undercrossing*

own. At first he attempted to stabilize the subsoil by injecting a solution of sodium bicarbonate and sodium silicate into the ground at three-foot centers around pile locations. The next day, using 16-inch auger the contractor attempted to drill the holes. As the soil was gravelly, the

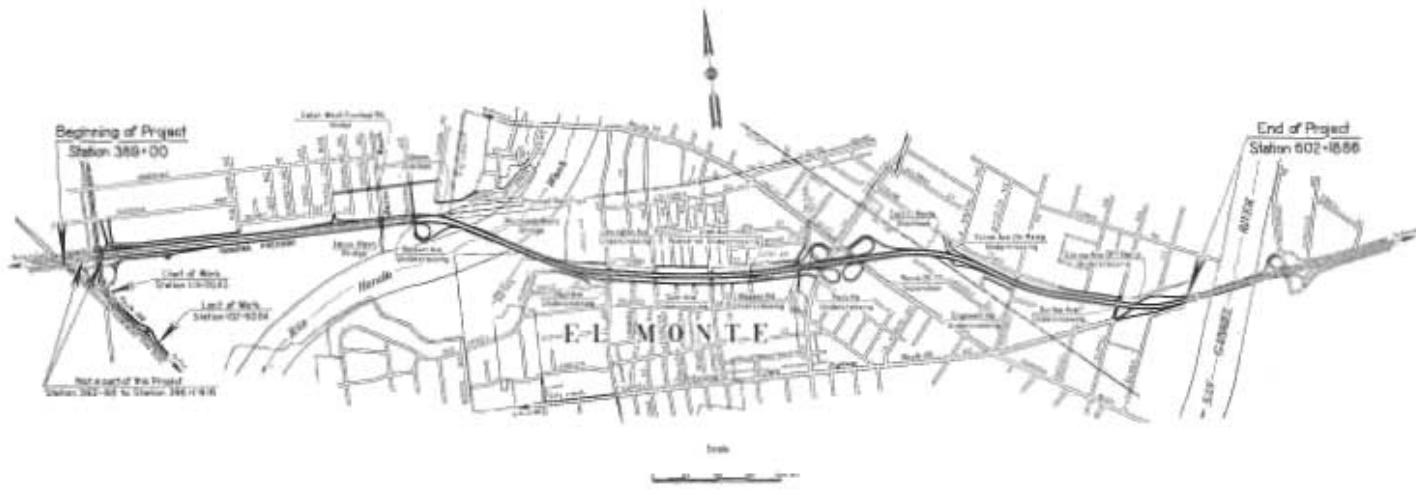
stabilizing did not take effect as planned and the holes had a tendency to cave. The contractor then decided to develop a pressure rig.

#### Pile Pouring

This consisted of an auger made of a five-inch ID pipe for the shaft. The

auger was drilled to the correct depth, concrete was placed into a two-cubic-yard pot which was hoisted up the leads and dumped into another two-cubic-yard pot on top of the drill. The concrete was then allowed to enter the shaft and as it came out the drill head at the bottom, the auger

MAP A. Peter Kiewit & Sons' Co. contract, extending from Rosemead Boulevard through El Monte to the San Gabriel River



was slowly pulled out. Thus the pile was poured in much the same way as tremie concrete is poured. When the hole had been filled to within 10 feet of the ground surface, the auger was removed, cleaned off, and then put back into the hole to clean the top two feet of concrete. The steel cage was then inserted and the remainder of the pile poured. Several load tests were made on piles poured in this manner and all tests proved satisfactory.

All bridge work on this unit was completed well ahead of schedule by the Peter Kiewit Company. Mr. Ward White was the project superintendent for the contractor. H. R. Lendecke was the bridge representative for the Division of Highways.

#### UNIT 2—FROM THE SAN GABRIEL RIVER TO POMONA

The structures included in this unit comprising three separate contracts consist of 13 undercrossing structures, one railroad overhead, six stream crossing bridges, two pedestrian overcrossings and six pump houses at a total contract cost of \$2,260,000.

All of the major structures are of reinforced concrete which required the placing of approximately 29,000 cubic yards of concrete, 5,233,000 pounds reinforcing steel and 78,000 cubic yards of structure excavation and backfill. The six pump houses were constructed at undercrossings that could not be drained economically by gravity lines. The pumps

provide a combined pumping capacity of 10,750 gallons per minute.

Prestressing was of special interest and was used for various reasons in the design of these structures. The Freyssinet System of post-tensioning was used in the construction of the Bess Avenue Pedestrian Overcrossing to reduce the dead load and permit the precasting of the two main spans in the median and the erection over the traveled way with only a short interruption of traffic. Seven cables, each containing 18 wires were cast in each span and later stressed to produce a force of 570,000 pounds in each span.

#### Prestressing Bridges

The two frontage road bridges over Big Dalton Wash were also prestressed using the Freyssinet System to permit the lowering of the profile grade three feet on the frontage roads without reducing the channel opening under the bridges. Ninety-six cables, each containing 18 wires were cast in the bottom slab and girders of each span and were later post-tensioned with hydraulic jacks to produce a force of 6,898,000 pounds in each span.

The Roebling System of prestressing, using seven one-inch galvanized wire strands stressed to 52,500 pounds per strand, will be used to post-tension four of the girders of the existing bridge over Walnut Creek Channel. The portion of the existing structure to be prestressed was de-

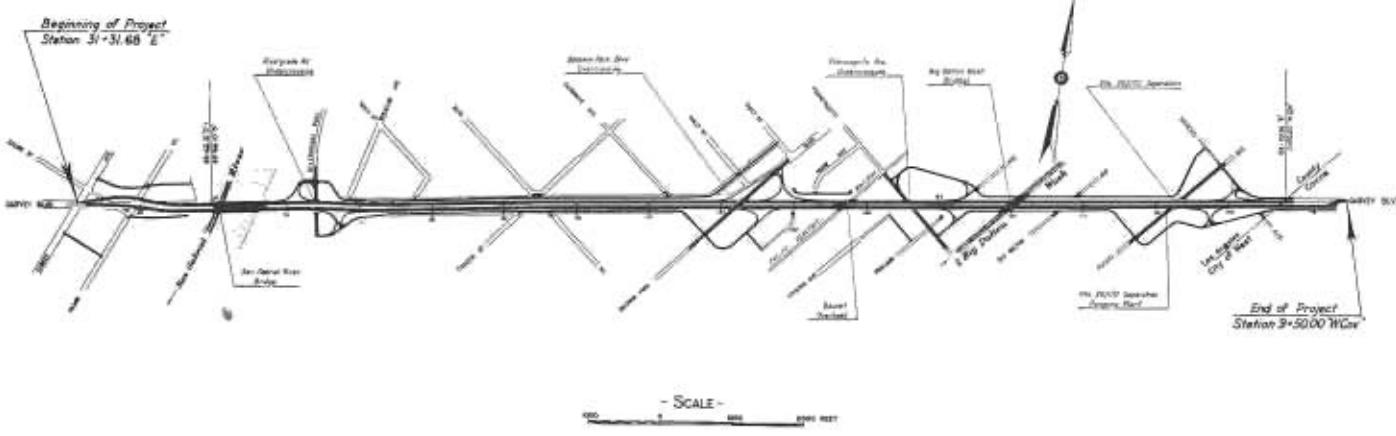
signed for lighter loads and was constructed over 20 years ago. This stressing operation will bolster the old structure to present day standards and so permit it to carry the east-bound freeway lanes. This strengthening operation resulted in a large saving to the State in that the existing structure could be utilized in place of having to be demolished and then replaced.

The bridge structures included in this first contract of this unit were constructed by the Griffith Company under the direct supervision of H. L. McGregor and R. MacCracken. The structures in the second and third contracts were built by the Winston Bros. Co. under the supervision of H. McCutcheon. The Bridge Department was represented in the field by W. A. McIntyre and T. M. Field.

#### Details of Road Work

Much interest besides the bridge construction has developed on the four major construction contracts that make up this 15 miles of freeway construction. Detailed information regarding the road work has been furnished me by Basil M. Frykland and James D. Hetherington who have had continuing responsibilities in connection with the construction of the San Bernardino Freeway for many years past. Hetherington was field office engineer and has been in close touch with all phases of construction. He held this position until about one year ago when he was promoted to the

MAP B. Griffith Co. contract, extending from the San Gabriel River to west city limits of West Covina



position of resident engineer and given supervision of other construction projects in this vicinity.

#### Forty Miles of Freeway

Completion of this section of the freeway, together with the already completed units from the interchange in downtown Los Angeles to Rosemead Boulevard west of El Monte and from San Dimas Avenue westerly of the City of Pomona, through Pomona and Claremont in Los Angeles County and the Ontario-Upland areas of San Bernardino County, will provide the motorist with over 40 miles of full freeway from Metropolitan Los Angeles well into San Bernardino County. No longer will the traveling public be delayed by cross traffic at signalized intersections nor slowed by restrictive speed zones through local developments.

The four construction contracts between Rosemead Boulevard and San Dimas Avenue constitute one of the greatest projects ever undertaken in California on a single freeway at one time. Total construction allotments alone are in excess of \$15,000,000.

#### Other Contracts

From Rosemead Boulevard easterly the contracts are as follows:

Peter Kiewit Sons' Company has the four-mile section from Rosemead Boulevard (Route 168) through the City of El Monte to the San Gabriel

River that was awarded September 13, 1954, and approved September 28, 1954. The contract allotment of \$6,391,600 made this the largest single highway contract awarded by the State of California up to that time.

Griffith Company had the 3.3-mile section from Durfee Avenue (easterly of the San Gabriel River) to 0.5 mile east of Puente Avenue near the west city limits of West Covina that was awarded June 30, 1954, and approved July 28, 1954. The contract allotment for this section was \$3,549,900. This contract was completed and accepted by Director of Public Works Frank B. Durkee on June 11, 1956.

Winston Bros. Company has the 4.2-mile section from 0.3 mile east of Puente Avenue near the west city limits of West Covina to 0.3 mile east of Citrus Avenue that was awarded November 12, 1954, and approved December 10, 1954. The contract allotment for this section is \$3,048,200, and completion is scheduled for January, 1957.

Winston Bros. Company also has the 5.2-mile section from 0.3 mile east of Citrus Avenue in West Covina to Ganesha Boulevard near the west city limits of Pomona that was awarded February 25, 1955, and approved March 16, 1955. The contract allotment is \$2,432,900 and completion is scheduled for December, 1956.

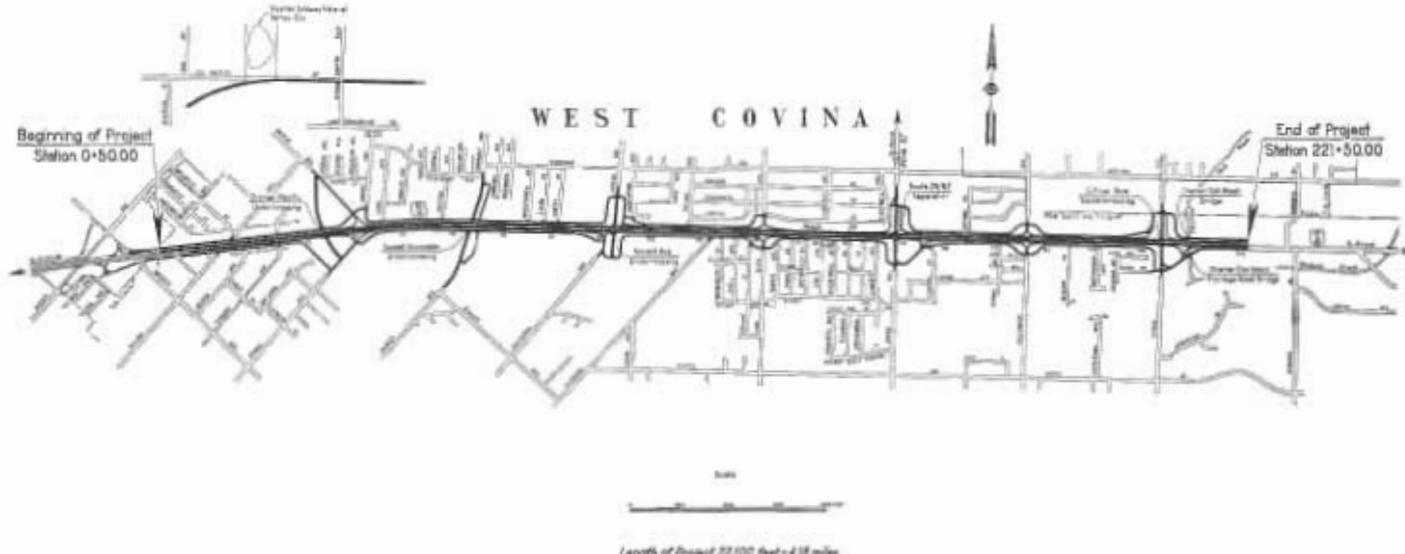
#### Numerous Structures

The magnitude and complexity of the Peter Kiewit Sons' Company contract may be visualized when it is considered that this single contract called for the construction of 29 major structures—26 bridges, two tunnel sections and one pedestrian undercrossing—and required over two million yards of roadway embankment. Fill material was required for approximately three miles of the contract, from the Rio Hondo River to the San Gabriel River, to raise the roadbed above the surrounding terrain permitting the freeway to cross over the waterways and existing traffic arteries. The fill was constructed generally with a base width of 260 feet and 132 feet crest width. Fill material was obtained from a number of sources—the excavation of the Hill Street Tunnel in the Los Angeles Civic Center, Arcadia Wash and Eaton Wash flood control projects, Monterey Park borrow pit, Whittier Narrows County recreational area and Consolidated Rock Products Company's Durbin pit.

#### Six-Lane Divided Roadway

Besides the construction of the above-mentioned structures and placing of fill material, this contract included paving with portland cement concrete the six-lane divided roadway and the construction of frontage roads on both sides of the freeway for a

MAP C. Winston Bros. contract, extending from west city limits of West Covina to Citrus Avenue



distance of about three miles, together with numerous on- and off-ramps from the freeway to surface streets.

Peter Kiewit Sons' Company was represented by Thomas H. Paul, District Manager; Ward W. White, Project Superintendent; Brad F. Lockwood and R. L. Davis, Project Engineers.

Resident Engineer for the State of California was B. N. Frykland until his advancement February, 1956, to construction department supervisor. His successor as resident engineer was C. J. McCullough. James E. Martin and W. D. Knutsen served as principal assistants and R. Lendecke was State Bridge Department representative.

#### Traffic Through Construction

While not as complex as the Peter Kiewit Sons' Company contract the Griffith Company contract was complicated by the stage construction necessary to provide for passage through the construction area of the large volume of public traffic using this route. From the San Gabriel River to the existing freeway west of Pomona, the new freeway construction follows the alignment of existing Garvey Avenue (State Route 26). The Griffith Company contract called for the construction of the eastbound freeway lanes including bridges as first stage construction while traffic was maintained on Garvey Avenue. Traffic was also permitted to cross the construction area at all major cross streets. Upon completion of this first stage operation,

traffic was diverted from the existing highway to the three new eastbound lanes, which were striped, utilizing the paved shoulder as a portion of one lane, for four lanes of traffic. The westbound freeway portion was then constructed over the old pavement with the most northerly lane of existing pavement being salvaged as a portion of frontage road to serve local business.

Like the Kiewit contract the Griffith Company contract called for raising the freeway grade above the surrounding low area. However, the fills are generally only a few feet above the existing grade except where the freeway crosses over the Pacific Electric Railway Company line. Fills in this area are over 25 feet above the existing ground line. In all, over 900,000 cubic yards of fill material was required. All material was hauled from Consolidated Rock Company's Durbin pit located approximately 1½ miles north of the project.

#### West Covina Construction

J. F. Porcher, General Construction Superintendent for the Griffith Company, headed the supervisory personnel for the contract with H. G. McGregor as construction superintendent. McGregor was promoted in 1956 and was succeeded by A. A. Kinnaman who completed the contract as construction superintendent.

For the State, B. N. Frykland and C. J. McCullough were also resident engineers on this project. The principal assistant was K. M. Johnson, W.

A. McIntyre represented the State Bridge Department until his promotion and transfer when he was replaced by T. M. Field.

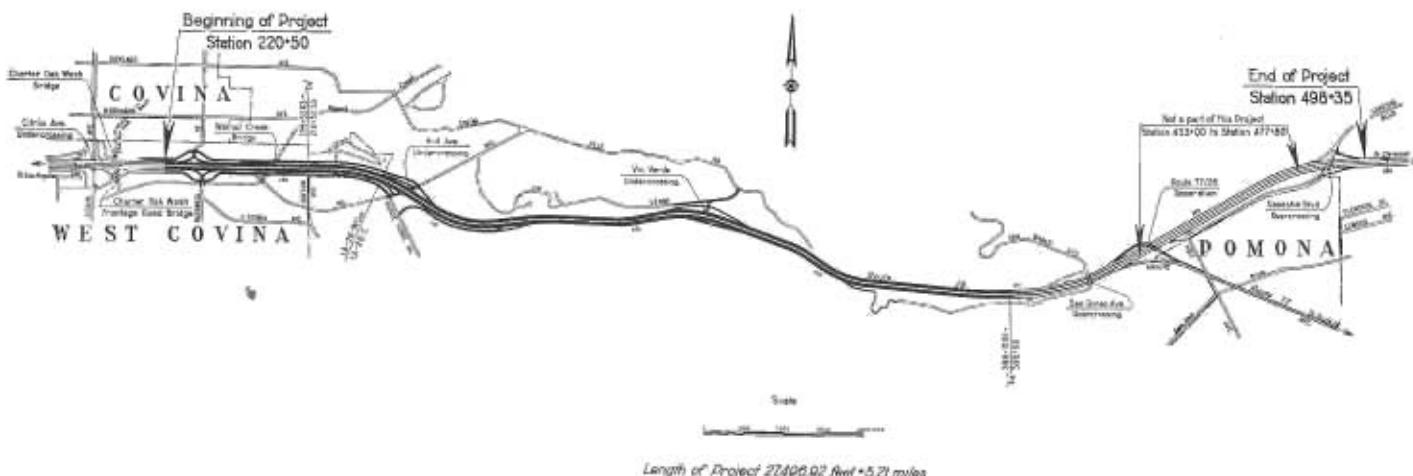
Winston Bros. Company, with two contracts having a combined mileage of 9.4 miles of San Bernardino Freeway work between Puente Avenue, near the west city limits of West Covina and Ganesha Boulevard near the west city limits of Pomona, has a total of 13 bridges to erect, 10 of them under the first contract through the City of West Covina.

The first Winston Bros. Company contract from 0.5 mile east of Puente Avenue to 0.3 mile east of Citrus Avenue in the City of West Covina is generally similar to the Griffith Company contract. This contract calls for the construction of a six-lane divided freeway with grade separations at major intersections. Two stages of construction are required to provide for traffic through the construction area. At the time of writing, stage one construction has been completed and traffic diverted to the completed freeway portion. Completed to date are the eastbound lanes from Puente Avenue to Orange-Pacific Streets and the westbound lanes to the vicinity of Holt Avenue on the second contract.

#### Second Stage of Project

Winston Bros. are, as much as possible, working their two contracts as one project. A portion of the completed westbound section mentioned above extended into the second contract.

MAP D. Winston Bros. contract, extending from Citrus Avenue to Ganesha Boulevard



At the present time Winston Bros. are constructing the bridges for the second stage and are reconstructing the salvaged portions of Garvey Avenue as a frontage road for local traffic. Unlike the Kiewit and Griffith Company contracts, all fill material to raise the freeway above the surrounding ground surface is being obtained from the cuts for underpass construction within the contract.

Construction under the second Winston Bros. contract must be carried out in three stages. First stage construction required the building of frontage roads and the construction of detours to permit construction of the Holt Avenue and Via Verde undercrossings. This work has been completed. Second stage construction, which is now in progress, calls for completion of bridge structures and paving of portions of freeway to permit diversion of traffic from Garvey Avenue. Completion of the second stage work will permit construction of the remainder of the freeway. Since most of this project is through the Kellogg Hills section, earthwork involves high cuts and fills to widen the present roadbed. Approximately 1,000,000 cubic yards of material must be moved with 39,000,000 station yards of haul. Excavation operations are complicated by the fact that a large portion of the material must be hauled across dense public traffic.

Unlike the three contracts to the west, which call for imported subbase and base materials, all subbase and base materials are being obtained from cut within this project. To improve the quality of materials used as base for the concrete pavement and plant mix surfaced ramps and frontage roads, all base materials are being cement treated.

#### Kellogg Hills Section

Of particular interest on the Kellogg Hills section of freeway was the requirement for jacking a total of 2,000 feet of various size drain pipe under the existing roadway. This was necessary at numerous locations where traffic could not be interrupted to permit trenching. For further information on this phase of work the reader is referred to the story by Resident Engineer R. M.



UPPER—Typical undercrossing, Sunset-Irwindale Undercrossing. CENTER—Prestressing operation at Big Dalton Wash. LOWER—Erecting precast superstructure at Bess Avenue.

Innis in the September-October 1955 issue of *California Highways and Public Works*.

Supervisory personnel for Winston Bros. on the two contracts are Hugh S. Thompson, project manager, and Ted Little, general superintendent.

B. N. Frykland was also resident engineer on the first Winston project with C. S. McCullough, present resident engineer. Norman C. Brinkmeyer is principal assistant. The State Bridge Department was represented by W. A. McIntyre, with T. M. Field presently in this position.

Resident engineer for the second Winston contract is R. M. Innis, with Harry Frazier as principal assistant. T. M. Field is State Bridge Department representative.

I am indebted to C. V. Kane, District Engineer, and C. G. Beer of District VIII for the information that follows regarding the San Bernardino Freeway developments in that district.

#### In District VIII

The present easterly terminus of the full freeway portion of the San Bernardino Freeway is at Archibald Avenue where grade separation and interchange ramps are in operation. The full freeway from the Los Angeles County Line to Archibald Avenue has a length of 7.15 miles. East of Archibald Avenue the expressway has grade intersections at Turner Avenue and Milliken Avenue.

Grade separation structure and interchange ramps have been constructed and in operation at Etiwanda Avenue since October 1955. Between Etiwanda Avenue and the City of Colton, there are a number of grade intersections. There is also a grade separated full interchange at Cedar Avenue.

At the present time, full freeway is under construction through the City of Colton beginning at Rancho Avenue on the west and extending eastward to the US 99-395 interchange, and from this point northerly to Mill Street in the City of San Bernardino.

The portion under construction consists of two contracts. Estimated completion date on the portion from Rancho Avenue to Warm Creek is November 1, 1956. The contractor on

this portion is W. F. Maxwell. The estimated completion date on the portion from Warm Creek to Mill Street is February, 1958. The contractor on this portion is Charles McCloskey and Crowell and Larson.

Plans are in preparation for full interchanges to replace all of the existing grade intersections between Archibald Avenue and Colton, but no definite construction schedule has been determined as yet.

#### Importance of Freeway

The importance of the San Bernardino Freeway in the development of the freeway system in District VII is not always fully appreciated. It is a portion of one of the main east-west traffic arterials on the U. S. system of interstate highways. The 30-mile section between Los Angeles and Pomona has the unique distinction of carrying three U. S. Highways designated by the Nos. 60, 70 and 99. This fact, alone, indicates the vital importance of the San Bernardino Freeway in the federal system of highways. It is the main connection between the Los Angeles metropolitan area and Imperial Valley, directly serving agricultural areas and industry. It is extensively used by recreational traffic between the metropolitan area and the many scenic and resort centers in the mountains and desert areas of Riverside, San Bernardino and Imperial Counties.

Within Los Angeles County, the San Bernardino Freeway is the major east-west arterial through the San Gabriel Valley, directly connecting the rapidly expanding cities of Los Angeles, Alhambra, Monterey Park, El Monte, and West Covina with Pomona and Claremont. In addition to many important city streets and county roads, seven state highway routes (2, 4, 62, 77, 167, 168 and 170) are intersected and at all these locations grade separations and interchange ramp connections with the freeway are provided. The freeway also serves a number of communities not directly traversed, such as Pasadena, San Gabriel, Temple City, Arcadia, Monrovia, Baldwin Park, Puente, Covina and Glendora. Although the development of the San Gabriel Valley is predominantly residential,



Cleaning drill rig auger

there is a corresponding expansion of local business areas and there is also considerable development of new industrial areas.

#### Cost Is \$50,000,000

In round numbers this 30.7 miles of the San Bernardino Freeway in District VII, from the westerly terminus from the junction of Santa Ana Freeway to the Los Angeles-San Bernardino County line, has cost a total of \$50,000,000.

The traffic service which this freeway is providing is indicated by traffic counts. Five years ago there were only six miles of the San Bernardino Freeway that were completed and opened to traffic. This was the most westerly section extending from the Los Angeles River bridge to Helen Drive in the City Terrace area just easterly of the Los Angeles City limits. The traffic on the then completed portions of the San Bernardino Freeway has been steadily increasing. The average daily traffic in 1950 was 25,000 vehicles per day whereas recent counts taken at Soto Street show 88,000 vehicles per day. This tremendous increase in traffic is to a consid-

erable extent due to the unprecedented building program in the areas passed through.

This explosive growth in the San Gabriel Valley area may be attributed in no small measure to the development of the San Bernardino Freeway and the fact that the area is thus brought closer, measured in travel time, to the Los Angeles metropolitan area.

## Bidders Pulled Out of a Hat

When an organization of contractors goes about letting a contract for itself, the method will vary considerably, although not entirely, from the detailed procedure followed by the Department of Public Works in dealing with the same contractors. Competitive sealed bids are submitted—but not everybody gets a chance to bid.

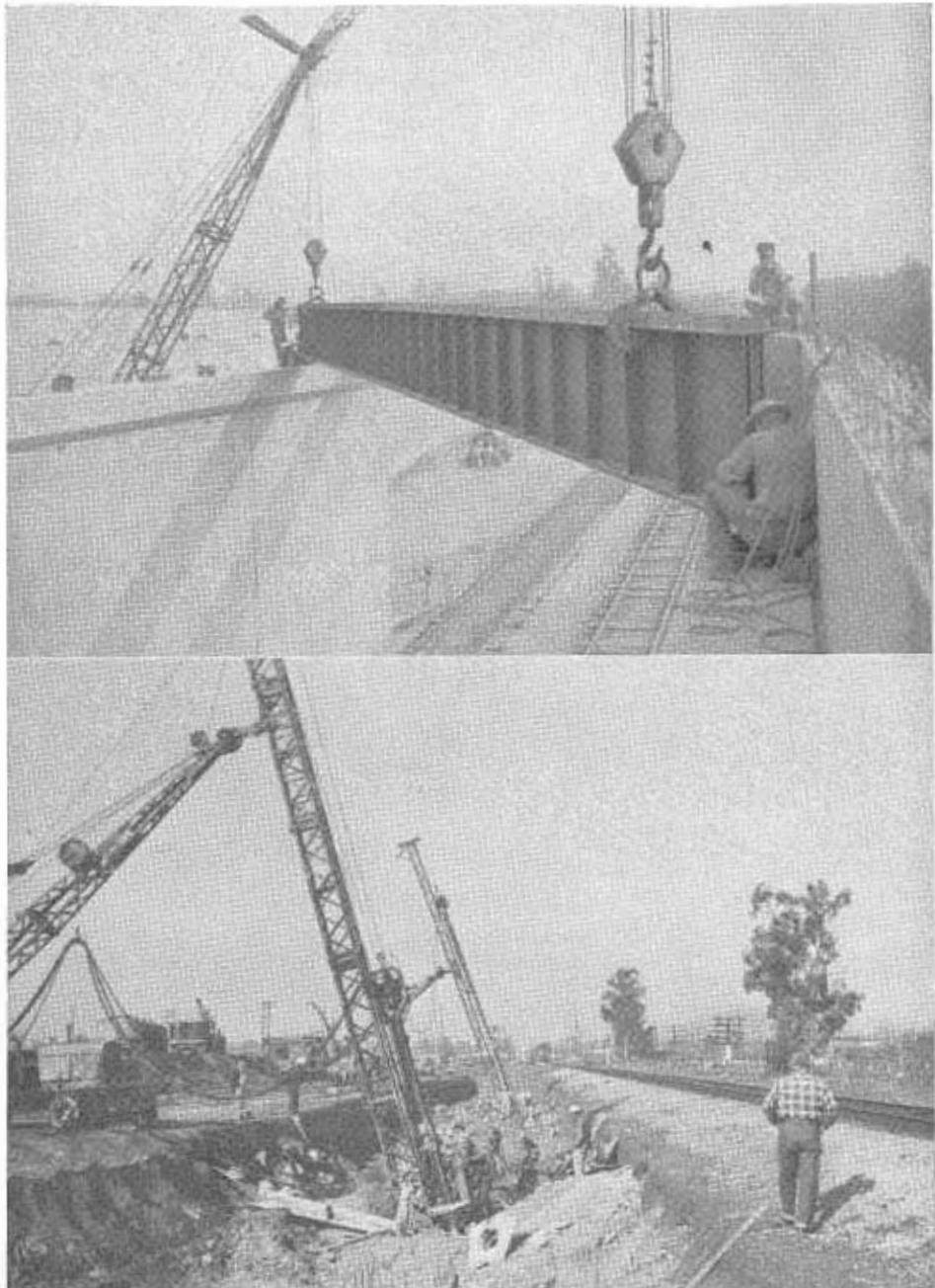
The Associated General Contractors of America, Southern California Chapter, is about to put up a new chapter building. Which of the chapter members should get the job?

As described in the chapter's news bulletin, the procedure first called for asking how many of the member firms were interested. There were 22 responses.

The building committee then listed the name of each interested firm on a separate piece of paper and placed all these names in a hat (the news bulletin does not say whose).

Chapter President Walter F. Maxwell then drew six names, and these firms constituted the official bidders' list. Plans were sent to each of the six lucky ones, and at a designated time the bids are to be opened in the presence of the bidders.

"Although this procedure may seem contrary to custom and practice within the construction industry," the news bulletin states, "we feel certain of your understanding of the Building Committee's problem in this connection, and that under the circumstances the committee is to be complimented for its fair and unbiased treatment in the handling of a situation which inevitably arises when a general contractors' trade association decides to build a new home for itself."



UPPER—Erecting steel at East El Monte structure. LOWER—Drilling pile holes at El Monte structure.

### HORN AND "HORSE SENSE"

Many a motorist depends a great deal more on his horn than on his "horse sense" to get him by in traffic.

The National Automobile Club points out that you've probably seen the type. Somehow or other he seems to feel that if he blows that horn loud enough and long enough and often enough, all will go well. When he finds himself caught in traffic that is a little congested, he just starts to blow his horn. Whenever anyone interrupts his line of travel in the slight-

est, he leans on that button. Whenever he's approaching an intersection, he makes no slow down in his speed, makes no allowances for the cars that might be coming in the other direction, but just blasts the horn and then crashes on through.

Don't drive so. It's always much better to use that horn sparingly and to use your brakes, your steering wheel, and your accelerator more skillfully and more judiciously. Don't depend on your horn. Depend on your "horse sense" to get you by in traffic.

# Cost Index

Rises Reported During  
Second Quarter of 1956

By RICHARD H. WILSON, Assistant State Highway Engineer; H. C. McCARTY, Office Engineer;  
L. B. REYNOLDS, Assistant Office Engineer

DURING the second quarter of 1956, state highway construction costs were up 16.6 percent over the first quarter of 1956 and were up 20.4 percent over the second quarter of 1955. The Index stands at 255.9 (1940 = 100) for this period which is 66.9 Index points above a low established in the second quarter of 1954. The first quarter of 1956 was 3.2 percent above the fourth quarter of 1955.

At the end of the fourth quarter of 1955, a separate Index was computed to include bid prices for construction under the Toll Bridge Act of the new parallel bridge and approaches across Carquinez Strait. The reasons for excluding the Carquinez Bridge contracts from the normal Index were based on the extremely large quantities of special steels and extremely large excavation yardage included in the design of the project that are not comparable in price to those found in normal highway construction. The combined Index for the fourth quarter of 1955 was 228.8, as opposed to 212.6 for the normal highway Index, and was at an all-time high. The present normal highway Index now exceeds the combined Index (normal plus the Carquinez contracts) by 11.8 percent in the second quarter of 1956.

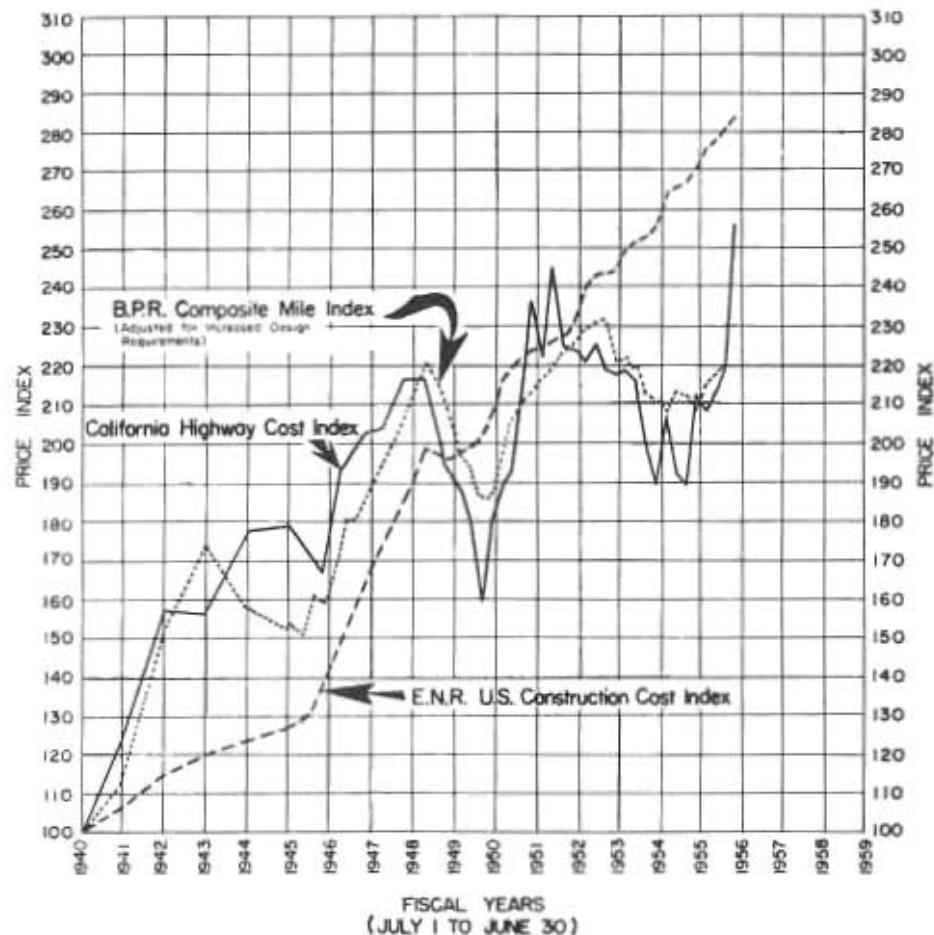
Opinion has been expressed in several preceding Cost Index releases that construction costs would continue in an upward direction and that any sags which might occur would be temporary. These predictions have held up as a review of the graph will show.

Several labor contracts directly affecting the construction industry have recently been consummated, resulting in increased labor rates and fringe benefits. At the same time material prices have risen and such increases can be partially attributed to increased labor costs in the various in-

STATE OF CALIFORNIA  
DEPARTMENT OF PUBLIC WORKS  
DIVISION OF HIGHWAYS

## PRICE INDEX CONSTRUCTION COSTS

1940 = 100



dustries. Labor rates affecting the crafts where contracts have not yet been renewed can be expected to follow in an upward direction.

The present labor situation in the steel industry is now having its effect in the construction field through cur-

tailment of steel deliveries to contracts now under way. The uncertainty in future deliveries will affect prices on construction projects which have been advertised for bids and also will affect prices on projects which will be advertised for bids in the future.

Material suppliers are no longer offering long-term firm prices on their commodities which will have its effect on many of the larger contracts that require several years for their completion.

For some indefinite reason, competition among contractors is on the decline. In the first quarter of 1956, the Division of Highways had a normal average of 5.4 bidders on each project, but during the second quarter of this year the average dropped to 3.8 bidders per contract. In previous quarters when a lag occurred in the average number of bidders, the final average for the period was bolstered by a few particularly inviting projects. This situation has not occurred during the second quarter. Bids have recently been received on several attractive projects in the "back yards" of many firms in the industry where considerable competition could be expected, but which did not materialize with the result that the average number of bidders per contract remains low.

Some effect on bidder competition may be due to the large volume of private work in subdivision construction and work of similar nature that has attracted some of the contractors who previously have been bidding on highway projects. These private projects provide an "in and out" operation which do not require tying up a large amount of equipment and material over a long period.

It is possible that many contractors have not shown interest in current highway work in anticipation of the forthcoming federal highway program. If this federal program has been a deterrent to bidder competition, it can be expected that an increase in the average number of bidders will occur as actual construction under the federal program will of necessity be slow in getting under way. The greater part of the federal funds applies to the interstate system, and the backlog of plans and right of way commitments on this system have not been built up to immediately absorb any considerable increase in actual construction projects over the present expanded state program. Federal regulations and standards for the interstate system have not yet been issued

**NUMBER AND SIZE OF PROJECTS, TOTAL BID VALUES AND  
AVERAGE NUMBER OF BIDDERS**

(January 1, 1956, to June 30, 1956)

Project volume	Up to \$50,000	\$50,000 to \$100,000	\$100,000 to \$250,000	\$250,000 to \$500,000	\$500,000 to \$1,000,000	Over \$1,000,000	All projects
<b>Road Projects</b>							
No. of projects	130	29	43	17	18	1	225
Total value*	\$1,799,298	\$2,241,296	\$7,281,659	\$8,935,043	\$11,466,782	\$1,477,571	\$30,201,949
Ave. No. bidders	3.7	4.3	4.4	5.5	4.3	5.0	4.1
<b>Structure Projects</b>							
No. of projects	35	6	8	7	5	1	62
Total value*	\$685,746	\$390,129	\$1,105,961	\$2,866,290	\$3,679,497	\$1,859,354	\$10,586,917
Ave. No. bidders	4.2	4.5	4.9	6.0	7.2	4.0	4.8
<b>Combination Projects</b>							
No. of projects					1	18	19
Total value*					\$995,554	\$44,317,184	\$45,312,738
Ave. No. bidders					5.0	5.4	6.4
<b>Summary</b>							
No. of projects	155	35	51	24	31	20	306
Total value*	\$2,485,044	\$2,631,435	\$8,387,620	\$8,801,333	\$16,141,833	\$47,654,339	\$86,101,604
Ave. No. bidders	3.8	4.4	4.5	5.6	5.0	5.3	4.2

\* Bid items only.

**Total Average Bidders by Months**

	Jan.	Feb.	Mar.	Apr.	May	June	Avg. for six months
1956	5.9	5.1	5.1	4.1	4.7	3.3	4.3
1955	5.5	5.8	6.7	5.5	5.0	4.4	5.3

**NUMBER AND SIZE OF PROJECTS, TOTAL BID VALUES AND  
AVERAGE NUMBER OF BIDDERS**

(July 1, 1955, to June 30, 1956)

Project volume	Up to \$50,000	\$50,000 to \$100,000	\$100,000 to \$250,000	\$250,000 to \$500,000	\$500,000 to \$1,000,000	Over \$1,000,000	All projects
<b>Road Projects</b>							
No. of projects	263	79	82	30	20	3	477
Total value*	\$4,375,104	\$6,009,304	\$14,199,252	\$10,788,900	\$14,994,914	\$4,000,792	\$54,455,266
Ave. No. bidders	3.9	4.6	5.3	5.5	5.0	7.7	4.4
<b>Structure Projects</b>							
No. of projects	56	13	12	9	8	5	103
Total value*	\$1,015,040	\$852,735	\$1,637,660	\$3,711,505	\$5,472,436	\$20,908,572	\$33,597,948
Ave. No. bidders	4.3	6.5	4.8	5.9	8.0	5.2	5.6
<b>Combination Projects</b>							
No. of projects					5	35	40
Total value*					\$4,397,676	\$105,907,846	\$110,305,822
Ave. No. bidders					8.2	6.3	6.0
<b>Summary</b>							
No. of projects	319	92	94	39	33	43	620
Total value*	\$5,390,144	\$6,862,039	\$15,836,912	\$14,500,405	\$24,865,026	\$130,907,210	\$198,361,736
Ave. No. bidders	3.9	4.9	5.2	5.6	6.3	6.3	4.7

\* Bid items only.

**Total Average Bidders by Months**

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Avg. year
1955-56	4.9	4.2	4.6	5.4	6.2	5.4	5.9	5.1	5.1	4.1	4.7	3.3	4.7
1954-55	6.7	6.0	6.5	7.9	7.0	6.4	8.5	5.8	6.7	5.6	5.0	4.4	6.1

**THE CALIFORNIA HIGHWAY CONSTRUCTION COST INDEX**

Year	Cost Index
1940	100.0
1941	125.0
1942	157.5
1943	156.4
1944	177.8
1945	179.5
1946	179.7
1947	203.3
1948	216.6
1949	190.7
1950 (1st Quarter 1950—160.6)	176.7
1951 (4th Quarter 1951—245.4)	210.8
1952	224.5
1953	216.2
1954 (1st Quarter)	199.4
1954 (2d Quarter)	189.0
1954 (3d Quarter)	207.8
1954 (4th Quarter)	192.2
1955 (1st Quarter)	189.3
1955 (2d Quarter)	212.4
1955 (3d Quarter)	208.6
1955 (4th Quarter)	212.6
1956 (1st Quarter)	219.5
1956 (2d Quarter)	255.9

by the federal authorities, and a further delay to actual construction projects must be expected due to the necessity of heavy right of way expenditures in the first few years to clear the way for future construction of interstate projects.

Six items of the eight used in computing the Construction Cost Index have shown a rise during this quarter. Some of these increases can be partially attributed to the large volume of emergency repair projects resulting from storm damage during last winter which involves very difficult work and which have been put under contract in this quarter. Roadway excavation, Class A portland cement concrete (structures) and structural steel, the items which have the most effect on the Index rise are in this category. Roadway excavation stood at \$0.51 while in the previous quarter it was at \$0.40. Structure concrete is at \$57.13, an increase of \$4.62 per cubic yard, and structural steel jumped from \$0.166 to \$0.219 per pound.

The graph on page 49 showing the California Construction Cost Index, the *Engineering News-Record* Construction Cost Index and the United States Bureau of Public Roads Composite Mile Index compares the three, all of which are reduced to

1940 = 100 base. The latter two indexes are based on nation-wide figures.

The *Engineering News-Record* Cost Index continues in an upward direction this quarter which is practically a continuation of its first quarter rate of increase. It is up 3.5 points or 1.25 percent over the first quarter of 1956.

The rate of rise in the Bureau of Public Roads Composite Mile Index for the first quarter of 1955 conforms

closely to the previous quarter. It continues to approximate the pattern of the California Index. Figures for the second quarter are not available at this time, but past behavior of the Composite Mile Index leads us to believe that second quarter computations will show a continued climb. During the first quarter the Bureau of Public Roads Index stood at 220.0, which was up 0.96 percent over the previous period.

**AVERAGE CONTRACT PRICES**

	Roadway excavation, per cu. yd.	Crusher run base, per ton	Plant mix surfacing, per ton	Asphalt concrete pavement, per ton	PCC pavement, per cu. yd.	PCC structures, per cu. yd.	Bar reinforced steel, per lb.	Structural steel, per lb.
1940	\$0.23	\$1.54	\$2.19	\$2.97	\$7.65	\$18.33	\$0.040	\$0.083
1941	0.26	1.31	2.84	3.18	7.54	23.31	0.063	0.107
1942	0.25	1.81	4.02	4.16	9.02	29.48	0.073	0.103
1943	0.42	2.26	3.71	4.76	11.48	31.76	0.069	0.080
1944	0.50	2.48	4.10	4.50	10.46	31.99	0.064	0.122
1945	0.51	2.42	4.20	4.88	10.90	37.20	0.059	0.102
1946	0.41	2.45	4.00	4.68	9.45	37.35	0.060	0.099
1947	0.46	2.42	4.32	6.38	12.38	48.44	0.080	0.138
1948	0.55	2.43	4.30	6.38	13.04	49.56	0.093	0.126
1949	0.49	2.67	4.67	4.64	12.28	48.67	0.096	0.117
1950	0.40	2.25	4.26	3.78	11.11	43.45	0.079	0.094
1951	0.49	2.62	4.34	5.00	12.21	47.22	0.102	0.159
1952	0.56	2.99	5.00	4.38	13.42	48.08	0.098	0.180
1953	0.51	2.14*	5.31	4.88	12.74	50.59	0.093	0.133
1st Quarter 1954	0.45	2.28	4.23	4.78	14.89	47.52	0.093	0.126
2d Quarter 1954	0.38	2.09	4.29	5.18	14.28	47.12	0.093	0.114
3d Quarter 1954	0.43	1.85	4.68	7.00	12.63	49.59	0.095	0.162
4th Quarter 1954	0.35	1.78	4.83	—	13.13	46.08	0.094	0.138
1st Quarter 1955	0.39	1.69	4.55	—	13.44	40.66	0.095	0.140
2d Quarter 1955	0.42	1.99	5.39	—	14.46	51.36	0.098	0.136
3d Quarter 1955	0.41	2.33	5.43	5.70	13.46	49.64	0.093	0.132
4th Quarter 1955	0.37	3.00	5.52	4.00	15.05	52.72	0.099	0.144
1st Quarter 1956	0.40	2.08	5.40	6.50	14.05	52.91	0.105	0.166
2d Quarter 1956	0.51	2.06	6.27	—	14.64	57.13	0.113	0.219

\* Untested rock has substituted for crusher run base at this point.

**ORINDA CROSSROAD**

THE ORINDA ASSOCIATION

P. O. Box 97, Orinda, California

DEAR MR. DURKEE: The Board of Directors of the Orinda Association wish to thank you as head of the Department of Public Works, and Mr. B. W. Booker of Division Four of the Division of Highways, for the beautiful landscaping of the Orinda Crossroads.

The plantings are now attractively green. The oleanders are starting to bloom, giving color greatly adding to the effect.

We are deeply appreciative of these thoughtful efforts for beautification. We know that the more this type of planting is done to alleviate the scars of road building, the more interest people will take in helping to further such work, and the ultimate results of such interest should be a program that

will turn our roads and freeways into parkways.

Most sincerely,

MRS. RITCHIE R. WARD

**LIKES OUR HIGHWAYS**

DEAR MR. ADAMS: I've driven on an average of 100 miles per day for the past 40 days, over the finest system of roads and highways, anywhere. Quite a number of times I've driven to the East Coast by various routes, as well as Canada and there is *nothing*—anywhere—to compare to even our secondary state highways. Your work must be particularly gratifying when you can keep many persons informed as to the work that is being done as well as projects for the future.

Thank you very much.

Sincerely,

HUGH BROWN

# El Monte

Governor Knight Opens New  
Section of Freeway in South

By C. A. MAGHETTI, Secretary, State Highway Commission

NEGOTIATIONS which began as far back as 10 years between the California Highway Commission and the City of El Monte came to a successful conclusion Monday, July 16, 1956, when Governor Goodwin J. Knight snipped the ribbon which opened up four more miles of highway through El Monte on the San Bernardino Freeway.

Over 300 persons joined in the eventful occasion which was preceded by a luncheon in the Civic Auditorium hosted by the Rotary Club of that city.

Presented for introduction were many of El Monte's leading citizens. Included in the group were Charles Gallagher, President of the Rotary Club; Arden Danesson, President of the Chamber of Commerce; William Allen, Mayor; City Councilmen Dale Ingram, Lester Dagley, R. L. Johnson, and Sidney Cading; Fred King, City Administrator; Telpher Wright, former assistant to the city council.

Former city officials present who were in office at the beginning of negotiations were: Ex-Mayor R. C. Miller; Councilmen Cecil Cady and Chester Langan.

Representing the state office were: Highway Commissioners James Guthrie of San Bernardino, and Fred Speers of Escondido, C. A. Maghetti, Highway Commission Secretary, and C. Max Gilliss, Deputy Director of Public Works.

Supervisor Herbert Legg represented the County of Los Angeles.

From the district highway office: Lyman R. Gillis, District Engineer; Frank B. Cressy, Assistant District Engineer; W. D. Sedgwick, Assistant District Engineer; A. D. Griffin, Assistant District Engineer; L. S. Van Voorhis, Assistant District Engineer (Design); L. M. Wade, Senior Highway Engineer (Design); Basil Frykland, District Construction Engineer



Governor Knight officiates at El Monte Freeway dedication. Left to right: Governor; C. M. Gilliss, Deputy Director of Public Works; Highway Commissioner Fred W. Speers, Assemblyman L. M. Backstrand, Highway Commissioner James A. Guthrie.

(Field); C. J. McCullough, Resident Engineer; Wally Knudson, Assistant Resident Engineer; and James Martin, Senior Highway Engineer.

From the Bridge Department of the Division of Highways: James McMahon, Principal Bridge Engineer; George Laird, Bridge Construction Engineer; and Bob Lendecke, Bridge Representative.

In his speech, Governor Knight complimented the work of the Highway Commission, the Department of Public Works, Division of Highways, and the El Monte City Council for the joint efforts which made the freeway possible. He referred to the time, September 22, 1954, when he made a special trip from Sacramento to officiate at the ground-breaking ceremonies.

He continued in part:

"We are dedicating today a splendid four-mile section of the San Bernardino Freeway through El Monte, on which traffic will flow within a few days. This freeway section, which extends from Rosemead Boulevard to the San Gabriel River, is typical of the freeways California is building today.

"But impressive as it is, this freeway is only a part of the picture in this area, for the year 1956 is a most significant one in the history of the San Bernardino Freeway in Los Angeles County.

"During this year four construction contracts, covering a continuous length of a little over 15 miles from Rosemead Boulevard nine miles east of Los Angeles, through the Cities of El Monte, West Covina, and extending to Pomona, will be completed at a cost of nearly fifteen and a half million dollars. Of this amount, nearly \$6,400,000 was expended on the El Monte project.

"Completion of the four projects in this area, together with already completed sections, will provide the motorist with over 40 miles of full freeway from metropolitan Los Angeles well into San Bernardino County.

"No longer will the traveling public be delayed by cross traffic at signalized intersections nor slowed by restrictive speed zones through local developments.

"The entire freeway program in Southern California will be stepped up under increased federal aid for highways under legislation just signed by the President.

"During the past 10-year period, the amounts budgeted or spent for highway construction purposes have reached the impressive total of more than \$1,640,000,000."

#### NEW YORK LETTER

STATE OF NEW YORK  
DEPARTMENT OF PUBLIC WORKS  
Albany 1, N. Y.

GENTLEMEN: I wish to express my appreciation of your *California Highways and Public Works* magazine and certainly wish to continue on your mailing list.

## Two Ladies About To Cut a Ribbon

Mrs. Anthony Nizetich, President of San Pedro Chamber of Commerce, Women's Division (left), and Mrs. Jean Hagler, President of the Wilmington Chamber of Commerce, Women's Division (right), cooperated in cutting ribbon on June 4, 1956, upon the opening of the westerly traffic lanes to southbound traffic on the Harbor Freeway between Pacific Coast Highway in Wilmington and Battery Street in San Pedro. At this ceremony Harold Coulthurst, Chairman of Transportation and Traffic Division of the Wilmington Chamber of Commerce was master of ceremonies. Among the speakers were Vincent Thomas, Assemblyman for the 68th District; Jack Yount, Vice President for Vinnell Constructors of Alhambra, representing the contractors; and Edward T. Telford, Assistant State Highway Engineer in charge of District VII. The easterly lanes of this 2.8 miles section of freeway were opened to northbound traffic on June 19, 1956.

I have been a close reader of your excellent magazine since about 1950 and your articles on Rights of Way have been of great interest to me in my capacity of Chief Appraiser on Land and Properties acquired here in New York State, especially on our "Thruway" and subsequent similar construction now in the planning stage.

I compliment you highly on your excellent composition and photographic material. I read your magazine from cover to cover.

Please extend my regards to Messrs. Frank Balfour, George Pingry, E. M. McDonald, and R. S. V. Pianezzi of your Rights of Way Department who were so kind and cooperative on my last visit to Sacramento back in 1950.

Very sincerely yours,

JAMES R. BARNARD  
Associate Land and Claims  
Adjuster



#### MAGAZINE FAN

San Francisco, July 2, 1956

MR. FRANK B. DURKEE  
*Director of Public Works*

DEAR FRANK: Thanks for the magazine, *California Highways and Public Works*. It is a very fine magazine, which gives a huge amount of information about our State. The pictures tell a wonderful story about engineering and how things are done.

Several of my friends have used it to get important facts that they were interested in. It is also wonderful for students who are interested in mechanical work and development. It would be a good magazine to have in every school library.

Sincerely,

CHAS. A. LEININGER

# New Money

## Effect of Federal Highway Bill on State of California

THE ESTIMATED \$367,500,000 in federal aid for highways which California is scheduled to receive during the next three years under the legislation just passed by Congress will mean many additional miles of modern highways throughout the State, it was announced by State Director of Public Works Frank B. Durkee.

State highway design and survey crews and right of way appraisers have been working overtime for several months to prepare projects for the construction stage.

The initial effect of the increased funds will be felt largely in additional allocations by the California Highway Commission for rights of way, Durkee indicated. He pointed out that this was the case in 1953, when highway revenues were sharply augmented by increased California highway user taxes. The result has been an increase in multilane divided highways of 450 miles in three years.

### Full Speed Ahead

"Acquisition of rights of way now will clear the way for construction to proceed full speed ahead in succeeding years, when the really substantial federal contributions provided in the bill begin to come in," he explained. "The 1956-57 program, with an additional \$63,700,000 in federal highway aid for California, is only a prelude to the following 12 years when we hope to complete the entire 2,172 miles of the interstate system in this State to freeway standards."

Although the bulk of the additional federal funds for California is earmarked for freeway development on the interstate system routes, the effect will be to speed up improvement on all types of state highways. Applying the federal money to the interstate system highways will release large amounts of state funds for other routes, in accordance with long-established state policy of meeting the most urgent needs in all areas as available funds permit.

### Planning Will Pay Off

"For the second time in three years," Durkee said, "the flexible long-range planning program of the Division of Highways and the advance route adoption policies of the Highway Commission are about to pay off for the people of California in the form of better highways without waste of time and effort."

Instead of the approximately \$40,000,000 per year in federal aid for state highways which California has been receiving since 1954, which is being increased to about \$104,000,000 for 1956-57, the federal highway allocation for California state highways is expected to amount to about \$135,000,000 in 1957-58 and to \$152,000,000 in 1958-59.

Beginning in 1959-60, California's share of federal funds for the interstate system will be even larger, under the terms of the new legislation.

### Interstate System

For the first three years of the augmented program, the apportionments to the states are being based on the traditional factors of area, population, and mileage of certain postal routes. For the following 10 years, however, the federal legislation provides for apportionments to be made on the basis of the needs of the interstate system. In California, because of great distances, heavy urbanization, difficult terrain and the State's particular dependence on highways for transportation in both urban and rural areas,

the need for modernization of these important routes is especially urgent.

In addition to state highways, additional federal funds are provided in the new legislation for improvement of important county roads on the federal aid secondary system. These are often referred to as "farm to market" or "feeder" roads.

The federal aid secondary allocation for 1956-57 for California is increased from the previous \$7,500,000 to \$8,800,000 and will be stepped up \$200,000 and \$300,000 a year respectively in the two succeeding years. Under California law, 87½ percent of these funds are made available to the counties for road construction, to be matched by county or state funds, or both. The matching basis is 58 percent federal and 42 percent county-state.

The new legislation also provides increased funds for state highways on the federal aid primary and urban systems. These must also be matched by the State on a 58-42 basis.

### Apportionments to State

On the interstate system, however, the Federal Government is supplying 90 percent of the funds, with the State paying only 10 percent. This is because the Congress has recognized the rapid modernization of the 40,000-mile interstate highway network as a primary responsibility of the Federal Government.

Apportionments to California under the new legislation are as follows:

Year	Interstate system	Primary system	Urban highways	Secondary (feeder roads)	Total
		(In millions of dollars)			
1956-57					
Previous basis	(9.8)	(14.5)	(15.4)	(7.5)	(47.2)
New legislation	57.0	2.6	2.8	1.3	63.7
Total 1956-57	66.8	17.1	18.2	8.8	110.9
1957-58	96.9	17.7	19.0	9.0	142.6
1958-59	114.1	18.2	19.6	9.3	161.2
Three-year totals of added funds	268.0	38.5	41.4	19.6	367.5

# Border Span

New Crossing of the  
Colorado River Dedicated

By C. WIGGINTON, District Administrative Assistant

OFFICIALS of Arizona and California hailed completion of the new bridge spanning the Colorado River at Yuma when some 5,000 area residents attended the ribbon-cutting ceremony marking the official opening of the bridge to traffic. Governor Ernest McFarland of Arizona and California Director of Public Works F. B. Durkee, representing Governor Goodwin J. Knight, wielded king-sized scissors which severed the ribbon at the center of the bridge and were the principal speakers for the occasion.

Other notable speakers included Yuma Mayor Hugh Faulds; Hugh Osborne, Chairman, Imperial County Board of Supervisors; Arizona Highway Commissioner William Copple; and District Manager of the Southern California State Chamber of Commerce Clark Galloway. Imperial County governmental representatives included: Supervisor Earl Cavanah, Assemblyman J. Ward Casey, El Centro Mayor J. P. Morgan, and Councilman George Bucklin of El Centro. The California Division of Highways numbered among its representatives California Highway Commissioner Fred W. Speers, Commission Secretary C. A. Maghetti, and Assistant State Highway Engineer F. W. Panhorst.

Arizona State Senator Harold Giss served as master of ceremonies, presenting many personalities and colorful events. National Defense was represented by a National Guard drill team and the Yuma Air Base furnished a flight of jet aircraft. Music for the occasion was supplied by the Yuma Indian Band and the Yuma Elementary School Band.

Dedication ceremonies were held at the new Arizona Inspection Station on the Arizona side of the bridge. Relocation of the bridge has resulted in new inspection stations for both Arizona and California as well as new



UPPER—New Colorado River Bridge. LOWER—Governor McFarland of Arizona and Director of Public Works Durkee shake hands at dedication ceremony.

approaches to the bridge on either side.

On the California side, from Winterhaven to the Colorado River, a distance of 0.8 mile, it was necessary to provide new alignment of US 80 to meet the new bridge. On February 16, 1955, Silberberger Constructors, Inc., and J. B. Stringfellow Co. of Riverside began construction of a four-lane divided highway with channelization provided as necessary. K. L. E. Greenleaf was appointed resident engineer for the State Division of Highways in charge of the California approach to the Colorado crossing. A welded plate-girder bridge 212 feet in length with reinforced concrete deck was built across the California Wasteway Canal, providing two 26-foot-wide roadways. Four spans are supported on concrete-pile bents with concrete-pile foundations and concrete abutments at either end. This contract was completed December 16, 1955, at a construction cost of \$382,600 and was opened to traffic when the Colorado River Bridge was dedicated.



## BURLEIGH DOWNEY RETIRES

Burleigh R. Downey, Maintenance Engineer of the Michigan State Highway Department, retired July 8th after 50 years of distinguished service in the engineering profession, 26 years of which have been with the Highway Department. Downey will remain active as a part-time engineering consultant. With Mrs. Downey, he will make an extended European trip during which time he will lecture before highway engineers of several countries and also visit his daughter and family, Capt. and Mrs. E. A. Rajala, and their son, Karl, in Athens, Greece. Captain Rajala is assistant U. S. military attache in the Greek capital.

# New Expressway

Orange County Dedicates  
Limited Access Highway

A FESTOON made of supersize oranges strung on a rope was cut instead of the traditional ribbon when city, county, and state officials participated in the recent opening of the first link of the Houston Expressway, on Sign Route 14, in Orange County, a four-mile limited access highway running from Cypress Avenue east to Santa Ana Canyon Road.

The ceremonies were held at the Anaheim side of Placentia Avenue near the west end of the \$1,154,900 project.

Gordon H. Wood, President of the Placentia Chamber of Commerce, cut the rope of oranges held by other officials. The Valencia High School band, of Placentia, provided music for the highway opening. A convoy of cars then formed and led by Captain Herbert Null of the California Highway Patrol, carried the participants over the new route. Then followed a luncheon in the Orangewood Ranch Cafe on Orangethorpe Avenue.

Among officials attending were Edward T. Telford, Assistant State Highway Engineer; L. R. Gillis, District Engineer; F. B. Cressy, Supervising Highway Engineer; and A. D. Griffin, Assistant District Engineer, all of the State Division of Highways; Leon T. Gillilan, Mayor of Placentia, and Charles A. Pearson, Mayor of Anaheim, and Orange County Road Superintendent Al S. Koch.

Beyond Cypress Avenue the new Houston Expressway link provides a new route for Orangethorpe Avenue, eliminating two grade crossings of the Santa Fe Railway, one a mile east of Placentia and the Yorba crossing, where Orangethorpe Avenue turns toward the Santa Ana Canyon Highway.

The new road underpasses the railroad and has a double bridge over the Santa Ana River and a bridge over westbound traffic on the Santa Ana Canyon Parkway. It merges into eastbound traffic without a stop.



Freeway ceremony opening the first portion of the Houston Street Freeway from Cypress Avenue east four miles to Santa Ana Canyon Highway. Left to right are Al Koch, Orange County Road Superintendent; Edward Telford, Assistant State Highway Engineer; L. R. Gillis, District Engineer; Gordon H. Wood, President of the Placentia Chamber of Commerce, cutting the ribbon; Leon T. Gillilan, Mayor of Placentia; and Charles Pearson, Mayor of Anaheim. In background are members of the Valencia High School band.

## In Memoriam

JOHN D. GALLAGHER

Mourned by the entire personnel of the Division of Highways, John D. Gallagher, Assistant Office Engineer of the division, died in Sacramento on July 3, 1956, at the age of 64.

Funeral services were held in the East Lawn Chapel, Sacramento, on July 6th. A native of Ohio, Mr. Gallagher graduated in mechanical engineering from the University of Cincinnati, and completed his studies in civil engineering at the University of California. From 1911 to 1921, he engaged in engineering work with private firms in California and from 1921 to 1928, was in the banking sales business. He returned to the field of engineering in 1928 and on June 25th, of that year entered the employ of the Division of Highways in District X, which then had headquarters in Sacramento. On February 1, 1929, he transferred to Headquarters Office where he was employed at the time of his death.

Mr. Gallagher's interest in highway construction was intense. He developed an intimate knowledge of highway work throughout the State, and was considered an authority on all phases of highway development. During the years of his state service he did a great deal of research work. At the time of his passing he was engaged in writing a history of the Division of Highways dating back to 1895 when the State took over the pioneer Tahoe Wagon Road, which signalized the start of the present State Highway System. He was a frequent contributor to *California Highways and Public Works*. His series of articles on "California Highways" attracted widespread attention.

Mr. Gallagher leaves a widow, Frances; a daughter, Joy F. Gallagher of Honolulu; a brother, James Gallagher of Sacramento; and sister, Rachel S. Gallagher of Chevy Chase, Md.

# Pioneer Spirit

*Exemplified Following Disastrous Floods in Northern Counties*

By A. F. KAY, Associate Bridge Engineer

THE FRONTIER spirit of the Old West always seems ready to revive and turn into a tangible asset when disaster strikes western communities. The full story of the disastrous floods throughout Northern California this past winter would include hundreds of stirring examples of courage and ingenuity by residents of hard-pressed localities.

Particularly in our north coastal counties, last December's floods left many small communities completely cut off from any access to the main roads. Although transportation facilities were quickly restored on major highways, outside help was unable to reach many isolated settlements and the job of restoring roads and bridges was left mainly to the local citizens, who had to solve their problems by use of materials, equipment and tools locally available. With native ingenuity they quickly restored and replaced many of the damaged bridges to a usable condition.

#### **Use Material at Hand**

For the most part, these people depend on logging and lumbering operations for their livelihood. They are loggers and logging equipment operators, skilled in handling all the tools and equipment necessary in cutting and hauling logs and timber. With ordinary construction material unavailable and all bridges and roads out so nothing could be hauled from the outside, the only way temporary bridges could be built and the roads opened quickly was to use the only source of material left—the logs and timber from the local forests.

It would take a book to tell all about the work of restoring the washed out and damaged roads and bridges. A few examples will illustrate the willingness exhibited by everyone to help and get the work done.



UPPER—Debris left at site of old Bull Creek Bridge. LOWER—Constructing temporary bridge of redwood logs.

#### **Bridges Repaired**

To replace the washed out Larabee Creek Bridge, the Pacific Lumber Company of Scotia cut special timbers, trucked them to South Fork, loaded them on a work train of the North Western Pacific Railroad and persuaded the railroad to deliver them to the job site as the train went by.

This area was doubly isolated by bridges being washed out across Eel River and Larabee Creek.

Five 60-foot logs were used to span the Eel River at Maple Hills. Trucking these logs down US Highway 101 was out of the question. A logger from the Salmon Creek area offered to get them for W. S. "Buster" Sel-

vage, who was building the bridge, by the time the pile bents were ready. The logger made good on his promise.

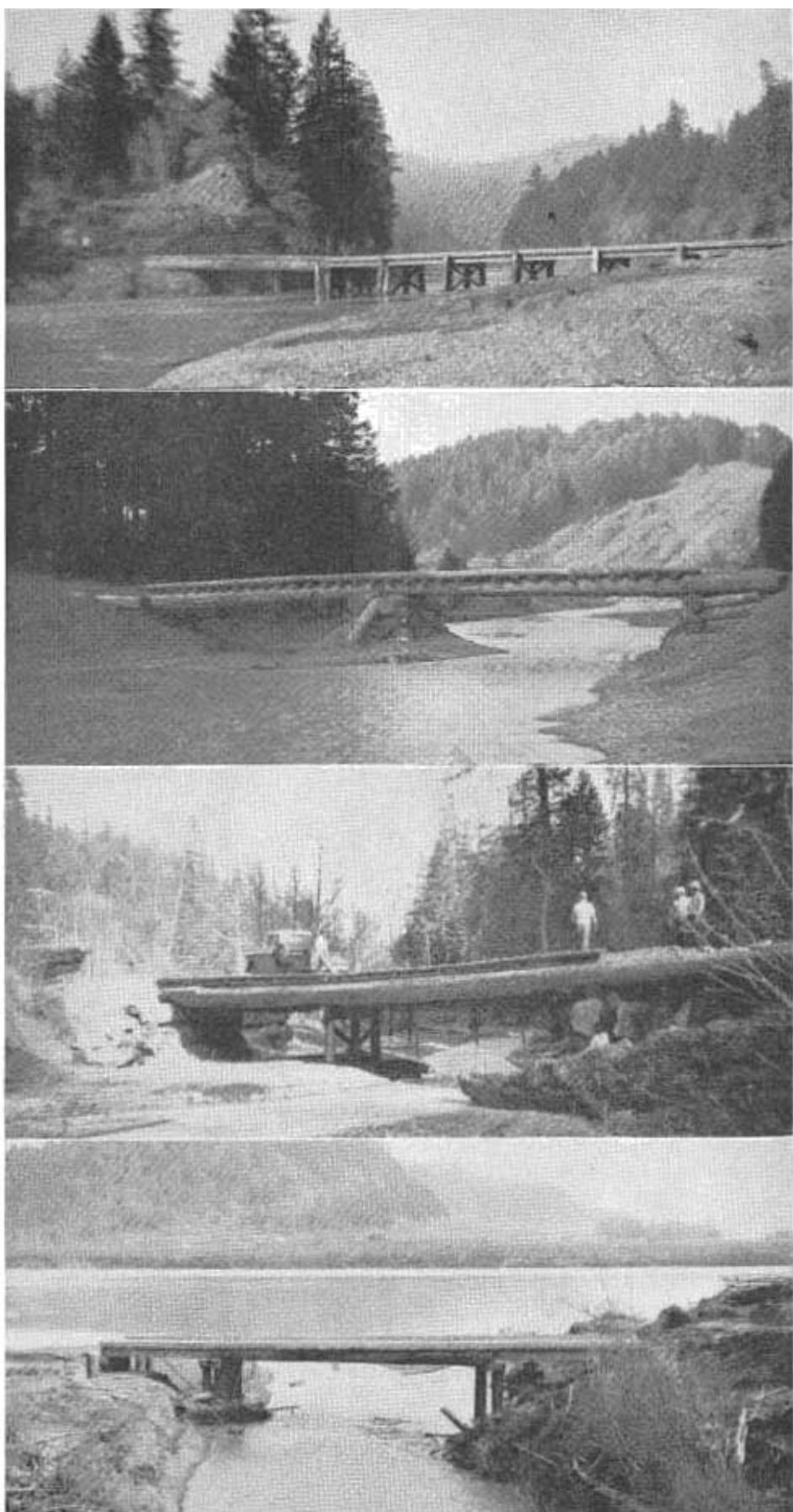
To help in getting washed out portions of the Eel River Bridge at Fernbridge repaired, the Hanson Pacific Lumber Company of Fortuna gathered up a crew and cut much needed 12 by 12-inch by 40-foot timbers for the job while their mill was still partially under water.

For the Slater Creek Trestle on the Blue Side Road which isolated the Howe Creek and Price Creek areas, a 50-foot pile was needed. This was obtained over night and hauled to the site by the Foster Drayage Company.

#### Two Log Bridges Built

The washout of half the Bluff Creek Bridge isolated the towns of Orleans and Weitchpec along the Klamath River. Construction of a standard timber bridge would have taken weeks. Two 50-foot log bridges were built and the road opened in nine days. The distance to the job from Eureka by way of Willow Creek, Hoopa and Weitchpec was 85 miles. With the bridge over the Trinity River at Hoopa washed out, Contractor J. J. Tracey had to get to the job site via Crescent City and Grants Pass, Oregon, and down the Klamath River, a distance of 315 miles. After getting word in Eureka to proceed, Contractor Tracey was on the job the next day with a three-quarter-ton pick-up truck and a bedroll. A local catskinner knew where there were two tractors, but they were 12 miles up in the mountains and under three feet of snow. The contractor said, "not so fine, but get them anyway." A local forest ranger located suitable logs but, again, these were in a remote area five miles from the job site and along a narrow and little used road. With a "never say die" attitude, the contractor and the local loggers were able to build two bridges within nine days and open the road to traffic.

This spirit of cooperation and teamwork by the loggers, the contractors, the lumber mills, the truckers, the rail-



TOP—Maple Hill Bridge over South Fork of Eel River. NEXT—Temporary Bear River Bridge. NEXT—Temporary Home Creek Bridge. BOTTOM—Reconstructed Price Creek Bridge.



UPPER—Showing flood-damaged Larabee Creek Bridge. LOWER—Repair work on bridge under way.

roads, and all who lived and worked in these areas made it possible to accomplish what seemed like an impossible task. The will and the spirit of the western pioneer is not gone. It is still with us ready to meet any emergency or challenge.

#### **CONSTRUCTION EMPLOYMENT HITS ALL-TIME HIGH IN MAY**

More workers were employed in the construction industry in May than ever before in the history of California, according to Ernest B. Webb, State Director of Industrial Relations.

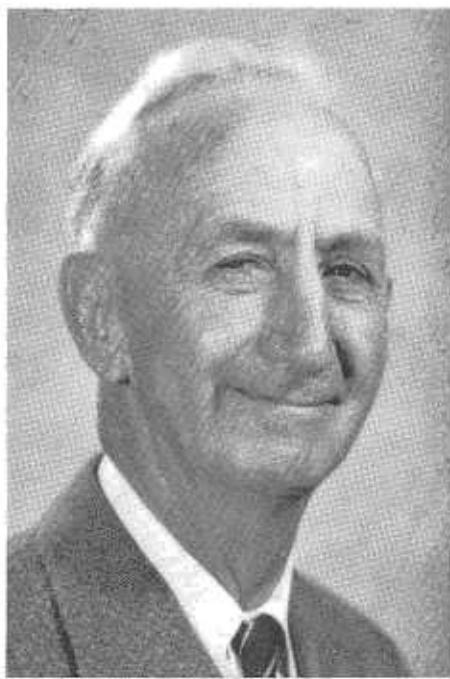
Construction contractors employed 295,600 workers in May. This was 27,300, or 10 percent, more than in May a year ago.

*and Public Works*

#### **Marc C. Fosgate**

Marc C. Fosgate, Assistant District Engineer, Operations, for District X of the Division of Highways, retired July 6th after 35 years of state service.

For the past 19 years Fosgate has been a resident of Stockton, having reported to District X in 1937 as district construction engineer. When the Division of Highways was reorganized in 1947 and he was required to handle the expanded highway pro-



MARC C. FOSGATE

#### **FROM KANSAS CITY**

CITY PLAN COMMISSION  
Kansas City, Missouri

K. C. ADAMS, *Editor*

DEAR MR. ADAMS: We have found your publication *California Highways and Public Works* to be of great interest and value to us here in Kansas City as we move forward on our own highway construction program. We very much appreciate the continuation of our name on your mailing list.

Sincerely yours,

PHILIP E. GEISSAL  
Chief Planning Engineer

gram, Fosgate was promoted to assistant district engineer in charge of operations. In this assignment he has been in charge of the district construction program averaging approximately \$10,000,000 a year in road building projects. He has also been responsible for the maintenance of about 1,400 miles of state highways in Alpine, Amador, Calaveras, Mariposa, Merced, Sacramento, San Joaquin, Solano, Stanislaus, and Tuolumne Counties. He also supervised the construction engineering on federal aid secondary county highway projects in these counties.

Prior to working in District X he was district maintenance engineer in

. . . Continued on page 65

# Nojoqui Expressway

*Bad Section of US 101  
Finally Is Eliminated*

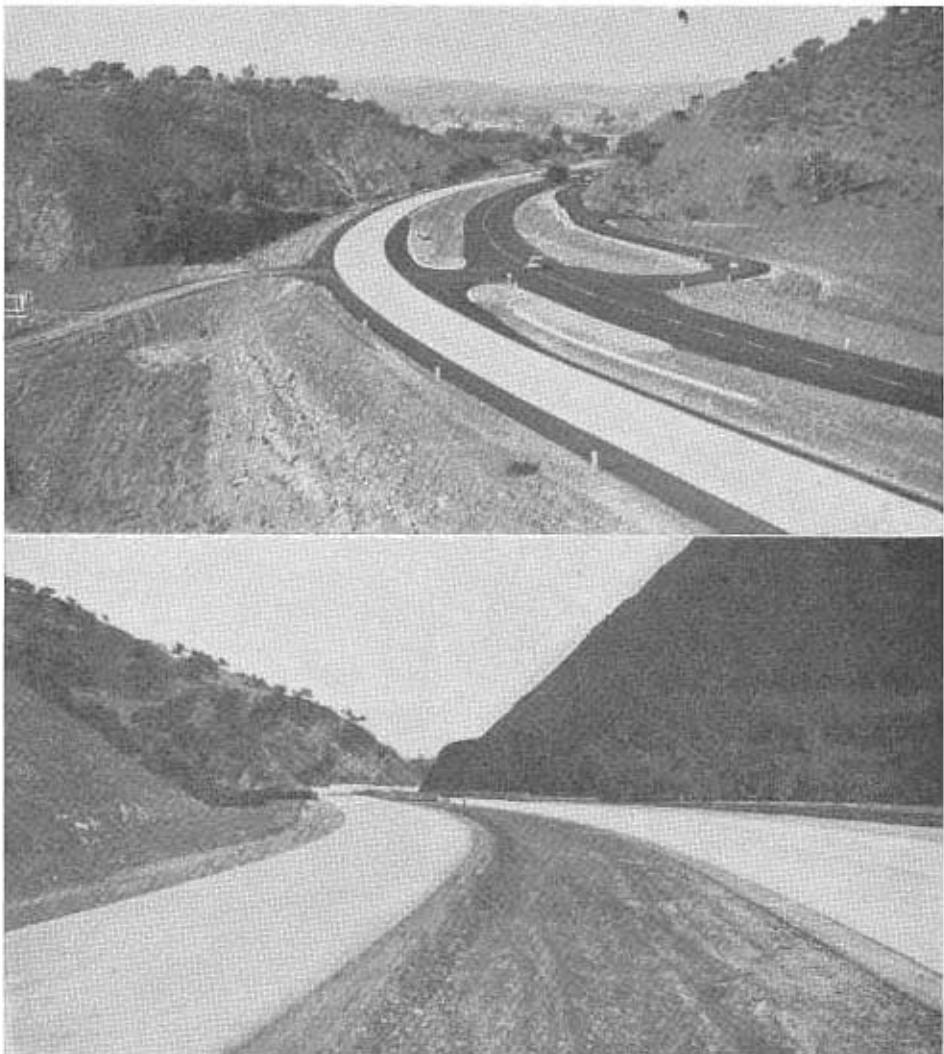
By A. M. NASH, District Engineer

THE HISTORIC route followed by US 101 through the rugged Santa Ynez Mountains between Gaviota and the Santa Ynez River at Buellton, Santa Barbara County, long considered one of the worst sections between the Mexican border and San Francisco, because of its steep grades and reversing curves, has become an 11-mile stretch of continuous four-lane divided expressway. Completion of the 4.1 miles between 1.0 mile north of Nojoqui Summit and 0.5 mile south of the Santa Ynez River marked the final step in eliminating this bad section of old highway.

This latest portion to be completed and the subject of this article begins at the foot of Nojoqui grade, northerly terminus of the four-lane divided expressway constructed over Nojoqui Summit in 1951. From here the new lanes follow narrow, winding Nojoqui Creek gorge northward on alignment and grade designed for travel at 60 miles per hour. Minimum curve radius on the new lanes is 1,223 feet compared with 750 feet on the old highway. Just south of the Santa Ynez River the new lanes transition into the older two-lane highway which is on tangent alignment until joining the Buellton Expressway.

#### Difficult Terrain Obstacles

Seldom have more difficult terrain obstacles been encountered in the design and construction of an expressway than those presented by Nojoqui Creek gorge. This is perhaps best illustrated by the following data. Within a two-mile stretch nine individual bridge structures, averaging 196 feet in length, were constructed over Nojoqui Creek. The creek channel was realigned at five different locations which involved the removal of over 210,000 cubic yards of ditch and channel excavation. Also, within the same area, in a three-quarter mile stretch, over 660,000 cubic yards of



UPPER—Looking north on new expressway, with Buellton in background.

LOWER—View looking south on expressway.

roadway excavation was removed in making two cuts.

The special provisions required that public traffic be allowed to pass through the construction area unobstructed and with the least possible delay at all times. This was accomplished despite the severe restrictions of the narrow gorge.

#### Storm Damage

An unusually severe rainstorm which started on December 23, 1955,

and continued intermittently over the next few days caused Nojoqui Creek to rise to flood stage. Considerable erosion took place along the banks of one of the channel changes and for a time the stability of a newly constructed bridge abutment was threatened. Heavy stone riprap was placed along the banks of the creek, in the vicinity of the threatened bridge, to prevent further destructive erosion.

#### **Channel Change vs. Bridge Alternatives**

During the course of the design of this project, it was first proposed to construct a channel change on the left between Stations 180 and 190 and thus eliminate the need for constructing four new bridges. Cost comparison studies, however, indicated that a channel change alternative would develop approximately 500,000 cubic yards of excess material that could only be disposed of outside the right of way. This, along with other considerations, pointed to higher costs and therefore effectively ruled out the channel change in favor of building the bridges.

The plan finally adopted involved removal of 882,000 cubic yards of roadway excavation with 17,260,000 station yards of haul. An excess of 140,000 cubic yards of roadway excavation was developed and utilized to construct embankment for future lanes ahead and, also, to widen embankments on this project.

#### **Structural and Geometric Features**

A uniform 46-foot width of median has been provided throughout the project with the exception of the portion between Stations 172 and 223 where the median is 22 feet in width. Ultimate development to a six-lane freeway may be accomplished in the future by widening on the outside where the median is narrow and on the inside where the wider median has been provided.

The southbound lanes are surfaced throughout the length of the project with portland cement concrete. The northbound lanes are surfaced with plant-mixed surfacing where it was possible to use the existing highway as a base for second stage construction. Otherwise, the northbound lanes are also surfaced with portland cement concrete.

#### **Structures**

Reinforced concrete T-girder bridges were used for each of the nine new bridge structures. Spans are supported by reinforced concrete piers and abutments. The deck slabs of reinforced concrete provide clear roadway widths of 28 feet in addition to two safety curbs, each 1 foot 9 inches wide. An exception to the latter is



*This view is looking south and shows overpass in center*

the private road approach bridge on the left at Station 166 which provides a 12-foot width of roadway and two curbs, each 1 foot wide.

Many smaller drainage structures were constructed, the majority of which were extensions of existing facilities. Included among these were four existing 8 feet x 8 feet reinforced concrete boxes which were extended in one case with a similar structure, in another with 96-inch reinforced concrete pipe and in the other two instances with 90-inch and 72-inch corrugated metal pipes respectively.

#### **Construction to Buellton Scheduled**

Construction of the additional 0.8 mile of expressway required to connect onto the existing four-lane di-

vided highway through Buellton is tentatively scheduled to begin in 1958. This project will involve construction of two additional bridges to carry new southbound lanes across the Santa Ynez River and Nojoqui Creek.

Construction of the project just completed between 1.0 mile north of Nojoqui Summit and 0.5 mile south of Santa Ynez River, including construction of the bridges, was performed under one contract which was awarded to joint venturers, B. J. Ukropina, T. P. Polich, Steve Kral, John R. Ukropina and Madonna Construction Company of San Luis Obispo on September 15, 1954. Work began on the day the contract was awarded and was completed at a cost of \$1,905,126.

*This view is looking north on expressway*





# Out of the Mail Bag

## LETTER TO THE GOVERNOR

INGLEWOOD CHAMBER OF COMMERCE  
Inglewood, California

June 4, 1956

HON. GOODWIN J. KNIGHT  
*State of California*  
*State Capitol, Sacramento,*  
*California*

MY DEAR GOVERNOR: I had occasion to make an automobile trip on Highway 99 between the San Francisco Bay area and Los Angeles. I do not travel the roads too often because I usually take a plane to save time—so my last automobile trip on the same route was something over a year ago.

May I take this occasion to congratulate you and your State Highway Commission for the rapid improvements that are being made in the highways of our State. It is becoming a pleasure to drive on 99, since almost the entire route is now a divided highway.

I would compliment, too, the marvelous engineering for freeways within the Bay area and the Los Angeles metropolitan area. It continues to amaze me that, with all the obstacles and complexities confronting the Highway Department people any freeways are constructed at all.

I think the Highway Commission is doing a fine job in trying to be fair with everyone . . . very frequently under trying circumstances.

Just taking a few minutes out to toss some bouquets your way. With kindest personal wishes.

Sincerely and respectfully,

RUBEN NEUHARTH  
Secretary-Manager

## MAGAZINE USED IN SCHOOL

OFFICE OF THE SUPERINTENDENT OF SCHOOLS  
Riverside County

K. C. ADAMS, *Editor*

DEAR MR. ADAMS: It occurred to me that you might be interested in knowing how this magazine helps us in school work. My wife teaches "Modern California" in the fourth grade. In addition to being helpful in teaching children about a tangible service of our State Government *California Highways* is valuable in teaching the study of maps since aerial photographs of known areas make map reading meaningful. The magazines are saved and loaned to teachers with whom I work in the country.

You are performing a valuable service to the people of the State of California and we do appreciate it.

Sincerely yours,

RAY W. JOHNSON  
Superintendent of Schools

## BOOST FOR DEPARTMENT

MARSH & McLENNAN  
San Francisco

MR. KENNETH C. ADAMS, *Editor*

DEAR MR. ADAMS: May I add one other to the many letters of congratulation which you have received on your interesting and valuable magazine.

I feel that the people of this State should have great pride in the remarkably fine job done by the Department of Public Works, and it is therefore most fitting that the loyal and able people who make up the department should have their efforts chronicled in your splendid publication.

Sincerely,

HERON L. PRENTISS  
Vice President

## MANY THANKS

ROCKLAND, MAINE

MR. KENNETH C. ADAMS, *Editor*

DEAR MR. ADAMS: As an employee of the Maine State Highway Department, I have an opportunity from time to time to see your fine magazine at the office. It is a grand magazine—in my opinion, the best in its field.

I find it particularly interesting as I lived in California for many years prior to settling here in Maine. Each time I see a new issue of *California Highways and Public Works*, I marvel at the changes that have taken place in your highway system since my departure from the coast 10 years ago.

Very truly yours,

GUY NICHOLAS

## READ IN MILWAUKEE

MR. KENNETH C. ADAMS, *Editor*

DEAR SIR: You perhaps might be interested to know that my copy of *California Highways and Public Works* goes with me when attending meetings and citizen discussion groups.

New divided highways are under construction near and around Milwaukee and we are gleaning lots of valuable information from your fine magazine.

It is read from cover to cover and is found to be very educational.

Sincerely yours,

MR. AND MRS. CLARENCE  
SCHUMACHER  
Milwaukee 12, Wis.

## FROM OKLAHOMA

*California Highways and Public Works*

SIRS: We have been receiving your publication for several years and as we finish reading it we send it on to various public offices of officials here in Oklahoma, hoping the information may have good influence on future road building and planning. It goes to small towns along routes we have traveled where the old main streets connect with the equally old highways.

We hope your publications have helped the towns west of Oklahoma City to accept the bypassing of their townships when 66 will be widened in the future.

Every year, usually in February, we are *home* for a vacation to visit our folks in Berkeley, Alameda, and Oakland. We ski up on US 40 where we first tried it in 1938-39-40. The wonderful new highway from Oakland to beyond Sacramento keeps us *always* going home for our fun! We have skied in Colorado, Utah, Idaho, Washington and Oregon. None have California's facilities, beautiful roads or maintenance.

With Oklahoma's present "Turner Turnpike" in use, and plans for another in the immediate future, we have reason to be proud of our *home* state and the great network of multi-lane highways free of any tolls! From actually driving on the Turner Turnpike we know your new highways have better surfacing and a better margin of safety.

The constant rising cost of owning and driving a car has gradually limited our touring habits to the point where we will not use a turnpike or toll road if a good alternate is available. To us, a toll road is a private road, closed to the average tourist traveling on a limited budget. It also can mean deliberate pressure on cars to use the toll road by neglecting repairs on the alternate. This is not our American way, and we hope the solution to better highways can be solved as you are doing with good planning and free roads.

Thank you sincerely,

MRS. JAMES O. SAVAGE

## MAGAZINE USED AS HANDBOOK

CONTRACTORS STATE LICENSE BOARD  
San Francisco

*California Highways and Public Works*

GENTLEMEN: For several years your magazine has come bringing current practice in highway and bridge construction, the result of laboratory research and tests on materials used in heavy construction, comparative cost data and modus operandi using recently accepted techniques and practices.

When a man has a desk job in an industry as active and changing as the heavy construction industry he is hard put to keep abreast of what is going on "in the field." Your magazine, supplemented by an occasional field trip, keeps me sufficiently close to the head of the parade to, at least, hear the music; if not see the band.

Your magazine stimulates my imagination, keeps me abreast of current techniques and practices in the field and is of greater value to me than many of the expensive "handbooks" in the preparation of examination material for such contractors' examinations as general engineering contractor; cement and concrete contractor; excavating, grading, trenching, paving, surfacing contractor and other classifications of contractor directly, or indirectly, operating in the heavy construction industry.

Very truly yours,

HARRY W. ABRAHAMS,  
Examiner, Grade 2,  
Contractors' State License Board

## THAT IS PURPOSE OF MAGAZINE

TIBURON, CALIFORNIA

MR. K. C. ADAMS, *Editor*

DEAR SIR: At this time I wish to thank you and state that I appreciate receiving *California Highways and Public Works*.

It not only is a very instructive and interesting magazine but has been a great help in disseminating information about just where our gas tax money is being spent.

Sincerely,

WALTER C. THIERBACH

## PRAISE FROM OVERSEAS

COUNTY BOROUGH OF TYNEMOUTH  
Borough Surveyor's Office

NORTH SHIELDS, ENGLAND

KENNETH C. ADAMS, *Editor*

DEAR SIR: For some time now I have been privileged to receive, regularly, copies of the official journal of the Division of Highways, Department of Public Works, State of California. I peruse them with great interest, and pass them to members of my engineering staff and subsequently they go to the county engineer and surveyor of Durham County Council—one of the largest highway authorities in England.

Yours sincerely,

DONAL M. O'HERLIHY

## OUTSTANDING PUBLICATION

PORTLAND CEMENT ASSOCIATION  
Memphis 3, Tennessee

*California Highways and Public Works*

GENTLEMEN: *California Highways and Public Works* magazine is an outstanding publication and the copies I have seen will certainly help us in our promotion of better development of highways in Tennessee and Arkansas. The September-October issue, a copy of which I saw briefly, contained some very interesting and, I believe, useful articles on freeway construction in your fine State that should interest people in this section of the Country.

Yours very truly,

JOHN L. FEAGIN  
District Engineer

## ANOTHER COMPLIMENT

Los Angeles 42

K. C. ADAMS, *Editor*

DEAR SIR: I want to take this opportunity to thank you for including me on your mailing list and to express my sincere appreciation for the fine magazine and its entertaining and informative articles.

Extending my best wishes to you and thanking you again for your courtesy, I am

Yours truly,

IRVING ANGEL

## A. K. Gilbert

A. K. Gilbert, associate bridge engineer with the Division of Highways Bridge Department, retired on July 1, 1956, after a 27-year career with the State.



A dinner was held in honor of Mr. Gilbert on June 6th at Swally's Key Club in Los Angeles. At the time of retirement, Gil was resident engineer on the construction of the Colorado River Bridge at Yuma.

Gilbert received his engineering education at the University of Utah where he studied mining engineering. He obtained his early experience with the Anaconda Copper Company of Butte, Montana, and later with the Utah Copper Company at Bingham, Utah.

After coming to California he worked for five years with the Pacific Gas and Electric Company before joining the Division of Highways in 1929. His work with the bridge department has been as resident engineer on many of the major bridge structures throughout the State. His wide knowledge of bridge construction and his pleasant, straightforward manner have won for him the friendship and respect of his associates.

All of Gil's friends wish him many happy years of retirement. He plans to devote part of his time to travel and prospecting.

## This Letter Is Self-explanatory

### FIRST PRESBYTERIAN CHURCH OF HOLLYWOOD

ROBERT BRUCE YOUNG, JR.  
BUSINESS MANAGER

1760 NORTH GOWER STREET  
HOLLYWOOD 3-7161

HOLLYWOOD 26, CALIFORNIA

May 9th, 1956

California Highway Commission  
Department of Public Works Building  
Sacramento, California

Gentlemen:

In these days when you are no doubt besieged with complaints of noise created by new freeway improvements, our Church is most happy to report that none of our services or other programs have been in any way handicapped by traffic noises due to the Hollywood Freeway. As you know, our Church is located on the Southeast corner of Gower and Yucca Streets in Hollywood and directly across Yucca Street from this heavily traveled Freeway.

Our Church, which is the largest single Presbyterian Church in the United States, has a membership of 6,357 and a Sunday School enrollment of 6,419. It operates seven days a week in its continuing effort to satisfy the necessary club and program activities of this large enrollment. Meetings of one sort or another seem to be in progress most all the time, day or night.

If anything, it is our candid opinion that the Hollywood Freeway has greatly benefited our Church by expanding its sphere of influence. Due to the improved transportation facilities provided by this freeway, we now have members who live in far outlying areas, such as Buena Park in Orange County, who regularly attend our services and other activities.

Although we were most gravely concerned some years ago as to the possible detrimental effect the close proximity of this freeway would have on our Church, it is now with a great deal of pleasure that we can candidly say our fears were entirely unfounded.

Yours very truly,

*Robert Bruce Young, Jr.*  
Robert Bruce Young, Jr.,  
Business Manager

RSY,Jr.,/a

### ARRESTS FOR SPEEDING

The California Highway Patrol made 83,530 arrests for speeding in the first four months of 1956.

### SUDDEN STOPS

If you make sudden stops or turns in traffic without giving any warning, you're in for trouble.

## Frank Escobedo Is Deputy Director Of Public Works

Frank B. Durkee, Director of Public Works, has announced the promotion of Frank J. Escobedo from Per-



FRANK J. ESCOBEDO

sonnel Officer to Assistant Deputy Director. He will assist the director and deputy directors on departmental administrative matters.

Escobedo is a graduate of the University of California at Berkeley, where he also completed graduate study in the Bureau of Public Administration. During his 14 years of state service, his work has been concerned primarily with personnel administration. He was a personnel officer in another state agency for five years prior to his coming to the Department of Public Works, where he has worked in a similar capacity since September, 1954. For 2½ years preceding that date, he was the personnel director for the City of Philadelphia.

Escobedo succeeds C. M. "Max" Gilliss who was appointed deputy director last January.

## PUBLIC WORKS SECRETARY OF BRAZIL VISITS HERE

On a tour of the West, Euclides Triches, State Secretary of Public Works, State of Rio Grande do Sul, Brazil, called upon Director of Public Works Frank B. Durkee. His official duties in his native country are similar to those of Durkee. He is a participant in the foreign leader program of the International Educational Exchange Service of the U. S. Department of State.

Triches is particularly interested in highways, irrigation in land waterways, water problems, and public works construction. He spent some time with officials of the Division of Water Resources. He expressed great interest in California's water problems.

### FOSGATE

*Continued from page 59 . . .*

District II with headquarters in Redding, and resident engineer in District IV at San Francisco.

Previous to his state service Fosgate worked at railroad and irrigation engineering and spent considerable time on railroad location and construction in Alaska. His tales of experiences in Alaska are many.

Fosgate was born in Paso Robles and attended grade and high school in Gilroy and State College in San Jose. His family consists of wife, Ina Mae; son, Marc Otis of Stockton, and daughter, Susan Anne, presently attending San Jose State College. He also has two grandchildren.

Marc's hobbies are cribbage, golf, hunting, fishing, and farming. He has a 30-acre ranch in Fiddletown, Amador County, an important element in his retirement plans.

Fosgate has been active in the affairs of the California State Employees' Association and served a term as president of the highway chapter in Redding. A Master Mason, he is a member of Masonic Lodge No. 57 of Santa Rosa.

Upon retirement, Marc and his wife plan to make an automobile trip to the Northwest and upon return, keep busy with his farming at Fiddletown and town living in Stockton.



UPPER—Director of Public Works Frank B. Durkee shows Mr. Triches an artist's drawing of parallel Carquinez Bridge. LOWER—Assistant State Engineer W. G. Schulz explains State Water Plan to Mr. Triches.

### LETTER TO DIRECTOR

CONNECTICUT GENERAL LIFE INSURANCE CO.  
Hartford, Connecticut

June 8, 1956

DEAR MR. DURKEE: We greatly appreciate your kindness in sending the material regarding your State's ambitious highway program. Several of us have been reading the material and have found many ideas which we believe will be extremely valuable not only in our commission's report but also in helping Connecticut to formulate a comprehensive long-range program.

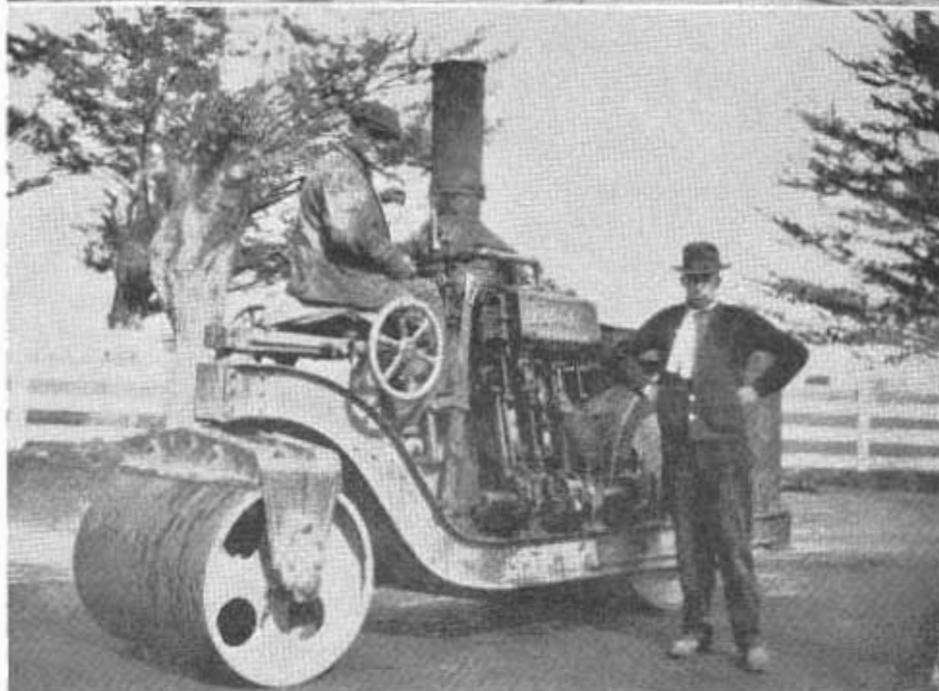
In reading your material, we are increasingly impressed by the job California has done and the example which you have set for other states to follow.

With our sincere thanks,

Very truly yours,

JAMES H. TORREY  
Secretary

## Highway Work Was Hard in 1913



On August 7, 1912, Percy A. Towne, Chairman of Governor Hiram Johnson's original highway commission, turned the first spadeful of earth signifying the start of actual construction work on California's State Highway System in San Mateo County.

Ransome-Crummey Co., San Francisco, was the contractor on this first highway contract. Edward E. Snider, 99 Wood Lane, Fairfax, California, was superintendent for the contracting firm and Leon Clark was resident engineer for the State. Mr. Snider

## Director of Public Works of Boys State Appointed

Newly appointed Director of Public Works James W. Ellis of Calipatria called at the Department of Public Works in Sacramento on June 21st to pay his respects.

Jim, 17, was appointed to his post by



JAMES W. ELLIS

Governor Richard Hammes, San Diego, of the Boys' State, which held its annual encampment on the State Fairgrounds, concluding its sessions on June 21st.

Jim is the son of Mr. and Mrs.

Gordon W. Ellis of Calipatria. His father is a highway foreman at Calipatria and is past president of the Imperial Chapter of California State Employees' Association.

The young Director of Public Works was recently elected President of the Calipatria High School student body. He passed a civil service test for engineering aid and went to work for the Division of Highways for the summer vacation on June 25th.

Estimated motor vehicle travel on the rural state highway system for 1954, based on the usual state-wide traffic counts, was 16.1 billion vehicle-miles, an increase of 1.4 percent over 1953.

found these old pictures in his photograph album, taken in March, 1913, at Uncle Tom's Cabin, a famous landmark in San Mateo County. They show a roller and truck used in those early days. Clark is in the driver's seat of the truck and Mr. Snider is standing by the roller.

"I think this truck is the first one used to haul asphalt on a state highway," Mr. Snider writes, "we had to wind it up by hand. It held six dumps or 54 cubic feet."

# ACCIDENTAL DAMAGES TO STATE FACILITIES

By W. D. SEDGWICK, Assistant District Engineer, Maintenance

When thinking or reading about accidents on our highways, we usually have in mind loss of life, injuries or damages to the vehicles. Little thought is given to the damage done to the highway or its facilities.

In State Highway District VII, which includes only Los Angeles, Orange and Ventura Counties, during the year between March 1, 1955, and March 1, 1956, 1,300 loss reports were processed involving a total of \$133,577. Of this amount, \$91,557 was collected from the parties causing the damage and \$42,020 was expended from the gasoline tax funds and charged to maintenance, because the cost was not recoverable. If policing agencies do not have report covering the accident, which caused the damage, there is little chance of recovery.

There are many repairs due to vehicle accidents which are too minor to collect the cost of as it would cost more to collect than the cost of the repairs. These total an appreciable addition to the above figures.

## Damage to Signs

In this district where the state highways probably handle the heaviest traffic in the world, the traffic signals are very important and must be kept in operation. The items involved in the 300 loss reports handled by our signal crews included repairs to 114 signal poles, 154 signal heads, 5 controllers, 57 street light poles, 41 luminaires and 19 flashes, for a total cost of \$58,876.

The warning, regulatory, and guide signs come in for their share of damage from vehicles. Many of the signs are costly and 102 reports totalled \$3,204 in repairs.

Almost the full time of a three-man crew is required to repair damaged fences on the freeways. The cost of these repairs amounted to \$30,273.

Other items which are continually having to be repaired due to vehicle damage are guard rails, \$18,054; bridge rails, \$10,161; and sight posts and reflectors, \$5,219.

## Clearing Debris

In addition to repairing the damaged facilities, our forces are called out by the California Highway Patrol to sand oil spilled on the pavement, clear the traveled way of bales of hay, boxes of tomatoes, broken glass, and many other types of debris due to vehicle accidents.

With the heavy traffic on the freeways in the City of Los Angeles which have been completed to date, there were 487 accident reports involving damage to state facilities which cost \$28,868 for repairs in one year.

In consideration of the number of loss reports and costs of repairs during the past few years, the rapid increase during this last year is something to think about.

## Cost During Five Years

The annual cost of repairs during the last five years is as follows:

1951-52	\$43,454
1952-53	45,271
1953-54	54,820
1954-55	78,032
1955-56	133,577

(Period of this report)

During recent years more and more lighting standards, guide posts, traffic signals, signs and guard rails are being placed for the safety and convenience of motorists. Admittedly, there are more of these facilities that can be hit and damaged by cars out of control, but excessive speed is one of the major causes of these accidents. This does not necessarily mean exceeding the legal or posted speed limit. Too often the driver says, "I was only going 35-40 miles per hour when the car in front of me stopped, and I had to swerve to miss it, when I hit the fence, guard rail, or light or signal post." He was exceeding the safe speed limit for existing conditions.

Studies are continually being made to place the highway facilities in such positions that they will be effective but be less likely to be hit and therefore more economically maintained.

## E. G. Van Leeuwen

E. G. Van Leeuwen, Associate Highway Engineer, District V, retired on July 6, 1956, after 37 years of state service.

"Van" was born in Minneapolis, Minnesota, on July 2, 1891. Two years later the family moved to San Francisco. An event of April, 1906, displaced them as far south as San Jose, where "Van's" high school education was completed. He then entered the University of Santa Clara and was graduated in 1915 with the first graduating class in civil engineering.

For four years he was employed by the City of San Jose, the County of Santa Clara and the United States Geological Survey. In 1919 he entered state service as a draftsman for the then Division V, San Luis Obispo. During the following 10 years he was promoted through various grades to associate highway engineer. He was transferred in 1929 to District I, Eureka, where he served as chief draftsman and as resident engineer. In 1937 he was transferred to District X, Stockton, and in 1941 returned to District V, San Luis Obispo. In 1950 he was appointed district safety supervisor, which office he held until his retirement.

"Van's" genuine interest in employee welfare caused him to serve the State Employees' Association in a number of local chapter offices and as regional director for two terms. In addition to these activities, he has been active in the California Society of Professional Engineers, the American Society of Safety Engineers, the Veterans of Safety, National Safety Council and Tau Beta Pi, national engineering honor society. He is also a member of various Masonic bodies in San Jose, San Luis Obispo and San Francisco.

He will continue to maintain his home in San Luis Obispo.

At the close of the 1954-55 Fiscal Year the Division of Highways was operating some 145 land radio stations and 650 mobile radio units throughout the State.

## In Memoriam

JEAN P. WINSLOW

Jean Paul Winslow, Assistant Bridge Engineer with the Bridge Department of the Division of Highways, died in Sacramento.

Born in Somerville, Massachusetts, on July 31, 1896, Jean attended schools in Utica and Syracuse, New York, and Sacramento, California.

He worked as a surveyor and photographer for the Southern Pacific Company, 1917 to 1923 when he joined the State Highway Department and shortly thereafter, the Bridge Department. He aided in the construction of a large number of bridges, including various stages of the San Francisco-Oakland Bay Bridge. The last 12 years, he had been in the bridge estimating section at headquarters.

Mr. Winslow is survived by his widow, Mrs. Anna Calvin Winslow, two sons, David J. and John C., both of whom are with the U. S. military service, and a brother, George Winslow, of the Division of Highways. Jean's father was the late George R. Winslow, one of the first engineers with the State Division of Highways.

Jean's hobbies were hunting, photography, and gardening. His outside activities included Boy Scouts, garden clubs, State Quarter Century Club, and various lodges.

A host of friends and co-workers deeply regret his passing and extend their sympathy.

### NEW RECORD

Sport fishermen and wild game hunters in the United States set a new record by purchasing 33,046,361 licenses during the fiscal year that ended June 30, 1955, according to the National Automobile Club. That was 392,162 more licenses than they purchased during the previous year.

### CALIFORNIA PLACES SECOND

California sold 1,285,980 fishing licenses during the 1954-55 season to place second in the United States, reports the National Automobile Club. Minnesota placed first with 1,374,942 licenses sold.

# State Fair

Will Start on August 29th  
For a 12-Day Run

THE "SPIRIT OF '56" State Fair and Exposition—themed in tribute to the energy and industry of modern Californians—will roar into life August 29th for a 12-day run. Most of the 800,000 visitors expected to share in the celebration will see one phase of the State's growth en route—the broad new miles of roadway in the vast State Highway System.

No one will go away dissatisfied either, because State Fair officials have rounded up a program that has something for everyone. There will be Hollywood star-studded night shows, thoroughbreds pounding around the track, band concerts and the aristocracy of the livestock world.

Fair directors have returned to the variety show format for evening performances, featuring three different shows, each with a four-night run. Talent already selected includes Eddie Fisher, Bob Crosby and Dennis Day.

Other top ranking evening events will include the nightly horse show, oldest continuous equestrian event in the West; and mammoth fireworks displays.

### More Racing

There will be an additional day of racing. The exposition will open on a Wednesday, rather than on Thursday as in past years, allowing those who follow the ponies one extra day at the pari-mutuels.

The race meet, to be 10 days in length, will be held on all days except Sundays. There will be several stake races, featured by the classic Governor's Handicap on September 6th, carrying a purse of \$20,000 added.

The exposition, a sure thing to wreck most records accumulated in its previous 101 years, will show products of the State in scores of buildings with emphasis on agriculture, horticulture, livestock, floriculture, mining and manufacturing.

As in past years, most of those attending the Fair will flock to the Counties Building and Hall of

Flowers. There are few, if any, exhibit halls more sensational.

Roaring waterfalls, limpid lily ponds, outdoor gardens, huge simulated redwood trees, and more than 1,000,000 blooms, shrubs, potted plants, cut specimens, and trees form a breath-taking panorama of the floriculture world.

### Much to See

The huge Counties Building is the delight of young and old. A symphony of light, color, and motion, it is filled with booths representing the counties of the State, their products, tourist attractions, natural resources, recreational facilities, and other advantages.

From the Counties Building visitors may fan out into a vast display of all the things shown at a fair. There will be sewing exhibits, canned and preserved foods, cooking demonstrations, wine tasting events, carnival attractions, hot dogs, exotic foreign dishes, hobby shows, more than 5,000 head of livestock, an art show, wildlife displays, rabbits, thousands of birds from pigeons to seldom seen "show" chickens, and many, many other items.

There are 207 acres of buildings, spacious lawns, shaded areas with benches, food stands, first aid stations, restaurants, horse barns, paved streets and walks, flowers, checking stands, and almost countless other places and things.

There is a fire station, headquarters for police, a bank, telegraph office, and a post office. There are fountains with iced drinking water, air-conditioned buildings, and a candy store.

The exposition is, literally, a city within a city, providing every comfort for those who come to wonder.

Transportation from the heart of Sacramento is provided by express busses, and the Fairgrounds is within easy taxicab distance from any part of the city. Those with their own autos will find conveniently located parking lots adjoining the grounds.



# Farewell

Division of Water Resources  
Leaves Public Works Department

By ROBIN R. REYNOLDS, Senior Hydraulic Engineer, Department of Water Resources

ON JULY 5, 1956, one of the divisions of the Department of Public Works, the Division of Water Resources, became a part of the new Department of Water Resources, created by the Legislature.

To head up the new department, Governor Knight appointed Harvey O. Banks as director and Marcel J. Shelton of La Mesa as deputy director. Banks was formerly State Engineer and Chief of the Division of Water Resources. Shelton is from Southern California, where he was general manager and chief engineer of the La Mesa, Lemon Grove and Spring Valley Irrigation District in San Diego County.

#### Major Reorganization

The legislative act brought about a major reorganization of the State's water agencies. On July 4th, the Division of Water Resources, the State Engineer's Office, the State Water Resources Board, and the Water Project Authority were abolished. In their places, on July 5th, the Department of Water Resources, the State Water Board, and the State Water Rights Board came into existence. The new department succeeds to all the powers, duties, and responsibilities of the abolished agencies except the administration and adjudication of water rights, which have become the responsibility of the new Water Rights Board.

In addition, the new department succeeds to all the powers, duties, and responsibilities formerly vested in the Department of Finance with respect to state filings for unappropriated waters in furtherance of general and coordinated plans for water development. The State Reclamation Board is continued in existence within the department, but with its present duties, responsibilities, and personnel continued.

On July 5th, Governor Knight appointed Henry Holsinger of Sacra-



HARVEY O. BANKS

mento, W. P. Rowe of San Bernardino and John B. Evans of Oakland members of the newly created State Water Rights Board.

The board will rule on legal rights to use the State's water resources for development of hydroelectric power and water supplies for industrial, municipal and farming purposes.

The new State Water Board has the same membership as the former State Water Resources Board, but its purpose and duties are to confer with, advise, and make recommendations to the Director of Water Resources with respect to any matters and subjects under his jurisdiction.

The creation of the new department to administer state control and development of the very important and valuable water resources is not only a major reorganization of the executive branch of the State Government but is also a vital demonstration of the increasing state-wide interest and concern regarding water.

#### Water Resources Division Created in 1929

The Division of Water Resources was formed in 1929 by combining the Division of Water Rights and the Division of Engineering and Irrigation, which were divisions within the Department of Public Works. However, an interesting history lies back of the Division of Water Resources. This history traces the growth of water development and water law in California. It also shows the impact which droughts, floods, depressions, wars, and general social and economic progress have had on development of the executive branch of the State Government to define and meet state responsibility for needed and orderly water resources development.

When California was admitted to the Union in 1850, the Constitution of 1849 contained no provision with respect to water and its use. The first Legislature, however, adopted the common law of England as the rule for decision in the State. With regard to the field of water law, this action of the first Legislature was to come in conflict with local customs and usages of the miners and early farmers, causing litigation and uncertainty which resulted in the slow development of the State's present unique water law.

#### Office of State Engineer Dates Back

The first Legislature also recognized the need for a state engineering office, and the Surveyor General, a constitutional and elective official, was given responsibilities in some ways comparable with present responsibilities of the Department of Public Works. The actual Office of State Engineer was first created in 1878 and continued until 1889, when it was abolished. The office was not created again until 1907. The State Engineer during this early period, Wm. Ham Hall, investigated the State's water resources and recommended that the

waters of the great Central Valley be developed in a systematic manner. The surveys and studies made by Hall and data which he collected revealed certain basic problems which were to become important and were to influence future water development in the State. The major problem, the maldistribution of sources of water supply with regard to locations of water requirements, was noted by Hall and others who followed. Since Hall's time, water development planning in California has aimed for a solution to this basic problem. Future water projects must be constructed to solve this problem.

#### Pioneer Agencies

When the Office of State Engineer was abolished in 1889, the State Mineralogist was made ex officio State Engineer. This arrangement continued until 1893, when the Office of Commissioner of Public Works was created. The California State Debris Commission was created in the same year. In 1897 a Department of Highways and the Lake Tahoe Wagon Road Commission were formed.

An important change occurred in 1907, when the Department of Engineering Act was passed, and all the former duties of the Commissioner of Public Works, Department of Highways, Lake Tahoe Wagon Road Commission, and the Debris Commission were delegated to the Department of Engineering under the State Engineer. In addition, all engineering work of the San Francisco Harbor Commission, and the design and construction of buildings and works of all state hospitals, prisons, schools, and other institutions were made duties of the department. Authority was also given to the department to carry out flood control investigations and construction, to cooperate with the Federal Government and its agencies in making surveys and investigations, and to perform other engineering duties. At that time, practically all engineering activities of the State Government, except those remaining with the Surveyor General, were vested in the Department of Engineering.



Secretary of State Frank M. Jordan poses with new officials of the Department of Water Resources before swearing them in. LEFT TO RIGHT—Henry Holsinger, Chairman of newly created State Water Rights Board; Secretary Jordan; Director of Water Resources Banks; and Marcel J. Shelton, Deputy Director.

#### Water Matters Become Important

An expansion of state governmental activities began in about 1911 with the trend to set up new offices to administer special and definite duties. Many of the new offices were assigned responsibilities which had formerly been those of the State Engineer. As a result, water matters became an increasingly important part of the responsibilities of the State Engineer.

A new and independent water agency, the State Water Commission, was formed in 1914. The commission was responsible for the administration of procedures to appropriate water.

Following World War I, in 1921, there was a major reorganization of the State Government. The Department of Public Works was created at this time. The department consisted of the Divisions of Highway, Architecture, Land Settlement, Water Rights, and Engineering and Irrigation. The State Highway Engineer was ex officio director of the department. In 1923 the State Engineer was made Director of Public Works. In

1927 the department was again reorganized and an independent directorship was created. In 1929 the Divisions of Water Rights and Engineering and Irrigation were combined within the department to form the Division of Water Resources under the State Engineer as chief of the division.

#### Six State Engineers

Six persons have occupied the Office of State Engineer since the Department of Engineering was created in 1907. Nathaniel Ellery served as State Engineer from 1907 to 1911, W. F. McClure from 1911 to 1926, Paul Bailey from 1926 to 1927, Edward Hyatt from 1927 to 1950, and A. D. Edmonston from 1950 to 1955. Edmonston retired from state service on November 1, 1955, and Harvey O. Banks was appointed to the position, which he occupied until the position was abolished on July 4, 1956. He then became director of the new Department of Water Resources.

The new department will be responsible for all planning, construction, and administrative activities of

the State pertaining to the development, regulation, and use of water resources. These activities include design and construction of the Feather River Project, operation and maintenance of flood control projects, water master service, supervision of state water filings, supervision of dams, surface and ground water and water quality measurements and investigations, water conditions forecasting and reporting, Sacramento-San Joaquin water supervision, land and water use surveys, state maps and surveys, geologic investigations, state-wide water development planning, ground water studies, delta and bay barrier studies, special cooperative investigations, major and local water development programs, waste water reclamation, water quality monitoring, Central Valley Project cooperation and studies, review of Federal reports, Sacramento River Trial Distribution activities, California district studies and investigations, and work for interstate compact commissions.

The Department of Water Resources is organized to include three divisions, the Division of Water Resources Planning under W. L. Berry; the Division of Water Resources Project Development under W. G. Schulz, and the Division of Administration under T. R. Merryweather. The Southern California District Office will be under the direction of Max Bookman. The law creating the new department provided that employees of the organizations abolished would be transferred automatically to the new department. In this manner many positions in the new department are being filled, although a number of vacancies exist in many classifications. Plans are being made to move most of the personnel of the department to new temporary quarters pending the availability of suitable quarters at some future date.

As one of its last acts the Water Project Authority adopted the following resolution proposed by Chairman Durkee:

WHEREAS, The State Legislature in 1953, by the Abshire-Kelly Salinity Control Barrier Act, Stats. 1953, Ch. 1104, directed the Water Project Authority to investigate and study the feasibility and economic value of construction by the

## GOVERNOR AGREES WITH YOU

AMERICAN SOCIETY OF CIVIL ENGINEERS  
New York

The HONORABLE GOODWIN J. KNIGHT  
*Governor of California*  
*Sacramento, California*

DEAR SIR: Acting in behalf of the American Society of Civil Engineers in convention at Knoxville, its board of directors has voted unanimously to commend you for an outstanding act of public service to your great State of California.

We refer to your recent selection and appointment of Harvey O. Banks and Mercel J. Shelton to be director and deputy director, respectively, of the newly created Department of Water. These men are distinguished members of our profession and our society. We are as confident as you are that they will ably perform the professional and executive duties of these new offices which are so important to the economy of California, now that it is faced with the urgent necessity of fully developing its water resources and protecting large areas from devastation by flood.

Very truly yours,

E. R. NEEDLES  
President

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State of a suitable barrier or barriers for salinity and flood control purposes, and for the purpose of affording a supply of fresh water for irrigation, domestic uses and related purposes; and

WHEREAS, On March 30, 1955, there was transmitted to the Legislature a "Report on Feasibility of Construction by the State of Barriers in the San Francisco Bay System"; and

WHEREAS, Said report contained the recommendations of the Department of Public Works, Division of Water Resources, and the recommendations of the board of consulting engineers; and

WHEREAS, Pursuant to the recommendations of the authority in said report the Legislature in 1955 passed the Abshire-Kelly Salinity Control Barrier Act, Stats. 1955, Ch. 1434, which made appropriations to the authority for the further investigation and study of the Junction Point Barrier and Chipps Island Barrier as described in said report, for the purpose of developing complete plans for accomplishing delivery of fresh water to

the San Francisco Bay area, including the counties of Solano, Sonoma, Napa, Marin, Contra Costa, Alameda, Santa Clara, San Benito and San Mateo, and the City and County of San Francisco; providing urgently needed flood protection to agricultural lands in the Sacramento-San Joaquin Delta; conducting subsurface exploration work in the delta and designing facilities appurtenant to the proposed cross-delta aqueduct, including the so-called Biemond plan; obtaining more complete information on the hydrology of the delta; and study-integration of the proposed project in the California Water Plan; and

WHEREAS, Such studies and investigations are now under way and it is contemplated that a report thereon will be furnished to the Legislature not later than March 30, 1957; now, therefore, be it

*Resolved by the Water Project Authority*, That: (1) it hereby expresses its belief in the great importance of said project to the State of California; and (2) that, by this resolution, it recommends that said Bay Barrier and related studies, including studies of the cross-delta aqueduct and water supplies for the bay area and nearby counties, be continued under the new Department of Water Resources to the end that all facts relative thereto, whether provided for by existing appropriations or requiring additional appropriations, be ascertained as expeditiously as possible and that, thereafter, consideration be given to the integration of said project with the California Water Plan; and be it further

*Resolved*, That the chairman be and he is hereby requested to transmit copies of this resolution to the Governor of California and to each House of the State Legislature.

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## WE HOPE TO

COVINA

Mr. K. C. ADAMS, *Editor*

DEAR MR. ADAMS: I felt it was proper to write and congratulate all who have anything to do with the making up of your tremendously interesting publication, *California Highways and Public Works*. It is a grand piece of work and you should be proud of it. Keep up the present standard, by all means.

Appreciatively yours,

RALPH BARSTOW

2580 North Oregon Avenue

California Highways

GOODWIN J. KNIGHT  
Governor of California

CALIFORNIA HIGHWAY COMMISSION

FRANK B. DURKEE	Director of Public Works and Chairman
H. STEPHEN CHASE	San Francisco
JAMES A. GUTHRIE	San Bernardino
ROBERT E. MCCLURE	Santa Monica
ROBERT L. BISHOP	Santa Rosa
FRED W. SPEERS	Escondido
CHESTER H. WARLOW	Vice Chairman Fresno
C. A. MAGHETTI, Secretary	Davis
T. FRED BAGSHAW	Assistant Director
A. H. HENDERSON	Deputy Director
C. M. "MAX" GILLISS	Deputy Director

DIVISION OF HIGHWAYS

GEO. T. MCCOY

State Highway Engineer, Chief of Division

J. W. VICKREY	Deputy State Highway Engineer
CHAS. E. WAITE	Deputy State Highway Engineer
EARL WITHYCOMBE	Assistant State Highway Engineer
F. W. PANHORST	Assistant State Highway Engineer
J. C. WOMACK	Assistant State Highway Engineer
R. H. WILSON	Assistant State Highway Engineer
F. N. HVEEM	Materials and Research Engineer
FRANK E. BAXTER	Maintenance Engineer
J. C. YOUNG	Engineer of Design
G. M. WEBB	Traffic Engineer
MILTON HARRIS	Construction Engineer
H. B. LA FORGE	Engineer of Federal Secondary Roads
C. E. BOVEY	Engineer of City and Cooperative Projects
EARL E. SORENSEN	Equipment Engineer
H. C. McCARTY	Office Engineer
J. A. LEGARRA	Planning Engineer
J. P. MURPHY	Principal Highway Engineer
F. M. REYNOLDS	Principal Highway Engineer
E. J. SALDINE	Principal Highway Engineer
A. L. ELLIOTT	Bridge Engineer—Planning
I. O. JAHLSTROM	Bridge Engineer—Operations
J. E. McMAHON	Bridge Engineer—Southern Area
L. C. HOLLISTER	Projects Engineer—Carquinez
E. R. HIGGINS	Comptroller

Right of Way Department

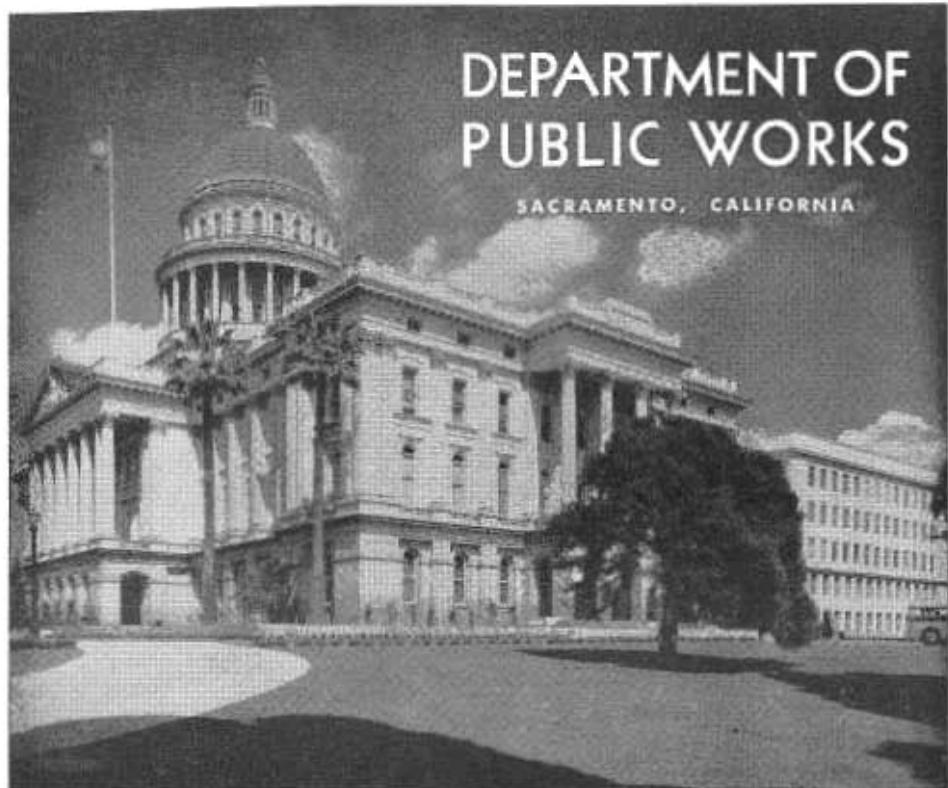
FRANK C. BALFOUR	Chief Right of Way Agent
E. F. WAGNER	Deputy Chief Right of Way Agent
GEORGE S. PINGRY	Assistant Chief
R. S. J. PIANEZzi	Assistant Chief
E. M. MACDONALD	Assistant Chief

District IV

B. W. BOOKER	Assistant State Highway Engineer
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District VII

E. T. TELFORD	Assistant State Highway Engineer
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# DEPARTMENT OF PUBLIC WORKS

SACRAMENTO, CALIFORNIA

District Engineers

ALAN S. HART	District I, Eureka
H. S. MILES	District II, Redding
J. W. TRASK	District III, Marysville
J. P. SINCLAIR	District IV, San Francisco
L. A. WEYMOUTH	District IV, San Francisco
A. M. NASH	District V, San Luis Obispo
W. L. WELCH	District VI, Fresno
GEORGE LANGSNER	District VII, Los Angeles
LYMAN R. GILLIS	District VII, Los Angeles
C. V. KANE	District VIII, San Bernardino
E. R. FOLEY	District IX, Bishop
JOHN G. MEYER	District X, Stockton
J. DEKEMA	District XI, San Diego
HOWARD C. WOOD	Bridge Engineer State-owned Toll Bridges

Administrative and Fiscal Service

EARL W. HAMPTON	Assistant State Architect, Administrative
HENRY R. CROWLE	Fiscal Assistant
THOMAS MERET	Construction Budgets Architect
WADE O. HALSTEAD	Principal Estimator of Building Construction
STANTON WILLARD	Principal Architect, Standards

Design and Planning Service

P. T. POAGE	Assistant State Architect, Design and Planning
ROBERT M. LANDRUM	Chief Architectural Coordinator
ARTHUR F. DUDMAN	Principal Architect, Sacramento
JAMES A. GILLETT	Principal Architect, Los Angeles
CHARLES PETERSON	Principal Structural Engineer, Los Angeles

CARL A. HENDERLONG	Principal Mechanical and Electrical Engineer
CLIFFORD L. IVERSON	Chief Architectural Draftsman
GUSTAV B. VEHN	Supervising Specifications Writer
JOHN S. MOORE	Supervisor of Special Projects

Construction Service

CHARLES M. HERD	Chief Construction Engineer
CHARLES H. BOCKMAN	Assistant to Chief Construction Engineer

AREA CONSTRUCTION SUPERVISORS

THOMAS M. CURRAN	Area I, Oakland
J. WILLIAM COOK	Area II, Sacramento
CLARENCE T. TROOP	Area III, Los Angeles

AREA STRUCTURAL ENGINEERS  
SCHOOLHOUSE SECTION

MANLEY W. SAHLBERG	Area I, San Francisco
M. A. EWING	Area II, Sacramento
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9-39

During the latter part of August and the early days of September last year a series of disastrous fires devastated over 300,000 acres of California's forests and watersheds. To the people living in the mountain communities, fire's destructive power was a very real thing for they observed land resources, property, and equipment going up in smoke. To most of the people in valley cities, and metropolitan areas it was just another of those disasters that unfortunately occur. In these areas there was no immediate effect on business or community life and probably the only tinge of concern felt by many was a passing hope that the fires were not affecting a favorite recreational area or would not last long enough to interrupt the hunting trip for later in September. This is a perfectly natural feeling for too few people see too little of the State's surface structure to fully appreciate the State's complete interdependence and the relationship of the populated centers and rural valley farm lands with the mountain resources that are often hundreds of miles away. Few people have the opportunity to look behind the scenes at the interplay of human and natural resources that together are building the great economy of California.

Because there is no direct or immediate effect on local business or community life when a forest fire in a remote part of the State burns, few people realize that fire continues to eat into the very strength of the State. Fire impairs the holding capacity of a watershed, exposes soil to erosion, wipes out today's, as well as tomorrow's timber supply and directly affects the economy of adjacent communities so dependent on timber and recreational resources for their livelihood.

The serious impact of the fire losses of last year on the State's basic resources and on local and regional economy explains the reason for considerable public interest in preventing a similar catastrophe this year and in future years. Preventing wild fires before they start is certainly the first line of defense. Every man, woman, and child in California has a role to play and can accept an individual responsibility by being careful with the use of fire and those things which start fires while at home, when on the highways, and during work or recreational trips to the wild land areas.

