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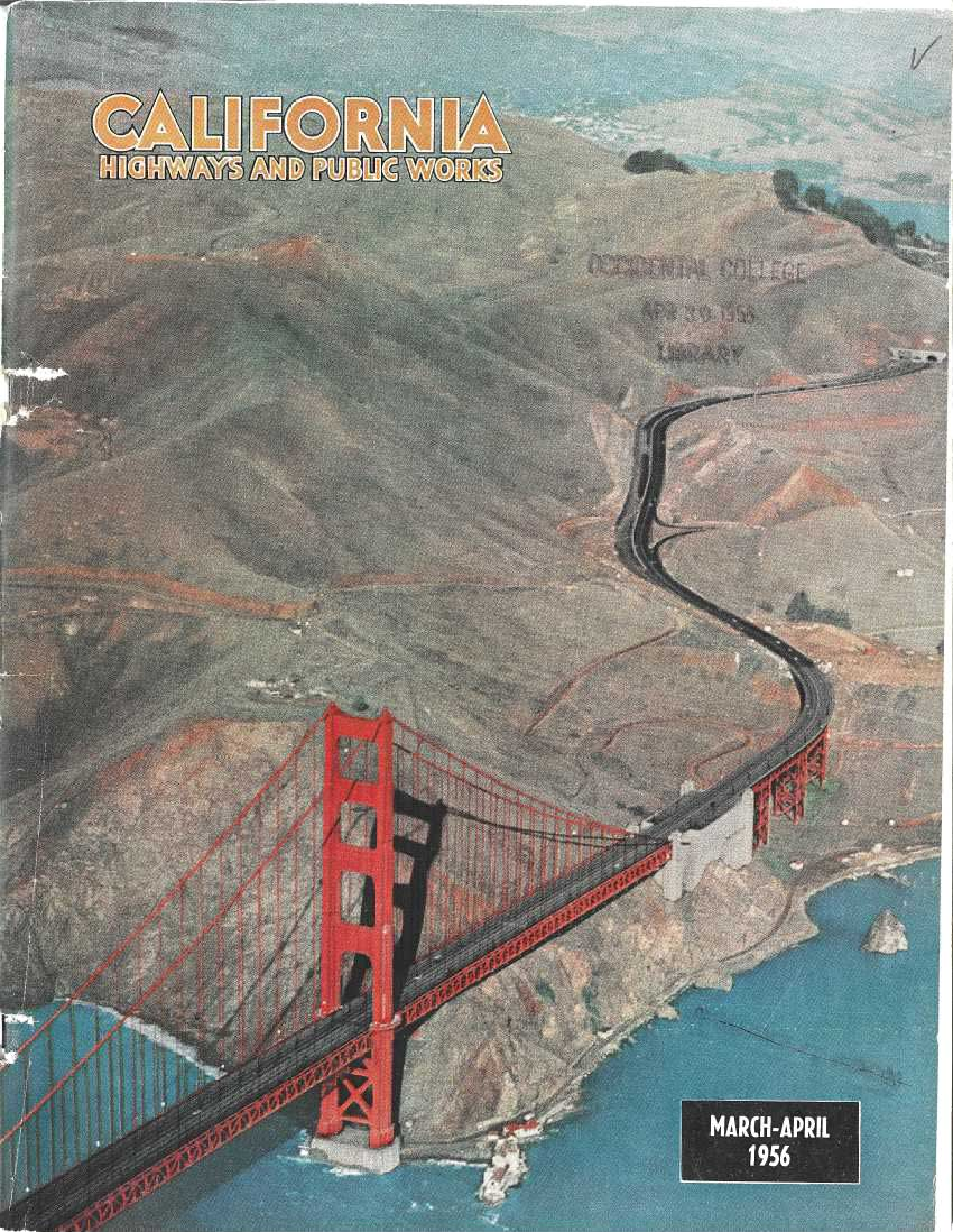
HIGHWAYS AND PUBLIC WORKS



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Freeways In District IV

By B. W. BOOKER
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Bay Area Network Is More Readily Evident

THE CHRONICLING of the development of the Bay area freeway system has followed the varied pattern of its construction. From the time of the opening of the first freeway section in 1947, as each small segment took form, articles appeared in various publications describing the planning and procedures which brought that section into being.

Although sometimes not apparent, these disconnected segments were part of an over-all plan. One might well have asked why the plan was not progressive in the sense of creating a continuous freeway, each completed segment extending the initial unit toward its ultimate destination. The answer is that priority of construction units have followed a logical pattern predicated on elimination of the worst deficiencies as quickly as possible within financial limitation. It was necessary to fit the construction program accordingly, and hence the disjointed aspects of the early stages.

Not until 1953, when various major projects were completed in the immediate metropolitan areas, did the plan unfold to a point wherein it was possible to treat the completed portions as an integrated development. Each year thereafter, it has been an interesting and pleasant task to record in this journal the progress of the preceding year, and to outline the program of current and future construction.

Complete System

In discussing the growth of the area's modern highways, one becomes conscious that the word "freeway" occurs with sometimes monotonous regularity. Actually, the goal is not merely to build this type of facility. The objective is to create a complete

B. W. BOOKER

system of all types of highways capable of moving people and goods rapidly, safely and conveniently between concentrations of population, at the same time affording similar service to dispersions along the routes. Since the main artery of such a system is the freeway, the name has become synonymous with modern highway development.

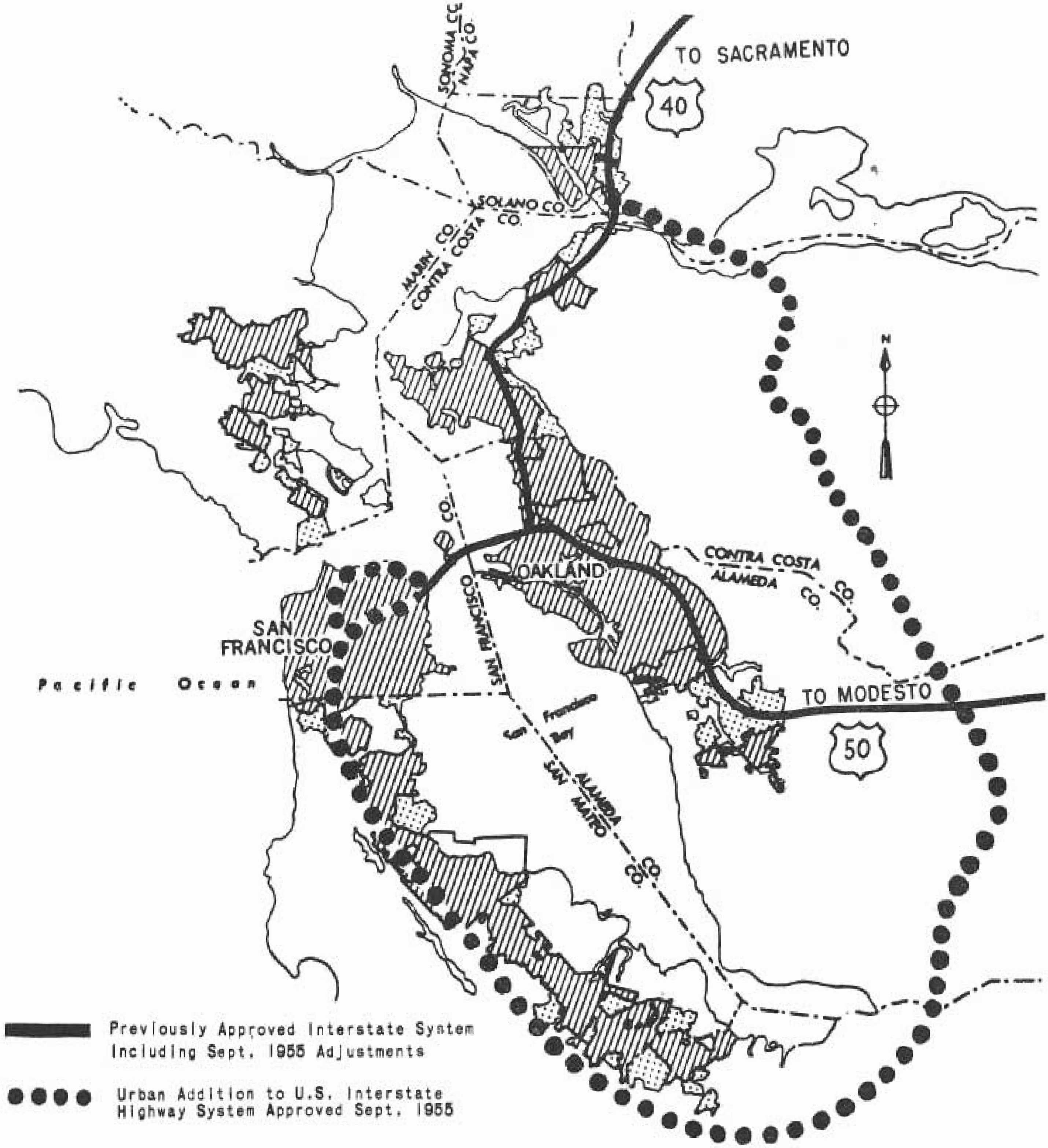
It would be difficult to imagine a modern public work upon which more people depend than that of motor transport and the roads upon which it operates. Affecting our daily programs and our manner of living as it does, it is to be expected that conflict of interests will arise in its construction and in its operation, and it follows that from such conflict will arise criticism. In the foreground of this criticism is the allegation that freeways are obsolete immediately after completion.

Logically, the fact that freeways are traveled to their maximum capacity is the reverse of obsolescence. It is conclusive proof that the freeway has accomplished its purpose. The advantages offered have drawn traffic from congested streets and roadways, the force of the attraction being limited only by the capacity of the facility. Pausing for a moment to reflect upon the rise of traffic volume since 1947, when the first section was opened, we can readily contemplate the complete strangulation of the area if the present freeways disappeared, and the system was returned to its pattern of that date.

Problem of Future

Obviously, the routes presently being constructed will not meet the needs of the future. It is equally obvious that we should not attempt to construct the ultimate development at this time. To do so would seriously delay initial correction of the numerous severe deficiencies throughout our highway system. Current construction does provide for additional lanes to be built when needed, and in one case, that of the Eastshore Freeway south of High Street, we are now constructing the additional lanes provided for in the original design.

However, the useful number of lanes which can be expected to operate efficiently is limited and studies are being made of new routes for area traffic distribution. Complicating such studies is the unusual geography of the area. Separated by the waters of the bay, the two great centers of population on the easterly and westerly sides must be served by virtually two systems, the integration of the sys-



tems being dependent upon crossings available. The cost and complexity of transbay facilities understandably limits their construction, thus creating restrictive controls in planning a balanced network.

New Major Routes

The year 1955 witnessed a significant step toward the creation of new major routes in District IV. As approved by Commissioner C. D. Curtiss of the U. S. Bureau of Public Roads, the National System of Interstate Highways was adjusted and augmented in the amount of 135 miles in the Bay area. These highways are eligible for substantial allocations of Federal Interstate System funds under the terms of legislation now being considered by the Congress.

Much of the routing added was already established as a part of the State Highway System and planning for the future development of these as freeways is generally well advanced.

Portions of the future freeway system in San Francisco are included in the addition but studies of the general location of these routes are not complete to date.

A major part of the addition is a 115-mile circumferential route around the San Francisco Bay area. This route begins at the south city limits of San Francisco and runs southeasterly, west and roughly parallel to US 101 (El Camino Real) then swings easterly in the vicinity of San Jose, veering northerly through central Alameda County and the San Ramon Valley in Contra Costa County to the Martinez-Benicia area, finally connecting with US 40 in Vallejo.

From San Francisco to San Jose, the proposed route would constitute a new highway not presently in the State Highway System. From a connection with Sign Route 17 west of San Jose, it follows the general location of State Sign Routes 17 and 21 as far as Benicia. A substantial portion of the East Bay route is in the planning stage, in design, or is currently under construction. The general location of the new route is shown on the accompanying map. It is apparent thereon that it will supplement the services of the present Bayshore Freeway on the San Mateo Peninsula as well as El Camino Real and the various local arterials accommodating both the through and many of the local traffic desires. Likewise, on the East Bay side, it will supplement the Eastshore Freeway and the transcontinental US 40, serving through traffic and the expanding local traffic of central Alameda and Contra Costa Counties along the way.

Sixty-three Construction Projects

As of March 1, 1956, District IV had a total of 63 construction projects under way. Twenty-seven of these involved development of the freeway network.

Seventy-one miles of new freeway construction were included in the work under progress. Budgeted and not yet started are another 27 miles of freeway improvement. After completion of the 1956-57 Fiscal Year construction program, a total of 250 miles of freeway will be in service in this district.

The district is currently operating under a program of $61,647,000 for construction and right of way in the 1955-56 Fiscal Year and $59,172,000 in the 1956-57 Fiscal Year. In addition, contracts under way as part of the Carquinez toll facility project amount currently to $28,834,000, of which $20,877,000 represents work located in District IV.

Status of District IV freeways is indicated on the accompanying map. Development of this network of modern arterials of safe, convenient and rapid transportation is becoming more and more apparent as the fruits of previous years of planning and endeavor are rapidly being transformed from blueprints to realities, commensurate with the availability of funds for highway construction.

Highlights of Progress

Highlights of the progress of these transformations during the past 12 months together with mention of projects financed but not yet under construction are indicated in the following excerpts from activities on our various freeway routes.

BAYSHORE (JAMES LICK FREEWAY AND SKYWAY)

Several additional units of this freeway were placed into service during the past 12 months.

Except for a short portion southerly of Third Street which will be completed in conjunction with the "open water" fill relocation now under way south of the city limits, all of Route 68 within the city has now been completed as a full freeway.

Traffic now traverses this six- and eight-lane Skyway from Third Street near the south city limits directly to the San Francisco-Oakland Bay Bridge.

Skyway service is also provided via a portion of the Central Freeway along 13th Street from the Division Street Interchange toward the Golden Gate Bridge. It presently terminates at South Van Ness Avenue and Mission Street.

The completed Skyway has already been a boon to both intracity and intercity traffic. With the completion of the part of the Embarcadero Freeway from the Bay Bridge to the Broadway Tunnel, portions of which are now financed or under way, effective distribution of Skyway traffic within the downtown San Francisco area will be accomplished.

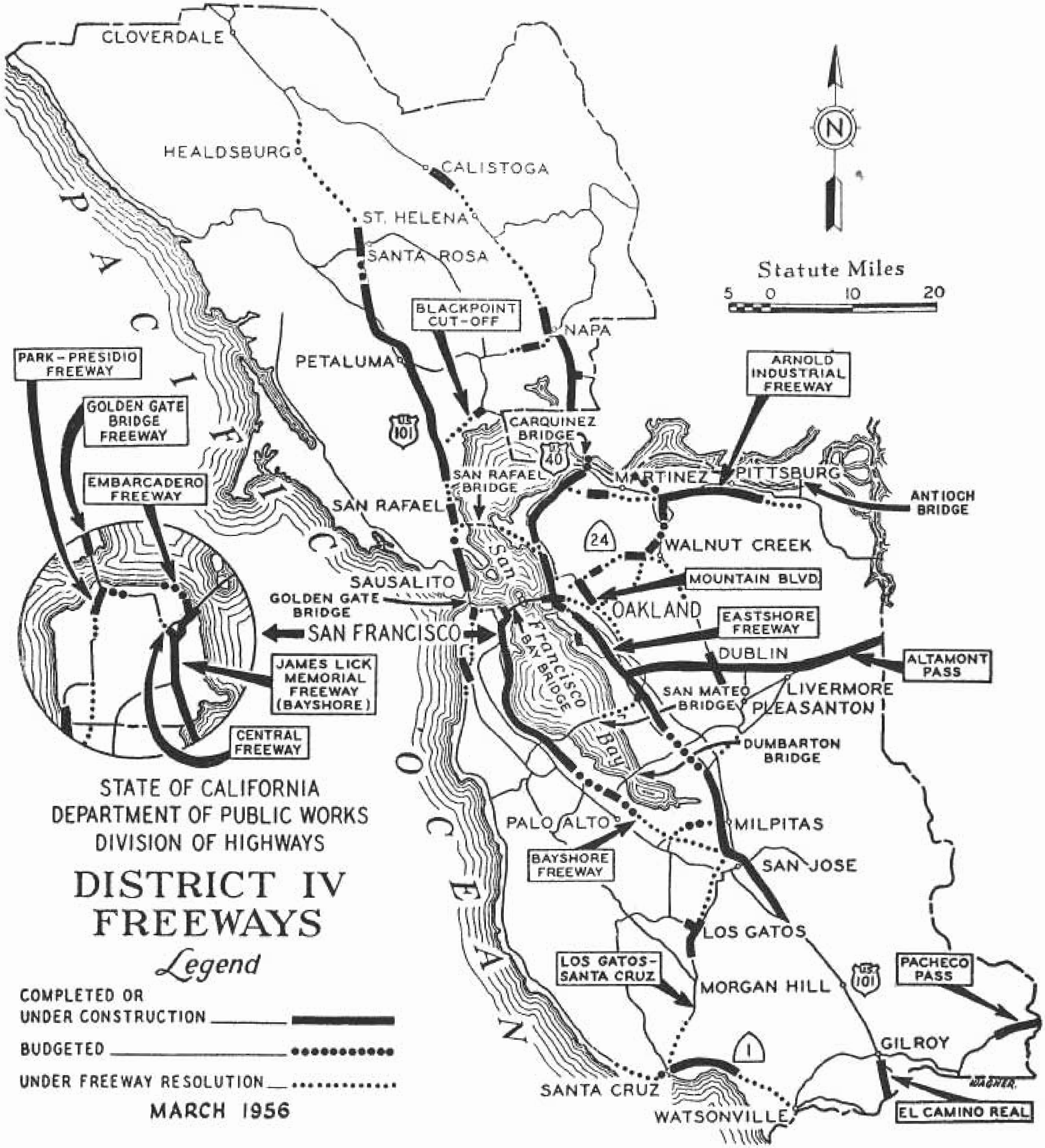
More and more use of the Skyway is being made for mass transit through the scheduling of busses destined for areas as far from downtown as Lake Merced.

Some 110,000 vehicles traverse the Skyway daily. All of these users are afforded a scenic, awe-inspiring panoramic view of the San Francisco skyline previously unseen by the multitudes of vehicle users who traveled the low level congested city streets.

The unit between Hester Avenue and Alemany Boulevard was started in June, 1953, and completed in September, 1955. Contractor on this $2,400,000 project was Charles L. Harney, Inc. This project is the southernmost part of the completed freeway in San Francisco and has practically eliminated the severe congestion at the Third Street intersection as well as along the old Bayshore Boulevard during peak hours. This will be further improved in the future when traffic will be routed over the Third Street Interchange and across the open water fill project to the south. This will be effected upon completion of the latter project presently contemplated for mid-year 1957.

The $3,900,000 unit from Eighth Street to Fourth Street which was started in October, 1953, was completed in July, 1955. This was also constructed by Charles L. Harney, Inc., and is 0.7 mile long.

The project from Fifth Street to Third Street was constructed by Eaton and Smith at a cost of $900,000. This was started in May, 1954, and completed in July, 1955. It connects the Skyway with the San Francisco-Oakland Bay Bridge and also will serve as a part of the connection to



the Embarcadero Freeway, construction of which is now under way.

CENTRAL FREEWAY

The first portion of the Central Freeway was placed in service during the past year with the completion of three projects by Charles L. Harney, Inc. This freeway is also on an elevated structure and is a part of the Skyway.

The unit along 13th Street from the Division Street Interchange to South Van Ness Avenue and Mission Street provided Central Freeway service to and from the south. It was started in

July, 1952, and completed in March, 1955. It consisted of two contracts, one for the substructure and footings, the other for the superstructure. The unit connecting the Central Freeway with the Skyway and Bay Bridge was started in June, 1952, completed in April, 1955. All three projects amounted to one mile in length and cost $5,000,000.

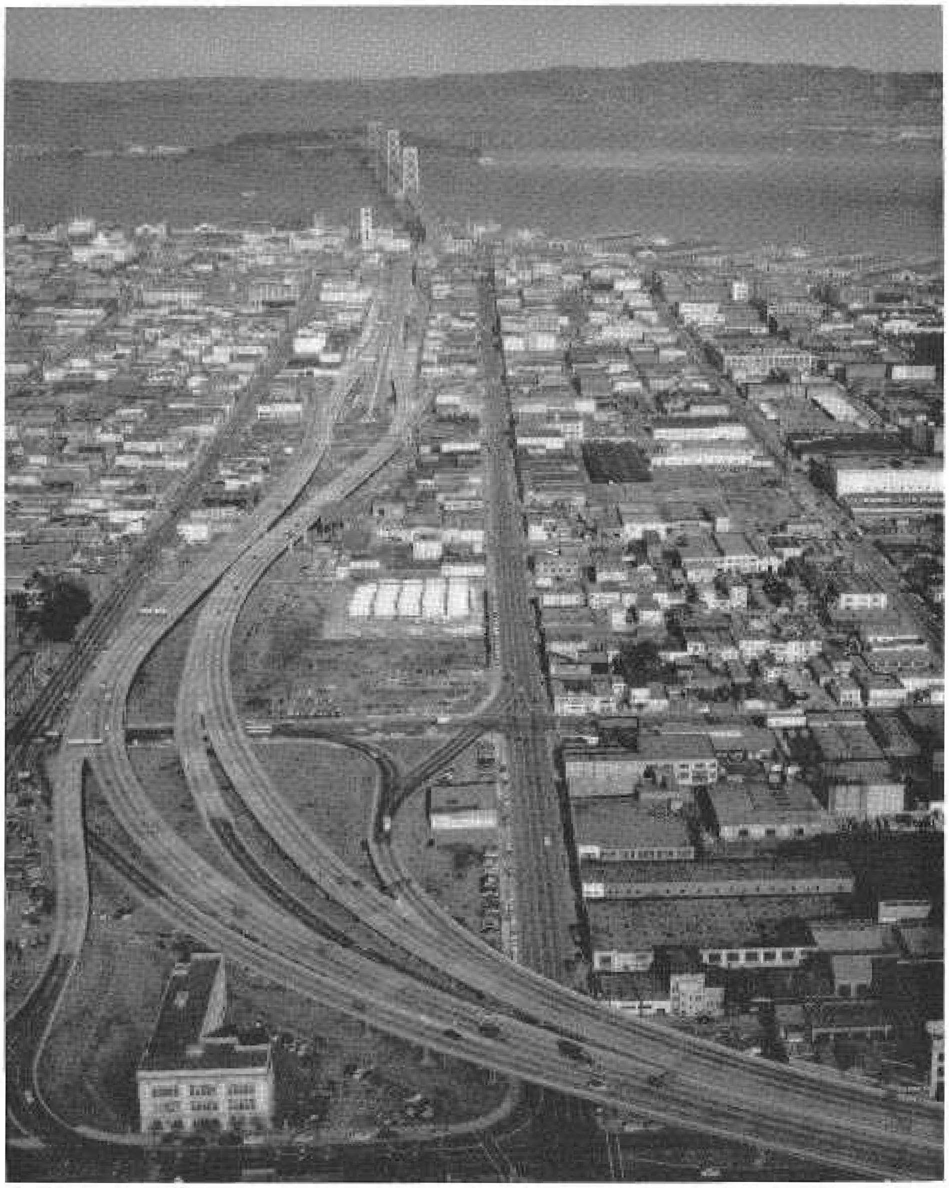
Plans are nearing completion for the continuance of this freeway from South Van Ness Avenue to Turk Street, a distance of approximately 1.1 miles. Right-of-way acquisition is now under way. This future unit, like the rest of the Skyway, will be elevated viaduct, but will be a two-level facility. Three southbound lanes will be elevated over the three northbound lanes and all will be elevated over the existing city street system, with most streets remaining open.

EMBARCADERO FREEWAY

Construction of the first project on this multilane elevated freeway was started in May, 1955, and is now in progress. This work is being performed by MacDonald, Young and Nelson, and Morrison, Knudsen Co., Inc., at our estimated cost of $5,600,000. It is 0.9 mile long and will provide a connection between the Skyway and Mission Street at Main and Beale Streets. The Oakland bound movement and the extension of the freeway to Howard Street is estimated at $2,000,000 and is now under way under a contract with C. L. Harney, Inc. Plans for the continuance of this freeway past the Ferry Building to Broadway are virtually complete and it is expected that a contract will be advertised in May of this year. This will complete the total of 1.5 miles between the Bayshore, Bay Bridge and Broadway. It is planned to eventually extend this freeway to a connection with the Central and Golden Gate Freeways near Lombard Street. Studies are in the early stages at present and the location for this future development has not been determined.

SOUTHERN FREEWAY

With virtual completion of the Bayshore (James Lick) Freeway in San Francisco, and as the most needed units of the Embarcadero and Central Freeways are now in design and construction stages, planning has been directed to other near future segments of the much needed integrated San Francisco system.



James Lick (Bayshore) Freeway in San Francisco toward Bay Bridge; Seventh and Eighth Street ramps in lower center; Fourth and Fifth Street ramps in center

To this end, preliminary reconnaissance studies have been completed covering the Southern Freeway which begins at the south city limits near Junipero Serra Boulevard and traverses generally on relocation along the Southern Pacific Railroad roadbed and Alemany Boulevard to the Alemany Interchange on the Bayshore Freeway. This location has been presented to the public in a recent meeting held for informational purposes. The Highway Commission held a public hearing on the proposed location on April 6, 1956, in San Francisco.

The City of San Francisco is well advanced with their plans for the extension of the Southern Freeway from the Bayshore-Alemany Interchange to a junction with the proposed Southern Crossing and Embarcadero Freeway in the vicinity of Third and Army Streets.


RIGHT—First stage of Embarcadero Freeway construction; Bay Bridge approaches left.
LEFT—Embarcadero Freeway construction showing connection to Main and Beale Streets.

GOLDEN GATE FREEWAY

Included in the 1956-57 Freeway Construction Program is the amount of $3,900,000 for the revision of the interchange between the Golden Gate and Park Presidio Freeways at the south approach to the Golden Gate Bridge. This 1.3-mile project will add two more lanes to the Golden Gate Freeway between the Park Presidio Freeway and the Marina approach resulting in a total of eight lanes as well

LEFT—Construction scene on Bayshore Freeway, looking south from Third and Bayshore Interchange in San Francisco toward Sierra Point. RIGHT—Open water fill for Bayshore Freeway across Candlestick Cove. Grading operations at Sierra Point in foreground.


as revising the ramp connections accordingly. This project should be under construction by the end of this year.

BAYSHORE FREEWAY, SAN MATEO COUNTY

The over water fill section between the completed freeway at Third Street in San Francisco southerly to Candlestick Point and across the open water of an arm of San Francisco Bay to Sierra Point and connecting with the completed freeway near Butler Road, in South San Francisco is the only portion of the freeway remaining to be completed between the Bay Bridge and just north of Redwood City. With the exception of this remaining link, construction of which is now under way, the entire 25 miles can now be traveled on a full six-lane freeway to Alemany Interchange and on eight lanes to the bridge.

When completed in 1957, this project will afford six lanes of full freeway with provisions for eight lanes in the future. The present six-lane highway will continue to serve adjacent property and as an entrance into the city.

A saving of as much as 20 minutes of travel time in one direction will be realized by the great number of commuters who twice daily traverse this route.

On the north end of this unit, construction was performed by Edward Keeble. The contract was for grading and structures between Third Street and Candlestick Point. This $700,000 project is 0.7 mile long, and was completed in October, 1955. Paving will be done upon completion of the remaining portion of the grading and structures of the over water fill unit.

Over Water Project

From Candlestick Point southerly, work was previously completed on two contracts for filling experimental sections of embankment, displacing the highly fluid bay mud which reaches a maximum depth of 70 feet. The first job extended 0.3 mile southerly from Candlestick Point. It was performed by Edward Keeble and amounted to $160,000. The second experimental fill, 0.4 mile long, was not contiguous to the first one. It was performed farther south in the Bay where the mud depth was greater. This job was done by Guy F. Atkinson and cost $860,000. The fill closing the gap between the two experimental fills was started in April, 1955, and completed in February, 1956. John Delphia performed this 0.8-mile job at a cost of $400,000.

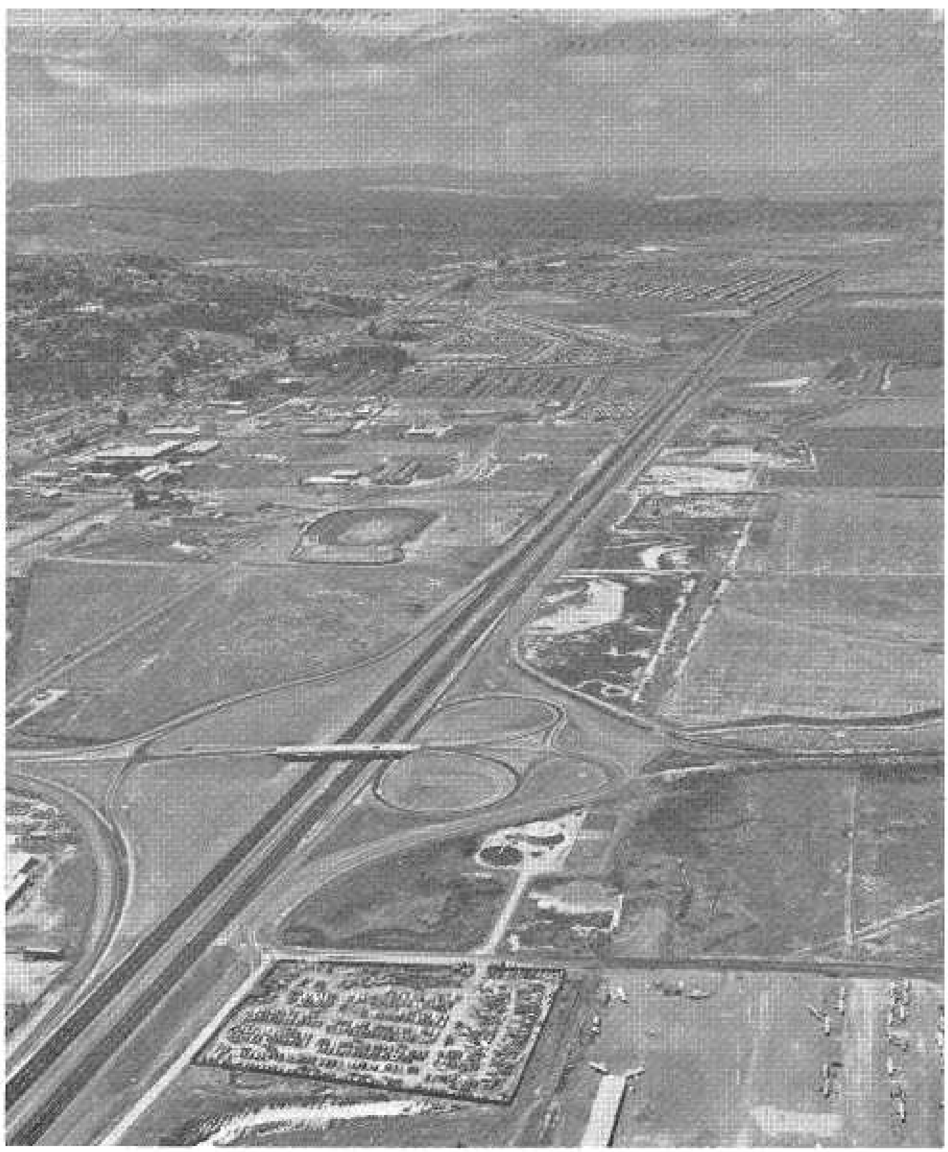
Continued progress has been made by the Guy F. Atkinson Co. over the remaining portion of the grading and structures in this unit of the freeway. This work is comprised of two contracts, one of which was completed in October, 1955. Construction totals $3,800,000.

The last project in this unit, the paving of this 3.6-mile link in continuous freeway is included in the 1956-57 Fiscal Year construction program and will be advertised for bids this summer.

BAYSHORE FREEWAY, SAN MATEO TO SANTA CLARA COUNTY LINE

After this next year's construction progress is completed, the entire Bayshore Freeway in San Mateo County will have been completed. In June, 1955, the Piombo Construction Co. completed the initial six-lane future eight-lane freeway between 16th Avenue in San Mateo and Bransten Road near the San Carlos-Redwood City limits. This project was started in July, 1953, and cost $4,100,000. It eliminated many serious points of

Bayshore Freeway, showing completed portion at Holly Street in San Carlos, northerly to San Mateo



traffic conflict and provides interchange for local traffic distribution at 19th Avenue in San Mateo, East Hillsdale Boulevard further south, Ralston Avenue in Belmont, and Holly Street in San Carlos.

The remaining eight miles of freeway from Bransten Road to south of the Santa Clara County line is composed of four projects. Three of these amount to $7,000,000 and are included in the 1956-57 construction program. Construction will commence about July of this year. The other project, the Willow Road Interchange, is nearing completion at a cost of approximately $850,000. L. C. Smith Company is contractor on this project which started in May, 1955. It is now in use by traffic and eliminates the most congested intersection on the Bayshore Highway.

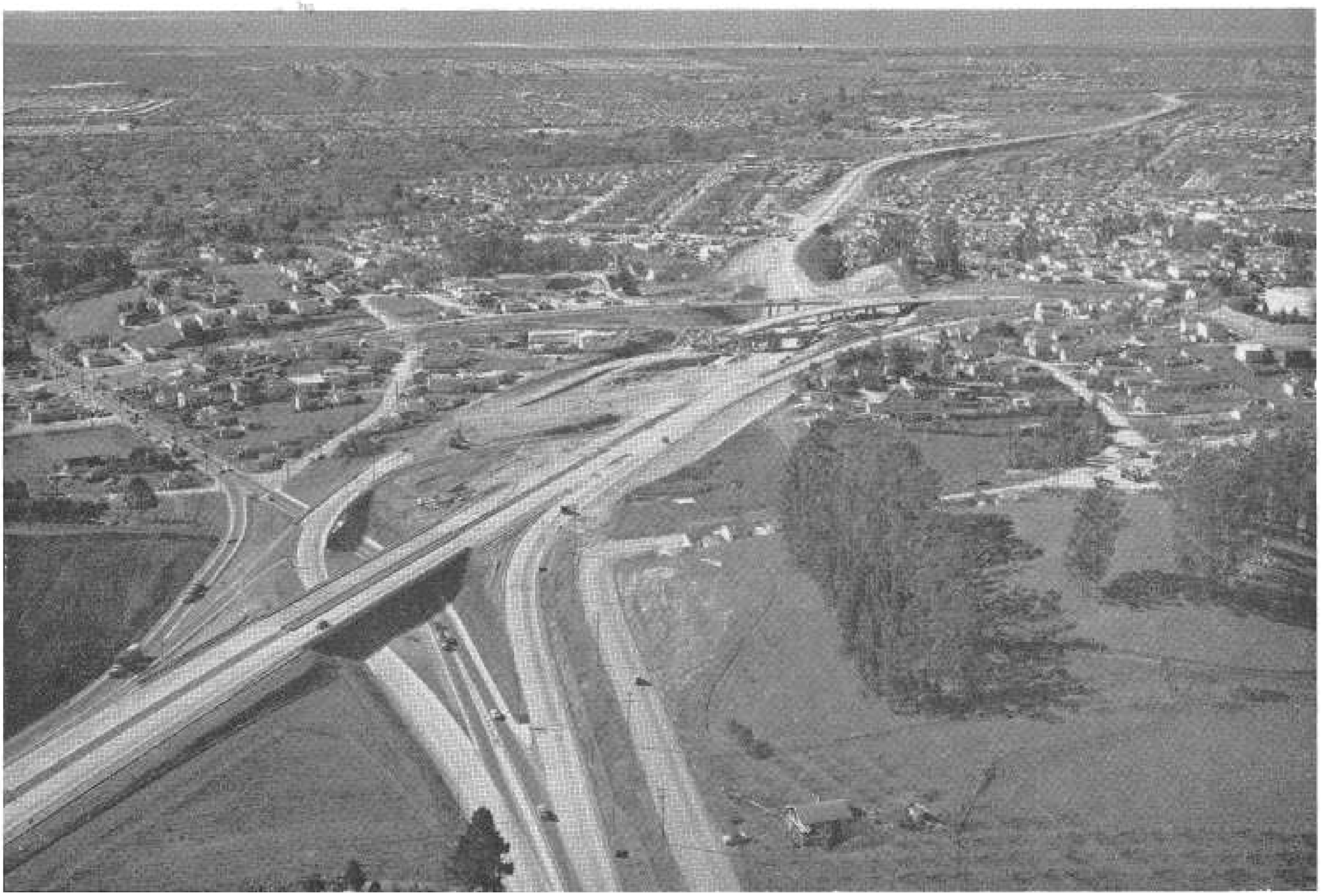
SKYLINE BOULEVARD, SAN MATEO-SAN FRANCISCO COUNTIES

In December, 1954, a 2.3-mile portion of expressway on Skyline Boulevard between Edgemar Road and Alemany Boulevard was placed in service. Plans have been completed for the future relocation for Sign Route 1 as an expressway from Edgemar on the coast to connect with the Skyline Boulevard expressway at Edgemar Road. Actual construction is dependent on availability of funds.

In July, 1955, continuation of the expressway northerly of Alemany Boulevard 1.3 miles to the south city limits of San Francisco was started under a contract awarded to Charles L. Harney, Inc. This project cost approximately $350,000. Concurrently, also under construction by Charles L. Carney for the City of San Francisco has been the 1.0-mile portion north of the city limits to Lake Merced Boulevard, also as an expressway and costing $350,000. Both projects were opened to traffic on March 15, 1956.

These Skyline Boulevard projects provide another major connection to and within San Francisco from the rapidly developing residential areas in

Willow Road Interchange on Bayshore Freeway, looking north



US 50 Interchange at Foothill Boulevard. Route 228 connection to Eastshore Freeway in background.

San Mateo County along the skyline and coastal routes.

EASTSHORE FREEWAY, ALAMEDA COUNTY

The two remaining unconstructed projects of the Eastshore Freeway between San Jose and Oakland are now contracted or financed. When these projects are completed, a total length of 38 miles of continuous freeway will be in service.

The nine-mile unit from Warm Springs to Beard Road north of Centerville is included in the 1956-57 Fiscal Year construction program. It is expected that this $6,000,000 initial four-lane, future six-lane freeway will be advertised in May, 1956, with construction starting in June.

The 5.8-mile portion from Beard Road northerly to Jackson Street in Hayward is being constructed by Gordon H. Ball and Ball & Simpson at a cost of $4,600,000. This is also an initial four-lane, future six-lane freeway. Besides interchanges at each end of this project local traffic distribution will be provided by interchanges at Alvarado-Niles Road, Whipple and Alquire Roads, and Tennyson Road.

Work has now started on the addition of two lanes to the existing four-lane portion of the Eastshore Freeway between Route 228 and High Street in Oakland. Work on this $2,000,000 project is being done by Fredrickson & Watson Construction Co. As is generally done in freeway design, provision was made in the original plans for the addition of the two lanes in the center median width. Provision was also made in the original structures for the present expansion and very little loss of original construction is involved. The funds which would have been required for the two lanes at the time of original construction were more effectively used for extending the freeway further south from Lewelling Boulevard to Jackson Street which resulted in considerably earlier traffic service to the area.

The two additional Eastshore Freeway lanes are now required in conjunction with the completion of the connection from the Eastshore Freeway at Lewelling Boulevard to US 50 and Foothill Boulevard near Hayward which will add more traffic to the already heavily traveled existing four-lane freeway. This $2,900,000 project is 2.9 miles long and is expected to be completed in early summer of this year. The work is being performed by Ball & Simpson, Erickson, Phillips and Weisberg. It is to be a four-lane freeway.

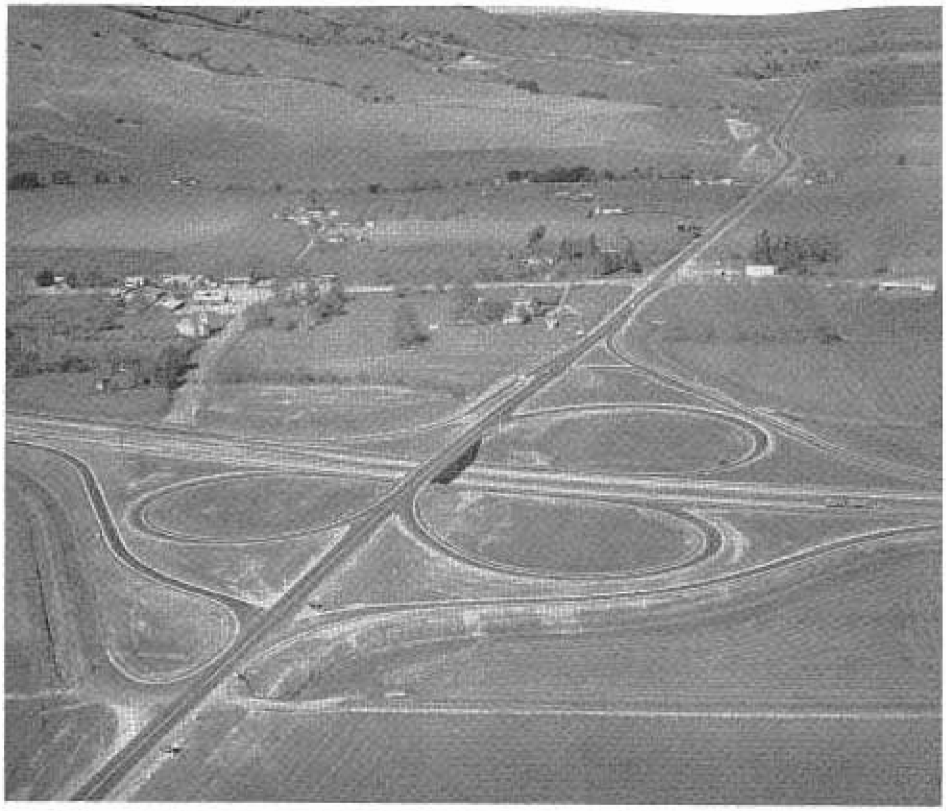
EASTSHORE FREEWAY, OAKLAND

The only portion of the Eastshore Freeway in Oakland remaining to be financed is the 0.9-mile unit from Fallon Street to Market Street.

In September, 1954, Fredrickson & Watson Construction Company, and M & K Corporation started constructing the unit from Market Street between Fifth and Sixth Streets to Eleventh and Cypress Streets. This elevated, eight-lane freeway was completed in October, 1955, and cost $1,700,000 for the 0.8 mile.

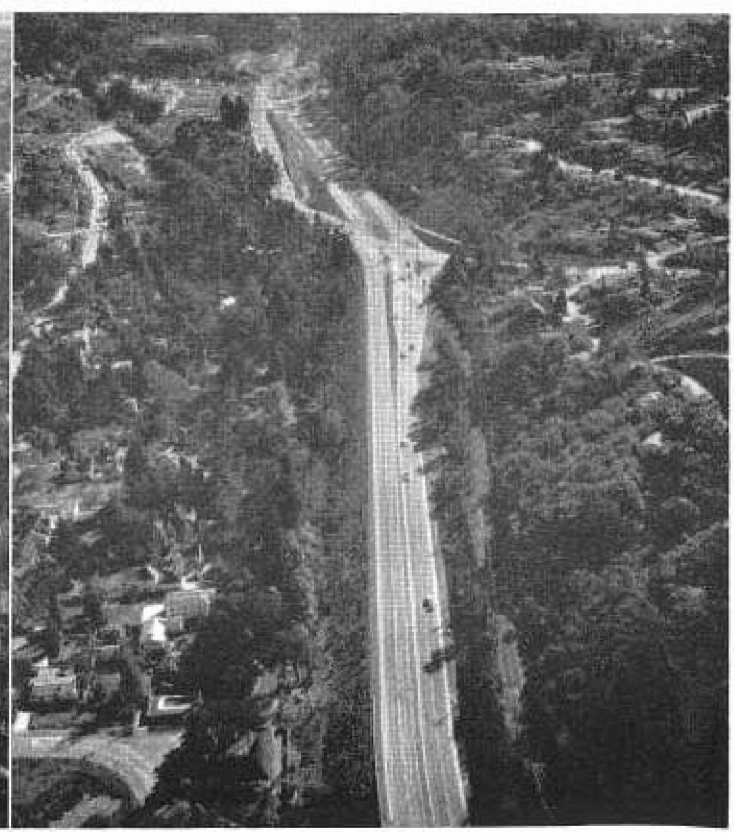
The remaining 1.4 miles from the foregoing project to the distribution structure is now under construction in the two separate contracts with Grove, Shepherd, Wilson & Kruge of California at an estimated total cost of $8,700,000. This section will be an eight-lane double-deck viaduct with opposing traffic carried on different levels.

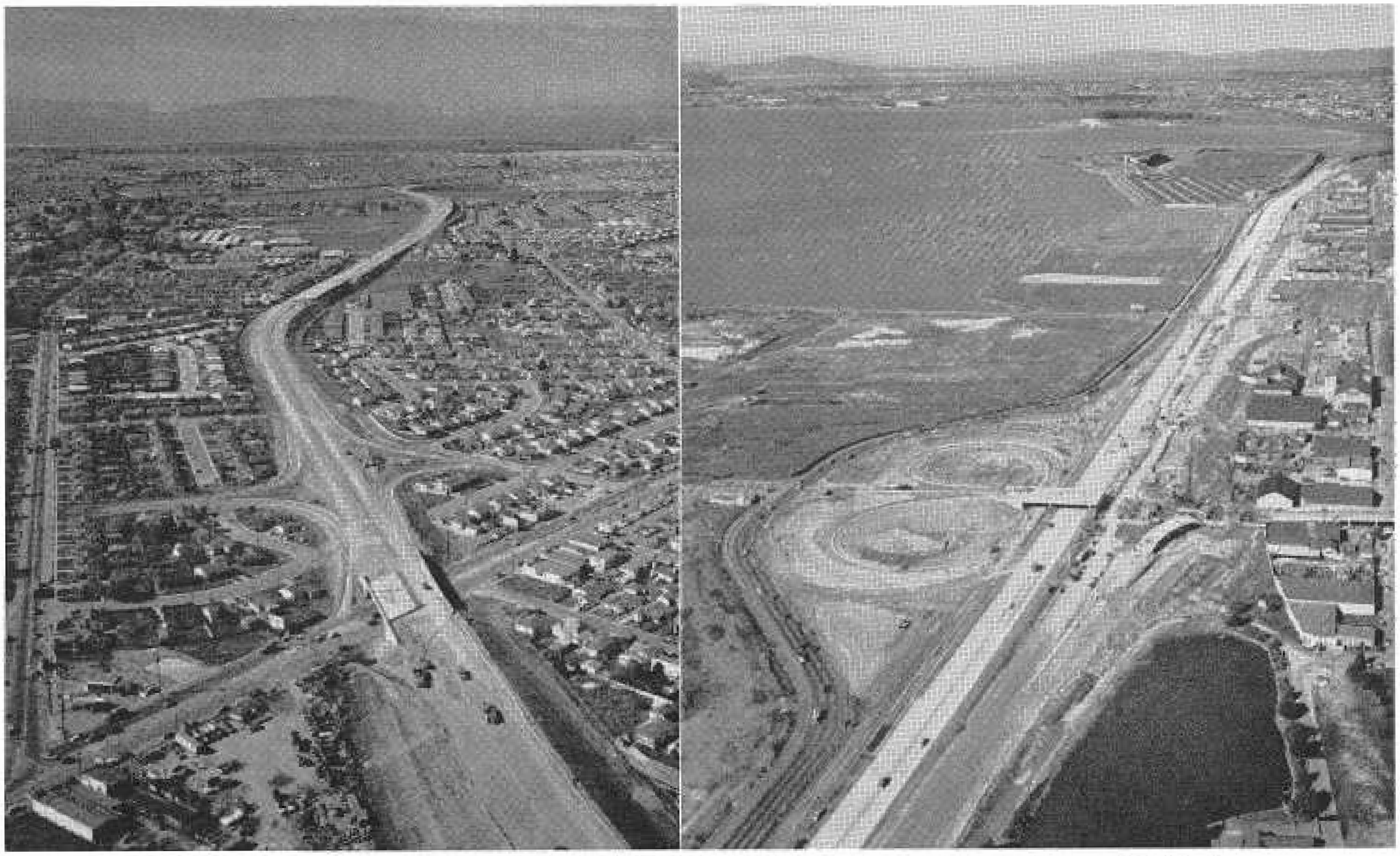
The $4,500,000 contract expanding the distribution structure at the east approaches to the Bay Bridge was completed in October, 1955. This project expanded the original structure which had been carrying a volume of 120,000 vehicles per day. The



Dublin Interchange looking north; showing two-lane freeway recently constructed with provision for future four lanes northerly to Contra Costa county line

LEFT—Mountain Boulevard. Freeway under construction; LaSalle Avenue Overcrossnig in center; Park Boulevard Interchange ahead. Existing street to left to be utilized as frontage road. RIGHT—Mountain Boulevard Freeway, completed portion to Moraga-Thornhill Intersection in foreground; construction from Moraga-Thornhill to Park Boulevard in background.





LEFT—East 14th Street Interchange, looking toward Eastshore Freeway. Through planning, development of area provided for freeway prior to construction. RIGHT—Eastshore Freeway, University Avenue north.

expanded facility will now effectively handle double the present traffic without congestion. Cross weaving of traffic necessitated on the original structure has been eliminated. The entire facility is a five-level one which provides three levels of highway movements on top of two levels of railroads which are also separated.

North of the distribution structure along the shore line of Berkeley and Albany to El Cerrito Overhead the eight-lane freeway is rapidly nearing completion. In 1954 it was completed from the distribution structure to northerly of Ashby Avenue.

From Ashby Avenue to El Cerrito Overhead, Peter Kiewit Sons Company, who had constructed the unit to the south, continued the freeway improvement. This project cost $4,800,000 and was completed in September, 1955.

The foregoing project did not include paving and structures for the 1.6 miles between University Avenue and El Cerrito Overhead. Stolte, Inc., and Gallagher & Burk, Inc., are contractors for this remaining $2,250,000 job which started in January, 1955, and which is expected to be completed in July, 1956.

US 40

The entire 12.5 miles from Jefferson Avenue in Richmond to the new bridge across the Carquinez Straits at Crockett are now under construction. The improvement will be an initial six-lane freeway with provision for future eight lanes north of Richmond. A separate and new bridge is to be constructed across the Carquinez Straits east of the existing bridge. This bridge will provide for four lanes of northbound traffic. The existing bridge will be maintained and used for southbound lanes.

Northerly of the city limits of Hercules near the Arnold Industrial Freeway intersection, the improvement is being financed by special toll bridge bonds. Southerly of that point, the project is financed from regular state highway user funds.

From Jefferson Avenue in Richmond to County Road 24 north of Rollingwood, Fredrickson & Watson Construction Company and M & K Corporation are the contractors. Construction began in November, 1954, and it is expected that this 4.8-mile project will be completed in the fall of 1956 at a cost of $5,400,000.

The toll financed projects in this district including the bridge, a portion of which is in District X, are as follows:

Contracts Under Way Description	Estimated construction cost
N. of N. C. L., Hercules to Crockett Road, 2.9 miles Contractors—Ferry Bros., John M. Ferry, Peter L. Ferry, L. A. and R. S. Crow	$7,829,000
Crockett Interchange and approach ramps Contractors—Peter Kiewit Sons Company	5,090,000
Carquinez Bridge substructure Contractors—Mason & Hanger, Silas Mason Co., Inc. and F. S. Rolandi, Jr.	5,942,000
Carquinez Bridge superstructure Contractors—United States Steel Corp.	9,973,000

UPPER—Completed portion of Eastshore Freeway from Market to 10th. Remaining portion from 10th to Distribution Structure shown left to right in center of photograph. LOWER—Eastshore Freeway northerly; Jones Avenue in foreground; Hegenberger Road beyond.

McCammon-Wunderlich Contracting Co. are the contractors for a $7,400,000 project from south of County Road 24 to the toll bridge projects north of Arnold Industrial Freeway. This unit is 4.9 miles in length.

An outstanding feature of the south approaches to the bridge is an earth cut to be made just south of Crockett. This cut will be 245 feet deep on center line. Approximately 8,500,000 yards will be removed. It is the largest cut ever undertaken by the California Division of Highways. Details of the project were covered in Mr. Hollister's article in the January-February issue of *California Highways and Public Works.*

Interchanges providing local traffic service along the route north of County Road 24 will be at County Road 24 (Hilltop Drive), Appian Way (Maloney Road), Alhambra Valley Road (Pinole Valley Road), Arnold Industrial Freeway, Willow Road, future county road (near Tormey), Crockett.

US 50, FOOTHILL BLVD., AND MacARTHUR FREEWAYS

In 1954, a 1.5-mile portion of this four-lane future six-lane freeway bypassing Castro Valley was completed. To the west, the 2.9-mile freeway connection to the Eastshore Freeway is under construction. That project was discussed hereinbefore in conjunction with the Eastshore Freeway.

East of Castro Valley, a $4,600,000 project is now under construction. This job begins west of Center Street in Hayward and ends at the completed freeway 2.3 miles west of Dublin. Peter Kiewit Sons Company is the contractor on this project which started in October, 1955. When this unit is completed a continuous freeway or expressway will be in service for the 51 miles between Tracy and Oakland via US 50 and the Eastshore Freeway.

From Castro Valley north, another freeway will eventually be constructed through Oakland to the distribution structure at the east approach to the Bay Bridge. To this end, planning and design are now under way, and a location for the MacArthur Freeway along MacArthur Boulevard between the distribution structure and Park Boulevard, approximately 3.5 miles, has been adopted by the California Highway Commission. Acquisition of rights of way has already commenced.

This additional freeway will serve US 50 and adjacent local traffic, much of which now uses the Eastshore Freeway as an entrance into and through Oakland. It will also effectively serve the future heavy residential developments contemplated through the areas served by this route.

MOUNTAIN BOULEVARD

This improvement in the City of Oakland when completed will provide 9.3 miles of full freeway from Sign Route 24 near Lake Temescal following the general route of Mountain Boulevard to a connection with Foothill Boulevard (US 50) near San Leandro.

Joint Highway District No. 26 was dissolved in July, 1954, but the County of Alameda and City of Oakland have agreed to continue to finance a total of $300,000 per year matching a like contribution by the State toward the continued improvement of this freeway through the Oakland hills.

Two projects were placed under way on this route during the past year. These supplement the previously completed portion which extends from north of Broadway Terrace to south of the Moraga Thornhill intersection, a distance of 2.3 miles.

One of the projects is being constructed by Charles L. Harney. It covers the 1.3 miles between Thornhill Drive and Ascot Drive. Cost is estimated at $1,250,000. Completion is expected in mid-summer of this year. Included in the project are the La Salle Street Overcrossing and the Park Boulevard Interchange. Provision is made in the latter design for the connection of the Shepherd Canyon Freeway into Moraga which will junction with Mountain Boulevard Freeway at this point in the future.

The other project amounting to approximately $130,000 was the Lincoln Avenue separation which was constructed by Stolte, Inc., and Gallagher & Burk, Inc., and completed in December, 1955.

Continuation of this facility to the south is contemplated as rapidly as availability of state, county and city contributions will permit.

OAKLAND-WALNUT CREEK-MONUMENT

Accelerated development through the northern half of Contra Costa County is continuing. In the past, congestion along the highways servicing the areas had been rapidly approaching a condition which could seriously affect the continuance of this rate of development. Material progress has been made toward alleviating this condition.

In March, 1955, a 1.2-mile section of initial six-lane future eight-lane freeway consisting principally of the Orinda Interchange was completed by Fredrickson & Watson Construction Company at a cost of $1,500,000.

Route 69 Freeway through Richmond; Macdonald Interchange lower center and San Pablo Avenue Interchange in center

TOP- Distribution Structure from Bay Bridge toll plaza east. LOWER—Distribution Structure in Oakland looking east; three levels of highway structure over two levels of railroad.

Further east a 2.8-mile Lafayette By-pass project was started in September, 1955. It will result in a full freeway by-passing the town to the north and allows the existing highway to remain as a high standard uncongested local arterial servicing the needs of the rapidly growing Lafayette community. Work is being performed by Gordon F. Ball. Construction will cost $3,300,000.

Also under construction is the Pleasant Hill Road Interchange at the east end of the Lafayette By-pass. This project, like the Orinda Interchange, will afford effective relief to a seriously congested intersection. Contractor on this $1,300,000 job is Stolte, Inc., and Gallagher & Burk, Inc. Completion is expected in midsummer, 1956.

From the Pleasant Hill Road Interchange to the vicinity of the north city limits of Walnut Creek, plans are nearing completion and right-of-way acquisitions are under way. This future unit will by-pass Walnut Creek to the west.

Northerly of Walnut Creek from Oakland Boulevard to 0.3 mile north of Monument a $2,900,000 unit of the freeway is also under contract to Stolte, Inc., and Gallagher & Burk, Inc. This unit is a part of the recent addition to the Interstate Highway System. Work started in October, 1955, and is 25 percent complete. Completion of this unit will afford relief to the 27,000 vehicle drivers and their passengers now using the existing two-lane highway daily.

MONUMENT-MARTINEZ-BENICIA BRIDGE

Preliminary studies have been completed for the southern approaches to the Martinez-Benicia Bridge. Construction of this freeway as a toll facility, the financing of which is in conjunction with the Carquinez Toll Bridge project now under way, was authorized by the Legislature in 1952.

The legislation sanctioned a toll facility from Arnold Industrial Freeway south of Martinez to a connection with State Highway Route 74 in Benicia. South of Arnold Industrial Freeway, the proposed facility will be financed from regular state highway funds.

Public hearings by the commission were not deemed necessary by Contra Costa County and the City of Martinez. The Highway Commission has announced that in its March meeting, adoption of the route as proposed between Route 75 north of Monument to the Solano county line, a distance of 7.5 miles, will be considered. The proposed improvement is a part of the recent additions to the Interstate Highway System which is further indication of the importance of this additional major north-south regional and interstate arterial.

WALNUT CREEK-DUBLIN

In 1955, the California Highway Commission adopted a route for the extension of the Central Contra Costa Freeway System from Walnut Creek to south of Danville. This four-lane future six-lane full freeway will be on relocation through the hillsides east of San Ramon Creek and outside of the beautiful Orchard Valley. Design and right-of-way acquisition have been in progress during the past year.

Further south, 2.2 miles of initial two lanes of a future six-lane freeway were constructed between the Contra Costa-Alameda county line to south of US 50 at Dublin. This project was under contract to Fredrickson & Watson Construction Co. It cost $550,000 and was completed in November, 1955. Included in the contract was a full interchange with US 50 south of Dublin which eliminated a serious at-grade intersection between these two important routes.

All of this route is included in the recent additions to the Interstate Highway System.

DUBLIN-MISSION SAN JOSE

Other activity on this interstate highway route occurred in January, 1955, when the California Highway Commission adopted a route for the future development of a four-lane freeway between Mission San Jose and Sunol. Location will be along the general location of the existing highway with substantial reductions in grade over Mission Pass. Design studies are presently under way.

LOS GATOS-SANTA CRUZ

Congestion relief to areas outside of the immediate metropolitan sphere is also underway in the Los Gatos area. Here, a 2.1-mile freeway is being constructed on a bypass of this critically congested city and when completed, the freeway will remove the large volumes of through traffic from the local street system thereby leaving the latter for the orderly functioning of local activities.

Completed in November, 1955, was a $370,000 contract for a bridge at Main Street on this unit of the freeway. The work was by Carl N. Swensen Company.

Under way is the major contract amounting to approximately $1,300,000 for the 2.1 miles between the sidehill viaduct south of the city, to Saratoga Avenue at the northern extremities. This work is being done by L. C. Smith Company. Included in this project is a relocation of Los Gatos Creek for a distance of 6,000 feet requiring a concrete line channel for the entire length and a double 18-foot x 15-foot x 450-foot concrete box culvert. Here the freeway passes over the channel and under the Main Street Bridge. The storms of the past winter resulted in an approximately $150,000 damage to the contractor's work on this drainage revision which was under way at that time. This project is expected to be completed in midsummer.

To start soon is a connection from the freeway easterly to a junction with San Jose Avenue at Charles Street. Part of this work will be financed by the City of Los Gatos as a cooperative project.

Acquisition of rights of way over the remaining portion of the Sign Route 17 Freeway to San Jose and beyond to a connection with the Bayshore Freeway is accelerating so that this freeway development can continue as rapidly as funds become available.

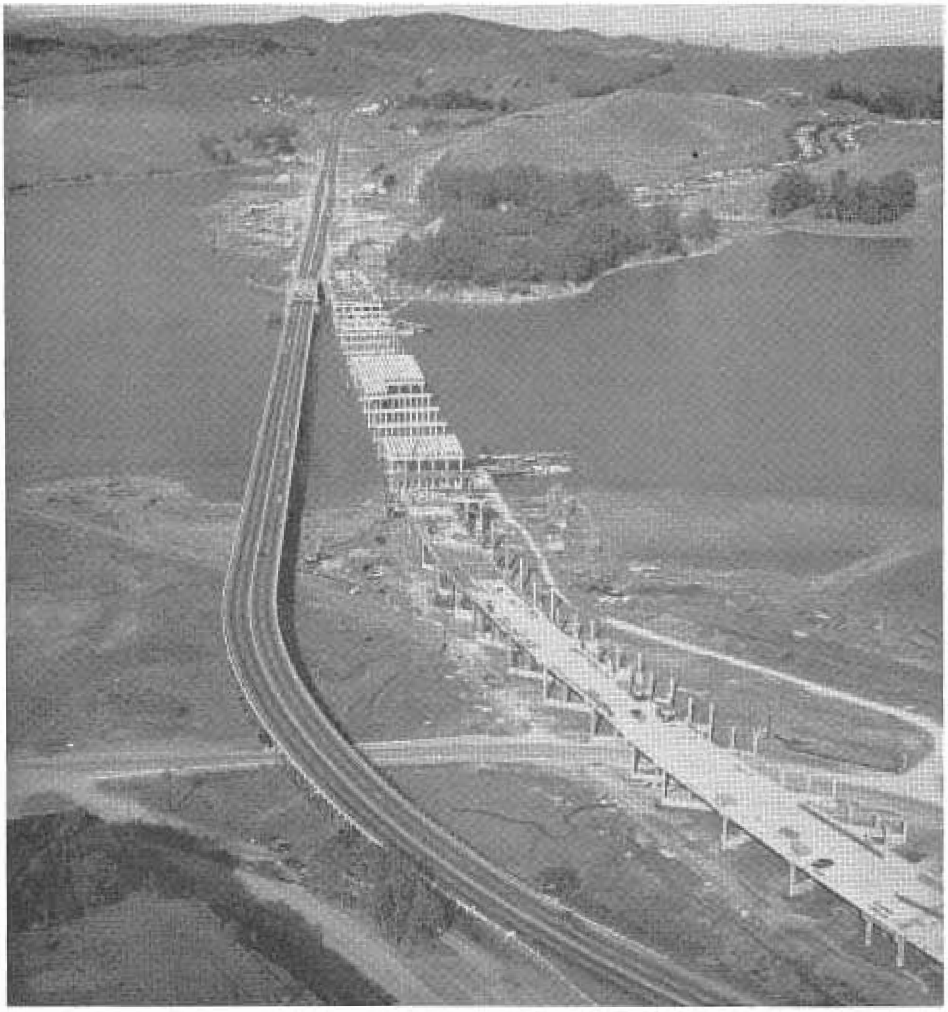
In Santa Cruz, a new freeway entrance into the city is being provided from existing Sign Route 17 at the north city limits to Mission Street. This project will provide a much needed facility for traffic distribution in the Santa Cruz area and is a part of the eventual freeway from San Jose to Santa Cruz. This project will cost $1,100,000. It is 1.2 miles long and the contractor is the Granite Construction Company. It is expected that the job will be completed in midsummer, 1956.

US 101 BYPASS, SAN JOSE AREA

A project which will improve the existing three-lane facility to an initial four-lane future six-lane full freeway from the present junction of US 101 Bypass and Sign Route 17 to Santa Clara Street is now in progress. This project is 1.6 miles in length, and will cost $1,800,000. The contract is being performed by Lew Jones and Leo F. Piazza and will eliminate the last of the three-lane width north of San Jose on this heavily traveled route.

OTHER MAJOR PROJECTS IN SAN JOSE AREA

South of San Jose, on US 101 from Ford Road to Llagas Creek the remaining three-lane sections on this route are being eliminated by the construction of a four-lane divided conventional highway over this 12.7-mile



Northerly at new Richardson Bay Bridge under construction

length. The contractor is Carl N. Swensen Co., Inc., and construction will approximate $550,000. This project is now open to traffic.

On Sign Route 9 between Lawrence Station Road east of Bayshore Freeway and 0.2 mile east of the San Jose-Alviso Road, a bypass of the town of Alviso which will be the initial construction of two lanes of a future freeway on new alignment and above flood and tide water level is financed and expected to be under contract in August, 1956. This project will approximate $1,000,000 construction cost.

On Sign Route 9 from 0.5 mile south of McClellan Road to Route 2 the existing, narrow two-lane facility with little or no shoulders is to be widened and shoulders added as interim relief prior to the future freeway development from El Camino Real to Los Gatos. An amount of $320,000 is allocated for this 3.9-mile improvement, and construction is expected to start in April, 1956.

US 101—GOLDEN GATE BRIDGE TO SANTA ROSA

Continued progress is being made toward the near future realization of a completed freeway between the Golden Gate Bridge and Santa Rosa.

The improvement of the Waldo approach to the western end of the Golden Gate Bridge to six-lane freeway standards was dedicated and opened to traffic on March 20, 1956.

Work on this four-mile facility between the bridge and Manzanita has been accomplished in two contracts.

The Guy F. Atkinson Company completed a $4,500,000 contract in April, 1955. This was the major project and covered grading, construction of a twin bore and various separation structures. The second contract now practically completed and amounting to $1,300,000 for completing the drainage, paving and lighting over the project and lining the existing tunnel was done by the A. G. Raisch Company. The Golden Gate Bridge and Highway District contributed $5,000,000 to the total financing.

From Manzanita northerly 5.8 miles to the Greenbrae intersection, full freeway construction is either under way or advertised and several bad intersections are being eliminated.

A new $3,200,000 six-lane structure is being constructed across Richardson Bay by Duncanson-Harrelson Co. and Pacific Bridge Co. Completion is estimated for early 1957. The existing bridge will be removed.

Immediately northerly of the Richardson Bay Bridge job a 2.4-mile contract will extend the freeway to 0.3 mile north of Alto and eliminate the serious condition at the Alto intersection by providing a clover-leaf interchange. This project amounts to $1,300,000 and is being done by Dan Caputo Company and Dan Caputo and Edward Keeble. Efforts are directed toward the completion of this project by the end of this year.

From the foregoing project to 0.6 mile north of the Greenbrae intersection, a distance of 3.2 miles, another project continuing the freeway is expected to be under contract in June, 1956. The sum of $2,900,000 has been allocated for the work which will provide a full freeway to north of Corte Madera Creek, eliminate a serious intersection at Tamalpais Drive and connect with the stage construction of the portion of the Greenbrae Interchange now underway. Most of the grading for the future extension to California Park Overhead will also be done.

Greenbrae Interchange

The Greenbrae Interchange project, amounting to $950,000, is being constructed by Carl N. Swenson Company. It is expected to be completed at the end of this year. This project will eliminate the southbound intersection conflict existing at the present intersection but another contract for the completion of the interchange will be required.

Included in the 1956-57 Fiscal Year construction program is the replacement of the existing bridge across the Northwestern Pacific Railroad at Forbes Overhead north of San Rafael. The existing bridge is nearing the end of its structural life. The new bridge and approaches which will cost approximately $500,000 for 0.8 mile is expected to be under contract in midsummer of 1956.

In Sonoma County, as a part of the freeway extension bypassing the congested Petaluma business district, two sets of twin structures were completed in April, 1955. This work cost $900,000 and involved structures across the navigable channel of Petaluma Creek and also across the Northwestern Pacific Railroad. The work was done by Erickson, Phillips and Weisberg.

The remaining work covering the entire freeway development from one mile south of Petaluma Creek to three miles north of Cotati at Wilfred Crossing, a distance of 13.5 miles, consists of two contracts, both of which are being performed by Parish Bros., Inc., and Carl N. Swenson, Inc. Total construction cost for both contracts amounts to $6,000,000. The southernmost contract, including the bypass of Petaluma, is expected to be completed in September, 1956, and the remaining work by the end of the year.

Early continuation of the freeway construction northerly to Santa Rosa is assured with the inclusion of that five-mile project in the approved 1956-57 Fiscal Year construction program in the amount of $2,900,000. Construction is expected to be under way early this summer.

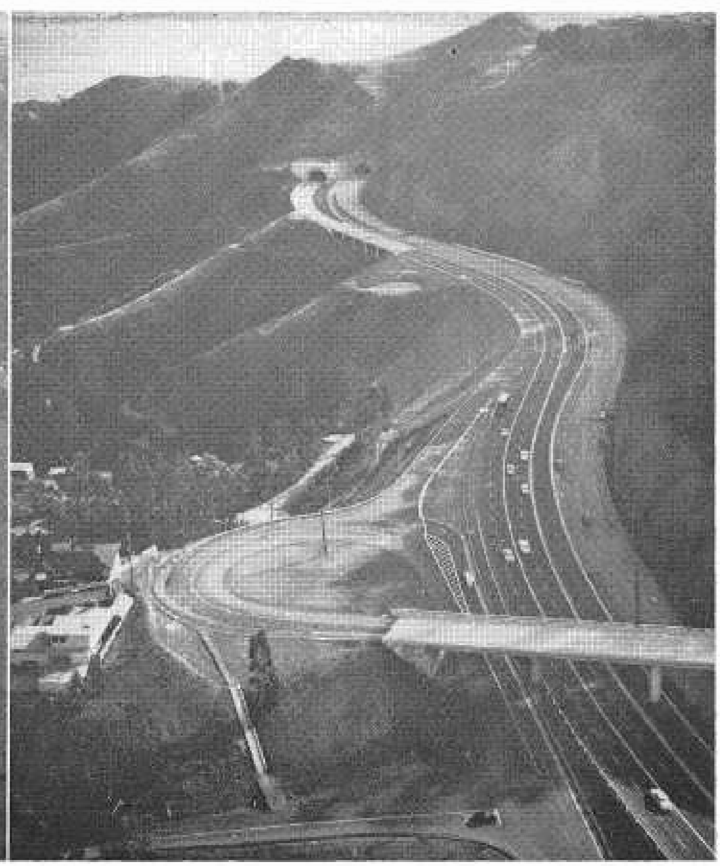
US 101—SAN RAFAEL-RICHMOND BRIDGE

A contract covering the development of a two-mile portion of the western approach to the San Rafael Bridge is expected to be under way in May of this year. An item of $900,000 has been included in the 1956-57 Fiscal Year construction program for the work which will provide a four-lane freeway westerly from the bridge to Sir Francis Drake Boulevard. One deck of the bridge will be open to traffic by October of this year and this project is timed to provide an adequate approach upon completion of the four-lane bridge. It is expected to be completed in midsummer, 1957. Limits of the project extend nearly to US 101, but this is primarily for the incorporation of earthwork encountered in the initial job into the future extension of the freeway from Sir Francis Drake Boulevard to US 101 at the San Quentin Wye. Present work will include an interchange at Sir Francis Drake Boulevard.

NAPA AREA

A 2.7-mile section of freeway on Sign Route 37 in Napa County was

LEFT—Looking north along Waldo approach to Golden Gate Bridge. Sausalito Interchange in foreground. Note extensive grading required. RIGHT—Looking south along Waldo approach to Golden Gate Bridge. New tunnel exit on left. Spencer Avenue Overcrossing in foreground. Note viaduct construction to avoid extensive fills just north of tunnel. Photograph shows two-way traffic on new lanes. Upon completion new lanes will serve northbound traffic and existing roadway on right will carry southbound.



completed in November, 1955. This project extends easterly from a point two miles east of the Sonoma-Napa county line. Arthur B. Siri, Inc., was the contractor on this $450,000 project which constructed the initial two lanes of a future four-lane freeway with right of way and access control initially provided.

Acquisition of rights of way is now under way for the future development of the St. Helena Highway as a freeway from Union Station at the north end of the Napa Bypass to Rutherford. Construction, however, has not been financed.

The initial two lanes of a future four-lane freeway are under construction between four miles north of St. Helena to Calistoga, a distance of 3.7 miles. This project is under contract to Huntington Brothers and will cost approximately $550,000. Completion of the work is expected by the end of this year. This is another instance of the stage construction of a future freeway and at the same time correcting today's deficiencies with a minimum expenditure of today's funds, thus enabling the correction of other deficiencies in the area earlier than could otherwise have been financed.

CONCLUSION

Perhaps the greatest motivating force in the demand for improvement of highways has been the consciousness of the users themselves that needs were outgrowing the facilities available. One has but to become involved in slow-moving or conflicting traffic patterns to resolve there and then that something must be done. In any one given situation all motorists on the highway are involved and all suffer the consequence of inadequacy. This broad effect results in united and cumulative demand for relief.

Of as great, or even greater consequence is the matter of safety. In contrast with the effect of a traffic tie-up, damage to life and property involved in an accident is restricted to individuals or small groups. Our minds seem to have a defensive shield against catastrophes which occur about us daily, and we persist in our refusal to project ourselves into the field of accident liability. Only through the efforts of safety councils, traffic engineers and forward-looking newspapers and journals has the subject of safety been kept in the foreground of public conscience.

Fortunately, safety, convenience and expeditious movement are not incompatible. These three elements are served alike in fundamental freeway features. Elimination of grade crossings, reduction of side friction due to multiple access, high standards of grade and alignment, wide traffic lanes and improved signing, have, among numerous other features, produced facilities which encourage safe and convenient travel at maintained speeds over long distances.

As can readily be appreciated, the reduction of minor accidents usually attending vehicles traveling in the same direction, is not as impressive as the reduction of accidents involving fatalities. It is with the latter type that we are overwhelmingly concerned. The quoting of statistics is ordinarily unproductive, however, the comparison of 2.15 fatal accidents per hundred million miles of travel on freeways, against 8.38 like accidents for the same distance on ordinary rural roads, is more articulate than any descriptive phrase.

As we work toward the creation of an adequate network, we are fully aware that freeways alone are not a complete solution to the traffic problems, particularly with respect to the movement of commute traffic in peak hours in the urban areas. However, we believe that they are the heart of any transportation pattern augmented as it may be. With this firm conviction in mind we will continue to develop the system, confident that each year will bring added safety, pleasure, utility and convenience to public travel in the area.

STATUS OF DISTRICT IV FREEWAY PROJECTS

March, 1956

	Total miles	Completed projects		Under contract		Budgeted		Right of way expended and budgeted
		Miles	Const. cost	Miles	Const. cost	Miles	Const. cost	
Bayshore and James Lick Freeway; Bay Bridge to Ford Road south of San Jose	56.6	27.5	$38,043,000	5.3	$5,518,000	7.4	$8,740,000	$32,472,000
Central Freeway; James Lick Freeway to Turk Street	1.8	1.0	4,973,000					5,300,000
Embarcadero Freeway; Bay Bridge to Broadway	1.5			1.2	7,701,000	1.1	5,200,000	10,544,000
Golden Gate Freeway; Lyon Street to Route 56	1.1					1.1	3,900,000	
Park Presidio Freeway; Golden Gate Bridge to Fulton Street	2.1	1.2	1,439,000					50,000
US 101; Golden Gate Bridge to Lytton	66.6	24.3	*12,441,000	20.0	*12,720,000	8.2	6,038,000	7,666,000
Black Point Cutoff; Ignacio to Sears Point	7.3	0.8	1,090,000					280,000
Route 69; Route 1 to Richmond-San Rafael Bridge	2.4					2.1	900,000	483,000
Napa Area and Solano county line to Calistoga (portions)	37.9	14.3	2,235,000	2.7	555,000			1,619,000
US 40; El Cerrito Overhead to Carquinez Bridge	13.6		391,000	11.7	†41,708,000			5,666,000
Arnold Industrial Freeway; Hercules to Bridgehead Avenue	32.0	14.7	4,672,000		40,000			1,196,000
Monument-Martinez—to Solano county line	7.4							
Oakland to Arnold Industrial Freeway near Ohmer	19.8	3.1	1,029,000	6.7	7,446,000			9,530,000
Mountain Blvd.; Tunnel Road near Lake Temescal to San Leandro	9.3	1.1	‡1,408,000	1.3	‡1,617,000	1.0	‡950,000	‡1,125,000
Eastshore Freeway; Richmond-San Rafael Bridge to Bayshore at San Jose	52.7	26.5	35,799,000	9.3	17,587,000	9.0	5,785,000	21,435,000
Altamont Pass; San Lorenzo to San Joaquin county line	33.6	26.3	6,980,000	7.3	7,465,000			6,220,000
Route 107; Route 5 to Walnut Creek (portions)	10.1	2.1	550,000					759,000
Pacheco Pass; 1 mile east of Bell's Station to Merced county line	5.3	5.3	1,286,000					12,000
El Camino Real; Ford Road south of San Jose to San Benito county line (portions)	5.8	5.8	935,000					546,000
Four miles south of Davenport to Watsonville	21.0	7.7	2,740,000	1.3	1,065,000			2,546,000
San Jose to Santa Cruz (portions)	19.9	1.8	1,339,000	3.0	1,736,000	0.4	240,000	6,367,000
Route 113; Bayshore to Eastshore Freeway	8.0					2.1	610,000	99,000
Skyline Boulevard; Edgemar Road to Lake Merced Boulevard in San Francisco (Note: Major part of 1.0 mile in San Francisco financed by city—approximately $285,000 constr.)	3.9	3.9	1,325,000					764,000
Totals	419.7	167.4	$119,575,000	69.8	$105,158,000	32.4	$32,463,000	$114,679,000

* Includes total of $5,000,000 by Golden Gate Bridge and Highway District.
† $28,834,000 Toll Bridge Funds in this amount.
‡ Includes City of Oakland and Alameda County contributions.

Waldo Project

Golden Gate Bridge Freeway Is Opened

WITH ALL branches of the armed services participating, the Redwood Empire Association staged a spectacular dedication of the new Golden Gate Bridge Freeway celebrating the opening on March 20 of the additional westerly freeway tunnel just to the north of the Golden Gate Bridge.

Many dignitaries from the Redwood Empire counties, federal and state officials, headed by Lieutenant Governor Harold J. Powers, Director of Public Works Frank B. Durkee, George T. McCoy, State Highway Engineer, B. W. Booker, Assistant State Highway Engineer, Secretary of State Frank M. Jordan and Chelso Maghetti, Secretary of the Highway Commission, participated in the dedication. Bands from the 6th Army with headquarters at San Francisco, and the Hamilton Air Force provided stirring music for the occasion. Jet bombers from the 349th Fighter Bomber Wing broke the barrier in the air above the tunnels while a 49-ton army tank crashed through the barrier on the ground to the accompaniment of salutes from a battery of army cannon.

Vice President Dan E. London of the Golden Gate Bridge and Highway District acted as master of ceremonies, assisted by Committee Chairmen Thomas P. Ludcke and Ted Huggins. Among the speakers were Powers, Durkee, McCoy, Highway Commissioners James A. Guthrie, San Bernardino; H. Stephen Chase, San Francisco; Robert E. McClure, Santa Monica, and Robert L. Bishop, Santa Rosa, former Highway Commissioner Walter Sandelin, Ukiah; Reed W. Robinson, President of the Redwood Empire Association, George P. Anderson, President, and James Adam, General Manager, of the Golden Gate Bridge. Sydney Kesser represented Mayor George J. Christopher of San Francisco.

LT. GOV. HAROLD J. POWERS

At the conclusion of the celebration an auto caravan took officials and guests to Bermuda Palms in San Rafael for luncheon. State officials and highway commissioners went on to Santa Rosa where Commissioner Bishop was guest of honor at a civic dinner sponsored by the Chamber of Commerce. Bishop is the newest member of the highway commission, recently appointed by Governor Knight.

The very successful celebration was organized by Clyde Edmondson, general manager of the Redwood Empire Association and his staff.

Financing of the new unit of the Empire's $400,000,000 system of all-year highways is being done largely by the Golden Gate Bridge and Highway District, which is participating to the extent of $5,000,000. The remaining $750,000 is from the State Highway Fund.

Some 2,000,000 cubic yards of earth were used for fills on the freeway. Engineers of the State Division of Highways estimate that it would require 300 trains, each with 100 cars, to transport that quantity of dirt.

Huge Fills

Earth for the fills was obtained from excavations of the widened freeway, the borings of the new tunnel and from the sizable mound that remained at the north end of the Golden Gate Bridge after the original approach was built. Earth and rock from the mound was also used, after a special treatment, as a new base for the reconditioned original approach.

The A. G. Raisch Co., San Rafael, which had a $1,320,000 contract for relining the new tunnel, reconditioning the old tunnel and the final paving of the new and old approaches, subcontracted the tiling work to the Mills and Hinz Tile Co., San Francisco, and the Rigney Tile Co., Oakland.

Some 120,000 square feet of clincher-back tile was used in fully tiling the new 1,000-foot tunnel and partially tiling the original tunnel. Tile for the job was made by Gladding McBean and Co., San Francisco, the only firm on the Pacific Coast to make this type of tile.

Tiling of Tunnel

The subcontractors employed 21 tile setters and 21 helpers on the tunnel jobs which required three and a half months to complete and which cost $150,000.

The tile setters worked from an especially-built scaffold on wheels which permitted them easy access to all points of the tunnel arches. Tiling on the old tunnel extends upward four and a half feet. Above this tiling is a network of pipes designed to take care of leakage. A strip of tiling 17 inches wide extends along the two strings of tunnel lights in the old tunnel to permit an easy tie-in if it is decided to complete the tiling at some future date.

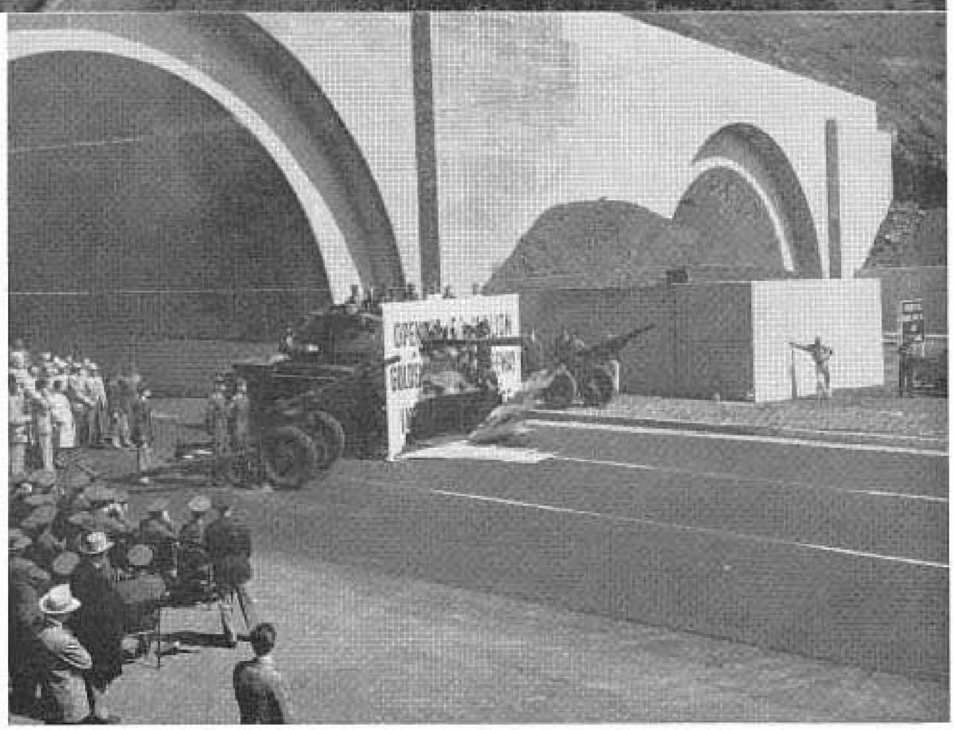
Traffic No Longer Impeded

With the completion of the project, traffic over what was known as Waldo Grade no longer will be impeded

greatly by slow-moving vehicles. Engineers of the State Division of Highways say that the six-lane freeway will assure a much smoother flow of traffic up the grade and will, additionally, increase the safety factor for motorists.

The new tunnel, which cost $1,750,000 and which has been handling two-way traffic pending reconditioning of the old tunnel and approach, will accept only northbound traffic with the reopening of the old tunnel. However, the full capacity of traffic flow will not be immediately utilized, for the pavement in the easterly tunnel will be resurfaced lane by lane.

The original four-lane approach, which handled two-way traffic and which now is converted into a three-lane artery for southbound traffic, was opened in 1937. The original approach was built at a cost of $1,226,-



UPPER—Aerial view of twin tunnels looking northerly, showing Golden Gate Bridge Freeway as it emerges from north portal. LOWER—Army tank crashes through barrier, signalizing freeway opening on March 20.

130, exclusive of the old tunnel which cost an additional $630,346.

The old and new approaches which now combine to form the Golden Gate Freeway have a total cost of more than $8,000,000. Thus the four miles of highways, including the twin tunnels, cost an average of $2,000,000 per mile to build. The freeway extends from the northern end of Golden Gate Bridge to a point a short distance beyond the bottom of the Waldo Grade.

Two Viaducts Built

The greatest fill on the new freeway was made near the crest of the grade, where 500,000 cubic yards of earth were dumped to provide a foundation for the widened highway. As the fill was built upward, it was tamped repeatedly with sheeps-foot rollers to settle the earth. A 50-ton roller was used to pack solid the top few feet of the fill to make a firm base for the highway.

Another substantial chunk of earth, about 242,000 cubic yards, was needed for the fill in the canyon where the Fort Cronkhite tunnel was extended 108 feet in order that the added footage might be built up to accommodate the widened highway at this point.

Just to the north of the tunnel, it was necessary to construct two viaducts over which the northbound lanes of the freeway pass. Engineers pointed out the terrain at this point was too steep for a fill.

As a safety measure, the north and southbound traffic lanes have a median dividing strip extending from the northern end of the Golden Gate Bridge to the bottom of Waldo Grade. The strip ranges in width from 6 to 16 feet and is six inches high at the curb. Additionally, there are guard rails, made of metal plate, at points of potential danger.

Work on the most vital traffic link with the Redwood Empire—the $35,000,000 Golden Gate Bridge—began about 23 years ago, on January 4, 1933. The bridge was opened to pedestrian traffic on May 27, 1937, and a day later to vehicular traffic.

Employees Receive Twenty-five-year Awards

Employees of the Division of Highways who became eligible for 25-year awards during December, 1955, and January-February, 1956, are:

Name	Total service Yrs.	Mos.	Days
ELIGIBLE ON December 31, 1955			
District III			
Stout, William C.	25	0	28
District IV			
Dake, Fred	25	0	15
District VII			
Harris, Paul M.	25	0	16
District IX			
Holt, Herman	25	0	9
Central Office			
Baumgart, Walter M.	25	0	21
Kerri, Gurne R.	25	0	9
Shop 2			
Young, Homer	25	0	30
Headquarters Shop			
Hamlin, Harold H., Sr.	25	0	29
Department of Public Works			
Division of Contracts & R/W			
Vance, Mable A.	25	0	22
ELIGIBLE ON January 31, 1956			
District I			
Paul, Bertus Leroy	25	0	16
District IV			
Davis, Dewitt D.	25	0	21
Greene, Clifton F.	25	0	20
District V			
Lessett, Theodore	25	0	9
ELIGIBLE ON January 31, 1956			
District VII			
Wakefield, Allen N.	25	0	3
District VIII			
Denny, Earl C.	25	0	6
Lloyd, John J.	25	0	7
District X			
Barber, Tom	25	0	23
Malatesta, Louis J.	25	0	16
District XI			
Ellis, Jack A.	25	0	28
Central Office			
Balfour, Frank C.	25	0	00
ELIGIBLE ON February 29, 1956			
District I			
Snook, Earl V.	25	0	14
District IV			
Levier, Gilbert W.	25	0	21
Morrill, Paul M.	25	0	23
District VI			
Miller, Scott	25	0	15
Steinman, John J.	25	0	13
District VII			
Verges, Raymond August	25	0	28
Walsh, Joseph F.	25	0	6
District X			
Daniels, James B.	25	0	4
District XI			
Elliott, James B.	25	0	15

The six-lane bridge, now meshing with the six-lane freeway, was designed to accommodate more than 283,000 automobiles for a 24-hour day, and an estimated 70,000,000 automobiles and 6,000,000 trucks annually.

In 1936, vehicular traffic between San Francisco and Marin County was 1,654,741; these vehicles were transported by ferryboat. In 1947, some 10 years after the Golden Gate Bridge was in operation, vehicular traffic had climbed to 7,816,147. In 1955, the vehicular count was 13,952,329.

An all-time high in Golden Gate Bridge traffic is anticipated in 1956 as the population of the Redwood Empire continues to mount and the influx of tourists increases. The growth of traffic over the bridge is reflected in the figures for January when 1,036,594 vehicles crossed the span, an increase of 72,630 over the same month in 1955.

KIND WORDS FROM MRS. HYATT

3634 Brockway Court
Sacramento 18, California

DEAR MR. ADAMS:

Your January-February, 1956, copy of Public Works magazine is a priceless document — wonderful reporting of a terrible tragedy. You and your assistants can be congratulated, as can the State of California, for the heroic work done by the Public Works men.

Sincerely,
DELTA GARST HYATT
(Mrs. Edward Hyatt)

During the 1954-55 Fiscal Year 20 grade crossings on state highways were closed or abandoned by changes in highway alignment, construction of grade separations or abandonment of railroad tracks, and three new grade crossings were opened, making a total of 832 such crossings on state highways on June 30, 1955.

Exit Bottleneck

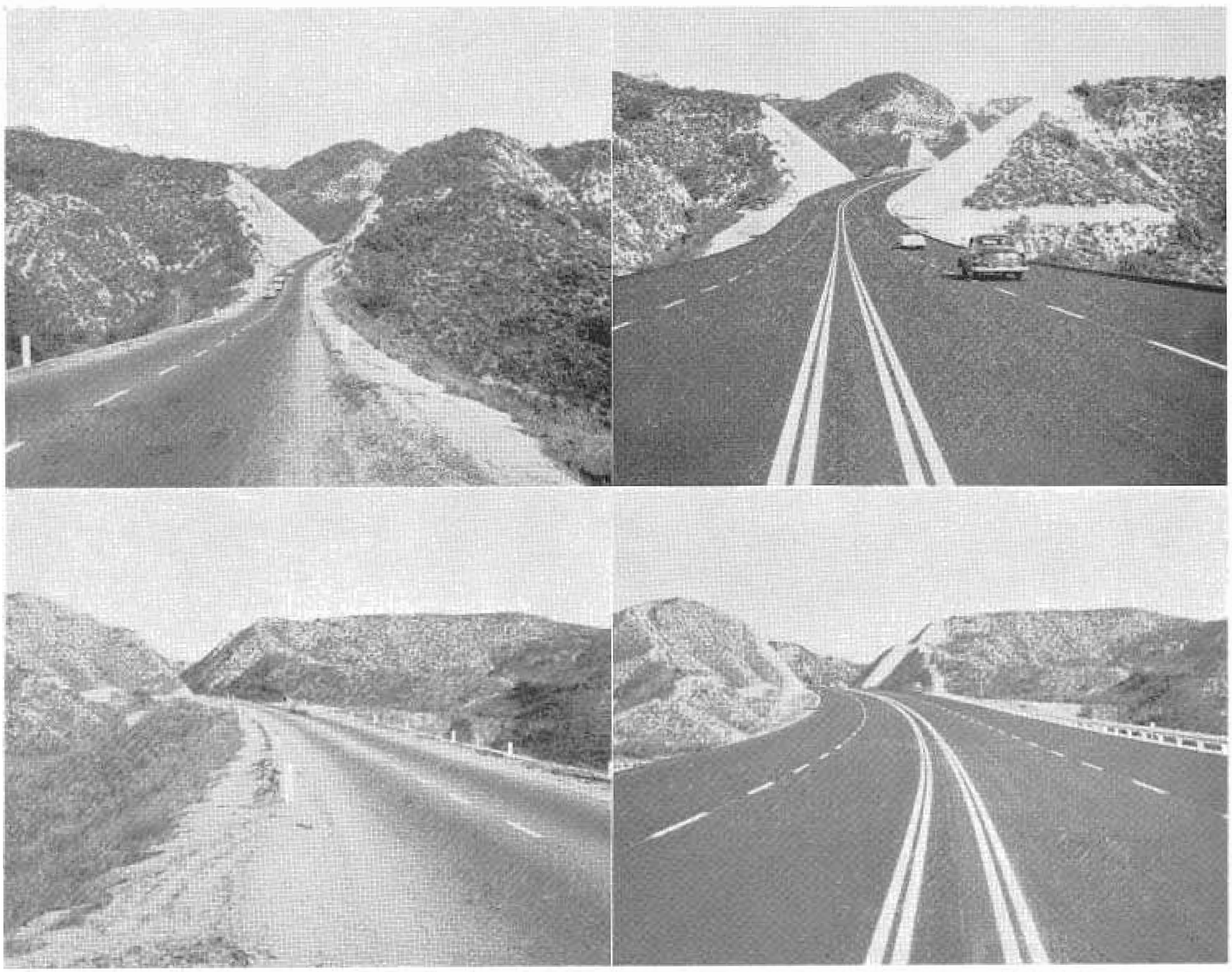
New Highway Through Badlands In Riverside County Completed

By K. B. STONE, Resident Engineer

The reconstruction and widening of U. S. Highway 60, Riverside County's "Main Street," was brought one step nearer to completion with the formal opening of the 5.2-mile highway through what is locally known as the "Moreno Badlands." Dedication ceremonies at the junction of U. S. Highway 60 and State Sign Route 79 on February 16, 1956, officially opened the newly completed section to public travel. Amid hills whitened by an overnight snowfall of two inches, Lieutenant Governor Harold J. Powers cut the unique ribbon, made up of a chain of Riverside County's principal agricultural produce. Assemblyman Lee M. Backstrand of Riverside acted as master of ceremonies. The combined bands from Banning and Beaumont High Schools interspersed the speeches with excellent musical numbers.

Queen Scheherazade of the Riverside County Fair and National Date Festival did not brave the snow or wintry blasts, which made Lieutenant Governor Powers feel right at home, but sent two of her camels to lead the cavalcade, after the dedication cere-

UPPER LEFT—On left, upper and lower, are shown photos of road through the Badlands. On right, upper and lower, are views of the new highway taken at the same location.



monies, to the opening of the Date Festival at Indio. Roy F. King, President of the Indio Chamber of Commerce, acted as toastmaster for the dignitaries at a luncheon given in their honor.

Jack Rabbit Trail

The first road through the Badlands was a wagon road, built back in 1895-96, which naturally snaked back and forth through the rough terrain. In 1913, the people of Riverside County, aware that their future commercial and agricultural progress was highly dependent on good roads, set up the Riverside County Highway Commission, with W. B. Clancy as president and George M. Pearson, then county surveyor, as engineer for the commission. A. C. Fulmor succeeded Mr. Pearson as county surveyor, and was one of the originators of the present route.

One of the routes selected for construction was a road from Moreno to Beaumont, which became known as the "Jack Rabbit Trail." The road was constructed in 1915-16, and for years served as an important link between the county seat and the fast-developing desert and agricultural district to the east. In 1923-24, the Jackrabbit Trail was paved and immediately experienced a large increase in traffic.

New Route Located

In 1931, this road became part of the state highway by legislative act. Because of the narrowness of the trail and its many sharp curves, it soon became apparent to the State that the road could not handle the fast-increasing traffic and the larger and heavier trucks. Immediate steps were taken by the State Highway Commission to alleviate the rapidly increasing traffic congestion. In 1934-36, construction of the present U. S. Highway 60 from Box Springs Grade to Beaumont on an entirely new location and alignment was started and completed. With the later completon of improvements to U. S. Highway 60 from the Los Angeles County line to Riverside, and by freeway improvements east of Beaumont on U. S. Highways 60, 70 and 99 (*See U. S. Progress by J. Dekema, Public Works, July and August, 1954*), additional traffic was

These are the Badlands through which, upper, new highway runs and lower, looking easterly toward summit on old road, showing hazardous passing movement around slow-moving truck. The first road through the Badlands was built in 1895-96 in rugged terrain.

diverted to this road, and a serious bottleneck developed through the Badlands and on to the junction of U. S. Highway 60 with U. S. Highways 70 and 99 at Beaumont. This congestion was further aggravated by truck traffic, often resulting in long lines of slow-moving cars.

Partial Access Control

By 1953, plans were practically completed for the construction of 5.2 miles of four-lane highway with partial control of access through the Badlands. By this time the truck and bus traffic had grown to 13 percent. The accident rate had risen to 4.0 accidents per motor vehicle mile.

. . . Continued on page 52

UPPER—Camels leading the cavalcade of the Beaumont and Banning High School bands, and the parade of cars. Taken at the junction of US 60 and Sign Route 79. LOWER—Lt. Gov. Powers cutting the unique ribbon at the dedication. Left to right: Carl M. Davis, President, Riverside County Board of Trade; Senator Nelson S. Dilworth, Hemet; Lt. Gov. Powers; William Jones, Chairman Riverside County Board of Supervisors; Assemblyman Lee M. Backstrand, Riverside.

Santa Claus

Popular Roadside Business Successful on Frontage Road

By JOHN F. KELLY, Headquarters Right of Way Agent

A UNIQUE name, attractive merchandising displays, good business management and a location along a main highway route are the principal factors contributing to the success of a group of roadside businesses known as Santa Claus, along U. S. Highway 101 in Southern California near Santa Barbara.

Along every major highway the traveling public has a choice of innumerable roadside businesses. Unfortunately, some of these businesses turn out to be a bad choice for the motorist. In these cases, poor management leaves the merchants with only the unsuspecting public who stop by once. Merchandising based upon the theory—where there is traffic, there is business—cannot expect to succeed.

Luckily for the traveling public, all roadside merchants are not happy highwaymen who feel they are going to get a certain amount of business just because they are located alongside a major highway. The successful roadside merchants realize that good business is not based upon chance, but upon sound business principles, regardless of where it is located. Santa Claus is an example of a group of roadside businesses that has attained success by treating the highway motorist as a customer who is wanted rather than one to be exploited.

An active and prosperous looking commercial area today, might have been referred to as a marginal roadside development a few years ago. Fence in left of photo separates frontage road from through traffic lanes of expressway.

Success Story

The business growth along U. S. Highway 101 at Santa Claus is a typical American success story, and like all success stories, it didn't just happen.

Santa Claus began in 1948 when Mr. Pat McKeon acquired an orange juice stand along the coast highway near Carpinteria. At that time there were several other roadside businesses in the immediate area, but none of them had made any special effort to attract the highway motorist. Recognizing the value of advertising in building up a business, Mr. McKeon named his juice stand Santa Claus. The name implies good will, and has been used as the theme for developing good public relations with the highway motorist. Customers turning off the highway are welcomed by a friendly voice on a loud speaker, and out-of-state travelers are given a special greeting referring to their home state. Customers leaving Santa Claus are wished a Merry Christmas and asked to return. All highway travelers feel good about a friendly welcome, particularly when they are some distance from home. They will remember this place and tell their friends to stop at Santa Claus. This is the best type of advertising any merchant can get. Of course advertising is just one phase of good merchandising. Courtesy, service, and good merchandise at a fair price are essential before advertising can be effective. Santa Claus businesses have all these essentials for success, and the result has in effect been Christmas throughout the year for the owners.

Good business management made it possible for the orange juice stand to be enlarged into a confectionery and date shop in 1950; a western and novelty shop was built in 1951; a pottery shop added in 1953, and a cafe known as "Santa's Kitchen" was built in 1954. This cafe has done so well that the owner plans to enlarge the building in the near future, in order to accommodate an additional 100 customers.

Santa Claus Area

Although the name Santa Claus applies only to the businesses owned by Mr. McKeon, the name is now used to identify all of the roadside businesses in the immediate area.

Santa Claus is contained within a half-mile strip of land along the southerly side of U. S. Highway 101, eight miles southeast of Santa Barbara and one mile west of Carpinteria. The Southern Pacific Railroad main line tracks southerly of the highway limit the highway frontage in this area to a maximum depth of 150 feet.

From the standpoint of driving distances between major cities or tourist attractions, the Santa Claus area is not a location that would be considered a logical site for the development of a commercial area catering to the highway motorist. Nearby Santa Barbara is the natural stopping place for all travelers in this section of the State. This world-famous city offers so many attractions to the motorist, it seems almost inconceivable that a group of roadside businesses, entirely dependent upon highway patronage for their livelihood, could succeed in the face of such odds. Despite the competition, original ideas and sound business principles have made it possible for the Santa Claus retail outlets to attract so many motorists that one of their biggest problems today is providing adequate parking facilities for their highway customers.

Highway Changed

Highway frontage at Santa Claus had direct access into a three-lane conventional highway until the average daily traffic on U. S. Highway 101 made it necessary for the State Division of Highways, during 1953-1954, to convert this substandard highway into a four-lane divided expressway. The curve in the alignment of the former highway made it possible to retain that portion of the highway in front of the roadside businesses at Santa Claus as a frontage road. Entrances were created at each end of the business area, approximately 1,500 feet apart, opening into a grade crossing of the expressway. A 36-inch chain link fence separates the old and the new highway to restrict access from the expressway to the frontage road.

Before the present highway revision became necessary, Santa Claus had become a popular stopping place for motorists. During the construction of the new highway the roadside merchants were greatly concerned about their future. Granted, this area would continue to have its unique name, the merchandising displays would remain as attractive, and management would be unchanged; but would a location on a frontage road, behind a fence with restricted access from the through traffic lanes, destroy the highway location that formerly had been considered so important to the success of these businesses catering entirely to the traveling public?

Retail Business Gains

A comparison of the year before and the year after completion of the new highway facility in December, 1954, reveals that businesses at Santa Claus which formerly had direct access into the conventional highway have made very substantial gains in gross sales after being placed on the frontage road. The source of authentic information for making this comparison has been from the reports made by each retail outlet to the State Board of Equalization for the purpose of paying state sales tax.

Those retail outlets which had not been in existence prior to the opening of the frontage road at Santa Claus were not included in the before-and-after comparison, although the records revealed they were doing exceptionally well considering the short time the businesses had been in operation.

Frontage Road Favorable

Acceptance of the frontage road as a suitable location for a retail business catering to the needs of the highway motorist is apparent at Santa Claus. Three major brand service stations have been constructed on this frontage road during the past year. The success of the existing Santa Claus business enterprises undoubtedly influenced these companies to build in this particular area. However, the popularity of Santa Claus could not attract enough customers if a frontage road were detrimental in serving the highway trade.

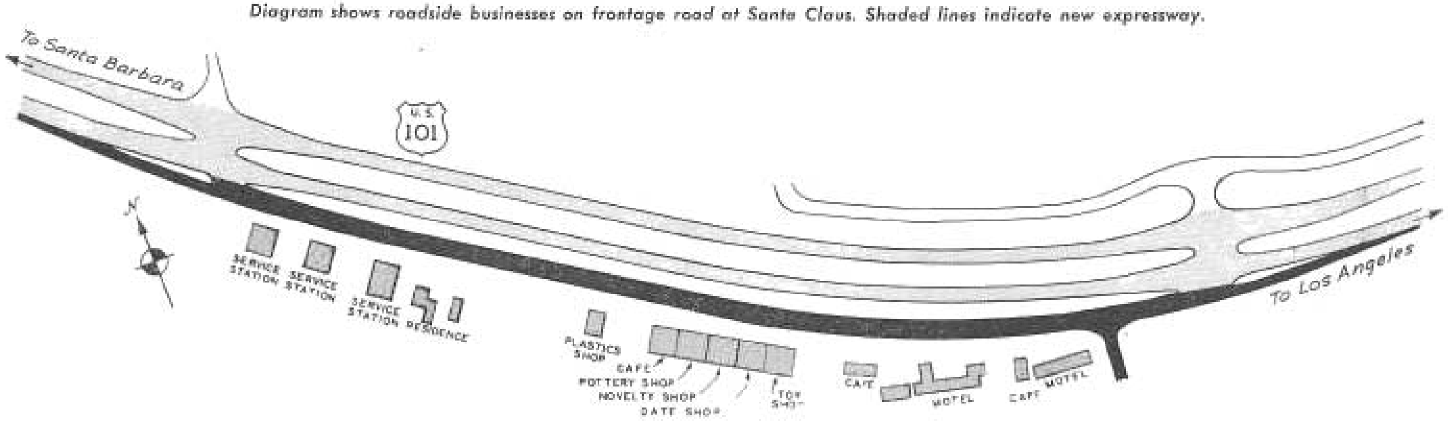
The group of retail outlets at Santa Claus provide services needed by the highway motorist. Retail developments on this frontage road is an example of the one-stop service which will undoubtedly become the type of roadside merchandising the motorist will find in California as the freeway mileage increases.

Roadside Merchant's Letter

The letter by Mr. McKeon, the man who put this group of roadside businesses "on the map," expresses the feeling of a merchant who developed a successful business enterprise along the side of a conventional highway, and then experienced managing those

. . . Continued on page 51

Diagram shows roadside businesses on frontage road at Santa Claus. Shaded lines indicate new expressway.



SANTA CLAUS of CALIFORNIA, Inc.

PAT McKEON
PRESIDENT

JUNE McKEON
VICE-PRESIDENT

SANTA CLAUS • CALIFORNIA
P. O. BOX 488 • CARPINTERIA

January 16, 1956

John F. Kelly
Headquarters Right of Way Agent
Division of Highways
Sacramento, California

Dear Sir:

The new highway has been completed in front of my businesses now for a little more than a year. In this time I have been able to make comparisons before and after. So as not to keep you in suspense, I will state now that everything has been most favorable.

As my business grew, and especially the last year on the old road, it became very apparent to me that the new highway with its turnoffs would definitely be to my advantage. My parking problem was becoming both difficult and dangerous. If you can imagine a car moving along at approximately 45 miles an hour with other cars following close behind on a curve having to suddenly pull off of a three lane highway and into a 10 foot parking space, you can understand what I mean by dangerous. I estimate that I lost 20% new business, and was not able to accommodate 10% of my already established business because of this road condition.

The summer of '55 was the first season on the new frontage road. My fears and anxious moments were over. Not only was my parking problem solved, but my parking area was considerably enlarged. Customers were able to safely turn in and leisurely find a parking space. I found that they would have a tendency to stay longer, which meant added business for me. My records show a 50% increase over the previous year.

Three major oil companies have now built new stations along this strip. Property values took a sharp incline. Business prospects for the entire area brightened. All in all, the new highway was definitely a turning point in our success. The future is laid out for us. We can plan expansion without that fearful question "What if the highway - - - - - - - - ?

In closing I would like to commend you on your field personnel engaged in this construction work. They were without exception most cooperative in every way - most helpful under all circumstances.

Very sincerely yours,
SANTA CLAUS OF CALIFORNIA, INC.

Pat McKeon
Pat McKeon

PM/j

DATE SHOP
GOURMET SHOP

GIFTS from CALIFORNIA

BASKET SHOP
WESTERN SHOP

California Bridges

Construction Costs Moved Upward During 1955

By W. J. YUSAVAGE, Assistant Research Technician, Bridge Department

> This article is the fourth of an annual series dealing with California Bridge Construction Costs. The most recent article appeared in the March-April, 1955, issue.
>
> For total California highway construction costs the reader is referred to a series of articles entitled, "Cost Index" by R. H. Wilson, H. C. McCarty, and J. D. Gallagher. These articles appear regularly in *California Highways and Public Works.*

THE THREE-YEAR decline in bridge item bid prices from the peak level of the third quarter of 1951 was reversed during the last three quarters of 1955. The cost level as of the end of the fourth quarter of 1955 is 8 percent higher than the average level of costs during the calendar year 1954 and 10 percent lower than the high average level of costs recorded during the calendar year 1951.

A general upswing in the trend of costs began in the second quarter of 1955 when the cost index value jumped to a reading of 237 from a reading of 217. The third and fourth quarters confirmed the rising trend with readings of 228 and 237 respectively. The level of costs for successive periods is presented graphically in the accompanying chart which summarizes the course of California bridge construction costs since 1933.

Value and Volume of Bridge Construction

Table I is a tabulation of statistics relating to the value and volume of the California Bridge Department construction program. The current value is shown in column VI where the figures represent the current dollar value of low bids for the various periods since 1934. Columns IV and V give the value and volume of bridge construction in the form of indexes, utilizing the value of base period 1939-1940 as the reference point of 100.

The index of value is computed by relating the value of any quarter to the average quarterly value ($5.1 + 5.2 million/8 = $1,287,500) of the eight quarters of 1939-1940. Thus the value index for the fourth quarter of 1954 is $7,600,000/$1,287,500 or 590.

The volume of bridge construction is defined as the relative physical quantity of bridge construction put in place during a given period. It is an inverse function of the cost index since a higher level of costs reduces the relative value of money and so reduces the relative volume of construction while a lower level of costs increases the relative value of money and thus increases the relative volume of construction.

The index of volume is computed in exactly the same way as is the index of value after each of the quarterly dollar values have been modified by the cost index values of the respective quarters. Thus the volume index for the fourth quarter of 1954 is $7,600,000/213 (cost index) = $3,568,000. This new value is then related to the average quarterly value of the eight base quarter values of 1939-1940, as, $3,568,000/$1,287,500 or 227. The 227 indicates that the actual physical bridge construction activity during the fourth quarter of 1954 was 277 percent greater than that which occurred during 1940.

The value and volume indexes show the marked increase in bridge construction which has accompanied the augmentation of state highway budgets during recent years. As a result of legislation which substantially increased highway user tax revenues during 1953 and the consequent continued development of full freeways with their requisite separation structures, expenditures during the past year for bridge construction rose to nearly $48,000,000 or to approximately 900 percent of the average annual rate of expenditure during the base period 1939-1940.

The indexes do not include the revenue bond expenditures for the construction of the Carquinez Bridge and approaches since the character of financing the construction and also the character of the design of the Carquinez Bridge are different from the usual character of California bridge construction. Inclusion of the Carquinez statistics would have the effect of raising the cost index to a value of 248 or to about 5 percent greater than the 237 reading for the fourth quarter of 1955. Also, adding the contract cost of $19,500,000, the approximate bid value of the bridge and approaches, to the dollar value of low bids would raise the normal budget figure from a total of $48,000,000 to $67,500,000.

General Trends

Average unit prices for the various items of construction as compiled for each quarter show a general upward trend during the last three quarters of 1955. Average bid prices for all major construction items, viz., concrete (structures), reinforcing steel, furnishing steel and concrete piling, and structure excavation are all up approximately 10 percent over the average bid prices of the first quarter of 1955.

This upward trend in construction costs began in the second quarter of 1955 when most of the contracts for another round of wage increases were negotiated. The increase in costs to the State may therefore be assumed to be the result of the economic adjustment the contractor organizations have made in response to the rising costs of labor and materials.

Outlook

The present upward trend of construction costs is currently in a period of transition. Construction costs for the various items vary from quarter to quarter with the high and low values showing a wider than normal variation. The condition implies a situation of adjustment wherein some of the contractor organizations precede others in making adjustments to a new cost situation. It is therefore presumed that the level of costs will stabilize at a somewhat higher level than the present one of 237. The new level may fall within an index range of 240-245 or at a level which is 12 percent greater than the average level of costs during the calendar year 1954.

The present indications are that construction activity for the United States will be slightly higher in 1956 than the record breaking 57 billion dollars of construction put in place during 1955. In this connection there are predictions that a record year of 60 billion dollars will be realized in 1956.

In view of this, the year 1956 may well be another year of wage increases and also of comparatively reduced competition, a combination of circumstances which may possibly add another 5 percent to the present level of bridge construction costs.

NEW TRAFFIC TEXTBOOK

A textbook on traffic engineering by three Yale faculty members is dedicated to one of the co-authors. The book, "Traffic Engineering," is dedicated to the late Theodore M. Matson, Director of the Bureau of Highway Traffic at Yale until his death. The manuscript for the textbook, first ever written on the subject of traffic engineering, was completed just before Mr. Matson's death last year.

The two other authors of the book, published by the McGraw-Hill Company, are Fred W. Hurd, now Director of Yale's Bureau of Highway Traffic, and Wilbur B. Smith, Research Associate in Transportation at Yale.

A total of $23,614,271 was expended by the Division of Highways for maintenance work, including operation and repair of the Martinez-Benicia Ferry System, during the 1954-55 Fiscal Year.

TABLE I

INDEXES RELATING TO CALIFORNIA BRIDGE CONSTRUCTION AND PERIODIC DOLLAR VALUES OF LOW BIDS ON CALIFORNIA BRIDGE CONSTRUCTION

I Year	II Quarter	III Index of the cost of California bridge construction (1939-1940—100)	IV Index of the value of California bridge construction (1939-1940—100)	V Index of the volume of California bridge construction (1939-1940—100)	VI Dollar value of low bids on California bridge construction (in millions of dollars)
1934		94	60*	64*	3.1
1935		88	138*	157*	7.1
1936		98	72*	73*	3.7
1937		114	60*	53*	3.1
1938		99	78*	79*	4.0
1939		101	99*	98*	5.1
1940		99	101*	102*	5.2
1941		122	78*	64*	4.0
1942		158	80*	50*	4.1
1943		165	16*	9*	.8
1944		153	29*	19*	1.5
1945		167	109*	65*	5.6
1946	1st	156	342	219	4.4
1946	2d	190	295	155	3.8
1946	3d	182* 224	247* 148	133* 66	12.7 1.9
1946	4th	217	202	93	2.6
1947	1st	224	280	125	3.6
1947	2d	216	629	291	8.1
1947	3d	215* 219	443* 450	202* 206	22.8 5.8
1947	4th	223	412	185	5.3
1948	1st	220	233	106	3.0
1948	2d	225	365	162	4.7
1948	3d	229* 238	307* 381	134* 160	15.8 4.9
1948	4th	231	249	108	3.2
1949	1st	207	186	90	2.4
1949	2d	210	342	163	4.4
1949	3d	201* 191	233* 194	117* 102	12.0 2.5
1949	4th	187	210	112	2.7
1950	1st	177	124	70	1.6
1950	2d	195	357	183	4.6
1950	3d	202* 212	262* 171	129* 81	13.5 2.2
1950	4th	218	396	182	5.1
1951	1st	243	528	217	6.8
1951	2d	250	948	379	12.2
1951	3d	248* 256	617* 598	247* 234	31.8 7.7
1951	4th	253	396	157	5.1
1952	1st	239	396	166	5.1
1952	2d	236	1,017	431	13.1
1952	3d	235* 239	561* 652	237* 273	28.9 8.4
1952	4th	223	179	80	2.3
1953	1st	243	140	58	1.8
1953	2d	224	707	315	9.1
1953	3d	229* 231	522* 893	227* 387	26.9 11.5
1953	4th	235	350	149	4.5
1954	1st	221	691	313	8.9
1954	2d	217	1,196	551	15.4
1954	3d	219* 220	870* 1,002	399* 455	44.8 12.9
1954	4th	213	590	277	7.6
1955	1st	217	1,039	477	13.3
1955	2d	237	500	211	6.4
1955	3d	228* 228	930* 1,047	408* 461	47.9 13.4
1955	4th	237	1,148	484	14.7

* Average annual information.

The division opened bids on 638 projects during 1954-55.

1,197 division employees had 25 or more years of service on June 30.

Freeway Interchange

Intricate Three-level Structure Progresses

ON JULY 19, 1954, the Attorney General approved a $2,477,821.40 contract for the construction of a section of the Long Beach Freeway extending from the present northerly terminus near Olympic Boulevard, thence south across the Santa Ana Freeway to the Atchison, Topeka and Santa Fe Railway yard, known as Hobart Yard in East Los Angeles, a distance of 1.04 miles. Work was started on July 12, 1954, slightly more than three years after groundbreaking ceremonies at the southerly terminus of the Long Beach Freeway. Other contracts are now under way and still others are contemplated in the near future that will permit unrestricted travel from Long Beach to the Santa Ana Freeway.

The Long Beach Freeway will connect the U. S. Naval installations at Long Beach and Terminal Island with the industrial area in Los Angeles and vicinity. This freeway was first suggested as early as 1921, but it was not until some 20 years later that the formal proposal was made by the Los Angeles Regional Planning Commission. Various proposals for the location were presented including location within the Los Angeles River Channel and locating opposing roadways on opposite banks of the river as well as locating the entire freeway adjacent to one bank of the river.

Adopted Route

The adopted route will parallel the Los Angeles River, first on one side and crossing to the opposite side in South Gate, from Long Beach to the Cheli Air Force Depot south of Santa Fe yards. From this point the freeway leaves the river to continue north and join with the Santa Ana Freeway. Included in this project are 1.04 miles of freeway grading and paving, ramps and eight major structures.

The intricate Santa Ana Freeway-Long Beach Freeway interchange is made up of five structures and constitutes a three-level separation. Even

UPPER—Looking westerly at Long Beach-Santa Ana Interchange. LOWER—Looking northerly showing in center interchange structures that will provide for traffic movement between the Santa Ana Freeway and the Long Beach Freeway. Completed structure to left will carry southbound Long Beach Freeway traffic and one to right will carry northbound.

the names of the structure give some indication of the complications, with such names as Route 167 EBd & NBd Interchange / Route 166 Separation. The three levels are made up of the Long Beach Freeway at the top level, the Santa Ana Freeway at the bottom level, and the ramps passing over the Santa Ana Freeway and under the Long Beach Freeway at the middle level. These multilevel interchanges are common to interchanges between major freeways where rights of way are restricted. In other words, where horizontal expansion is restricted, the vertical dimension must be expanded.

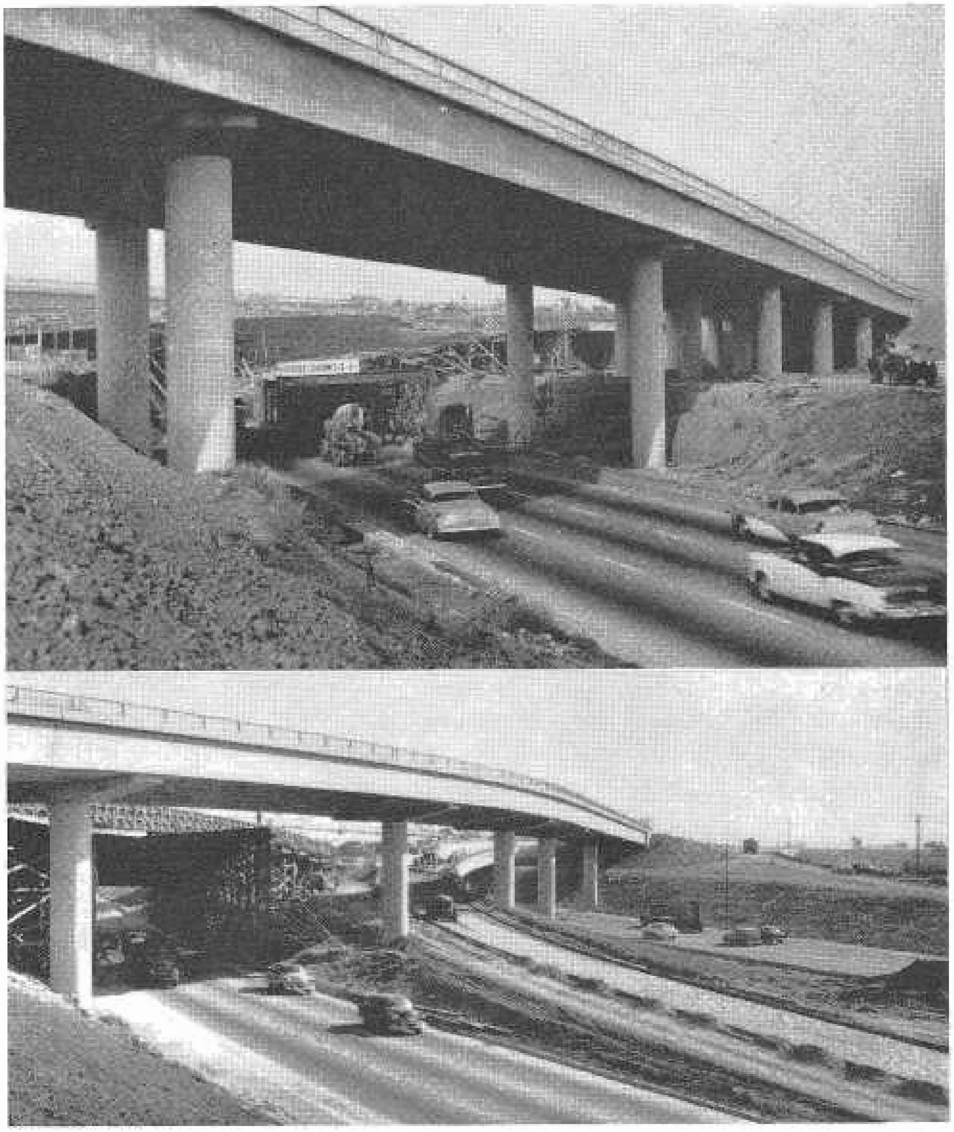
Five Structures

The five structures of the interchange are of the box girder type and are complicated in design because all are on curves, changing gradients, superelevations up to 12 percent, some with reversing superelevations and some with reverse curves. These factors, in addition to the restricted vertical clearances, complicated construction of the falsework and form work.

Falsework for the spans across the Santa Ana Freeway required a clear span of 40 feet 0 inches and maintenance of the minimum legal vertical clearance of 13 feet 6 inches. The contractor used 24-inch WF 110-pound steel I beams which were placed normal to the Santa Ana Freeway lanes and supported the superstructures which crossed at various skews. Since all of the interchange structures cross the Santa Ana Freeway at various skews, some very severe, and since it was necessary to place the falsework normal to the freeway to reduce the span length, the problem of correcting for deflection of the steel falsework beams developed.

Concentrated loads of the box girder diaphragms and girder stems, combined with the uniform load of the bottom slab, occurred at different locations on each of the steel beams. Deflections were calculated separately for each different loading, and adjustments were made by wedging the joist and stringers as required. Complexity of form work and danger of working adjacent to heavy traffic were not the only problems confronting the contractor. Practically all of the interchange structures are supported on concrete piles and the contractor chose the option of cast in drilled hole piles. The material was firm and drilling was satisfactorily done with a rotary bucket drill and an auger drill with very little caving. These drilled holes were 16 inches in diameter and the presence of many small children passing through and playing in the construction area caused the contractor to adopt a policy of filling all holes with concrete immediately, or otherwise protecting the children from falling in the holes and causing another "Kathy Fiscus" case.

Considerable care was taken to warn traffic of the restricted vertical and horizontal clearances. Reflectorized signs were placed on the Santa Ana Freeway as much as a mile in advance of



UPPER Looking along westbound lanes of Santa Ana Freeway. Northbound separation in foreground. Eastbound-northbound interchange under construction. Southbound separation in background. LOWER—Looking southeasterly along Santa Ana Freeway showing southbound separation bridge for Long Beach Freeway in foreground. Westbound separation bridge in right center background and eastbound-northbound interchange left center.

construction to warn truckers with high loads to turn off at Olympic Boulevard. Floodlighted signs were placed on existing overhead structures warning of restricted clearances ahead. Lighted signs were placed on the falsework stating, "Impaired Clearance 13′6″."

Despite these precautions overheight loads were another cause of construction problems. During most of the job it was necessary to have steel falsework beams across the Santa Ana Freeway lanes which restricted the vertical clearance. From the start, overheight loads struck the beams. The contractor welded 3-inch x 3-inch angle struts to the first four beams on the approach side in order to protect the falsework and prevent individual beams from being knocked down onto the freeway. This steel frame was sufficiently rigid to withstand all subsequent shocks. Some overhanging loads sideswiped the falsework posts, but this was held to a minimum by constructing concrete crash walls to support the posts.

The contractor on this project was Ukropina, Polich, Kral & Ukropina. J. M. Curran acted as resident engineer for the Division of Highways.

STATE INCREASES HIGHWAYS DESPITE ENGINEER SHORTAGE

By GEO. T. McCOY, State Highway Engineer

In the past 10 years, California has quadrupled its highway construction program and now stands ready to turn out plans, specifications and miles of modern highway at an even faster rate if the funds are made available—all in the face of a nation-wide shortage of more than 4,000 highway engineers.

How, despite that handicap, has the State been able to complete 1,000 miles of multilane divided highway in 10 years, with another 300 now under construction and another 200 miles to be advertised for bids this year?

The answer is a combination of modern management and technical methods. Developed and applied more intensively in recent years under the spur of a vastly increased highway construction program, these methods are effecting huge savings in three precious commodities—time, money and professional manpower.

New Techniques

The new techniques and devices range from greater use of subprofessional aids and technicians to aerial photographs from which location maps and even grading plans can be quickly produced; from new, simplified technical manuals to the latest electronic computing machines which calculate earthwork quantities and solve complex geometric problems in a fraction of the time formerly needed.

The eventual full use of these and other known methods will double engineering output. In particular, the application of photogrammetry and automation techniques, in combination, is regarded as the greatest advance in the science of highway engineering in many years.

At the same time, the highway contractors have more than kept pace, with streamlined operations of their own. Ever-larger earth-moving machines change the face of a landscape in a matter of days; moving assembly lines or "paving trains" can already place up to three-quarters of a mile of 12-foot concrete lane, eight inches thick, in one eight-hour day; batching plants serve up just the right mixture of rock, sand and asphalt at the touch of a button. Single contracts run as high as $6,000,000 or even more.

Competition Keen

And competition is as keen as ever, assuring the motorist the most highway for his tax dollar. On a recent typical freeway job, there were nine bidders, with a difference of only $154,000 between the lowest bid of $1,975,000 and the fifth lowest.

California's transportation growing pains, always severe, became acutely critical after World War II, and are still intense. From less than 3,000,000 motor vehicles in 1940, the State's traffic load rose to more than 6,000,000 by 1955 and is now approaching 7,000,000.

Highway construction, financed on a depression-born basis before World War II, came to a standstill during the war. The financing picture improved in 1947 with the Collier-Burns Act, and again in 1953 when the continued growth of traffic made still faster highway construction a matter of life and death to Californians—in the literal as well as the economic sense.

Noticeable progress is being made. California is now spending about $250,000,000 a year for highway construction purposes—admittedly not enough to provide the safe and adequate highways the State desperately needs, but enough to keep the situation from getting worse—and could effectively spend more. Where are the engineers to plan and build these modern trafficways, including many complex metropolitan freeways?

Shortage of Engineers

Far too few are coming out of the engineering colleges. The various state highway departments say that they need 4,000 more engineers right now. But the entire Nation's class of 1954 in civil engineering numbered less than 3,600; probably no more than 700 of them went into highway engineering and a third of these did not stay there long—quite understandable in the light of the higher salary and other inducements offered them in other fields.

Since there were not enough engineers to be had, the California Division of Highways, like other such agencies, stepped up its quest for ways to make more efficient use of what engineers it had and could get. Hand in hand with this effort, the constant struggle to stretch the highway tax dollar a little further, particularly in the face of rising costs, was intensified.

The battle continues without letup. It has not been won, but major gains have been made on several fronts and new victories are in prospect.

Photogrammetry Saves Time

There are six principal fields in which ways have been found to get highways planned and built in California with a saving in time, money and engineering manpower:

1. *Photogrammetry*, or measurements using aerial photographs, is already saving the time and effort of an estimated 200 engineers a year. In one section of California, two ground survey crews plus an aerial mapping contractor produced 75 miles of preliminary surveys that would otherwise have required seven additional ground crews for the field work alone. Remarkably accurate maps can be plotted and drawn from aerial pictures, permitting even the drawing of detailed design plans.

The Division of Highways estimates the cost of obtaining data by ground survey methods at an average of $3,500 a mile for a strip of terrain 400 feet wide. By aerial photography, it averages $1,000 a mile for a strip 1,200 feet wide.

Automation Cuts Costs

2. "*Automation*," or, more accurately, the use of electronic computing equipment to make and check engineering calculations which are time-consuming, tedious and costly when done manually by engineers in the drafting room. Tabulating machines have long been useful and economical in computing and analyzing traffic statistics, cost data and other figures, but now they have also been put to work on two types of calculations used directly in highway design.

One type is the calculation of traverses, or survey lines. The engineer in the drafting room instead of laboriously figuring and then checking the unknown bearings, distances or areas for a parcel of land, now sends in the available data to the Headquarters Office in Sacramento. There the material is punched onto cards, fed into the machines, and the solutions mailed back. To complete 1,000 to 3,000 traverse courses daily in this fashion takes 12 to 24 hours of key punch and tabulating machine operation time, on the part of technicians and operators. It would take five to seven times as long for the same work to be done by engineers using manual methods.

In addition to saving on engineers, the machine process saves an estimated $2,000 a month in money—it costs five cents per course by machine, against 13 cents per course by conventional methods, not including checking.

Machine Computations

Another and newer machine process computes the cubic yardage of earth to be moved for highway cuts and fills. Using field notes, the terrain data are punched onto cards, fed into the machine and the geometric solutions come out. A number of steps in the conventional design process, such as plotting of roadway cross-sections, are eliminated by this method. Various alternate locations for the highway can be quickly compared as to size and cost of earthwork involved, and the cheapest practical location readily selected. On one 10-mile divided highway project through rolling terrain, machine computation of earthwork quantities saved the time of four engineers for one month.

PHOTOGRAMMETRY—Above, a portion of an aerial vertical photograph taken along US 101 in southern San Luis Obispo County. Below, a corresponding portion of the detailed map which was plotted and drawn directly from the aerial photograph. The dark line running across the map near the top is the center line of the proposed four-lane expressway which will be under construction this spring. Modern photogrammetric methods drastically reduce the need for detailed ground surveys, thus saving many engineering man-hours for the Division of Highways in getting construction of modern highways under way.

3. *Management and Organization* techniques are being used liberally to conserve engineering time and manpower. The statistician, the delineator (female as well as male), the research technician, the junior executive, the construction inspector—the abilities of these and other workers are being effectively utilized throughout the highway organization.

4. *Efficiency* is being further emphasized in routing procedure not yet adaptable to machine operation. Improved surveying instruments, calculators, and other equipment; simplified drafting and reproduction

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Colorado River

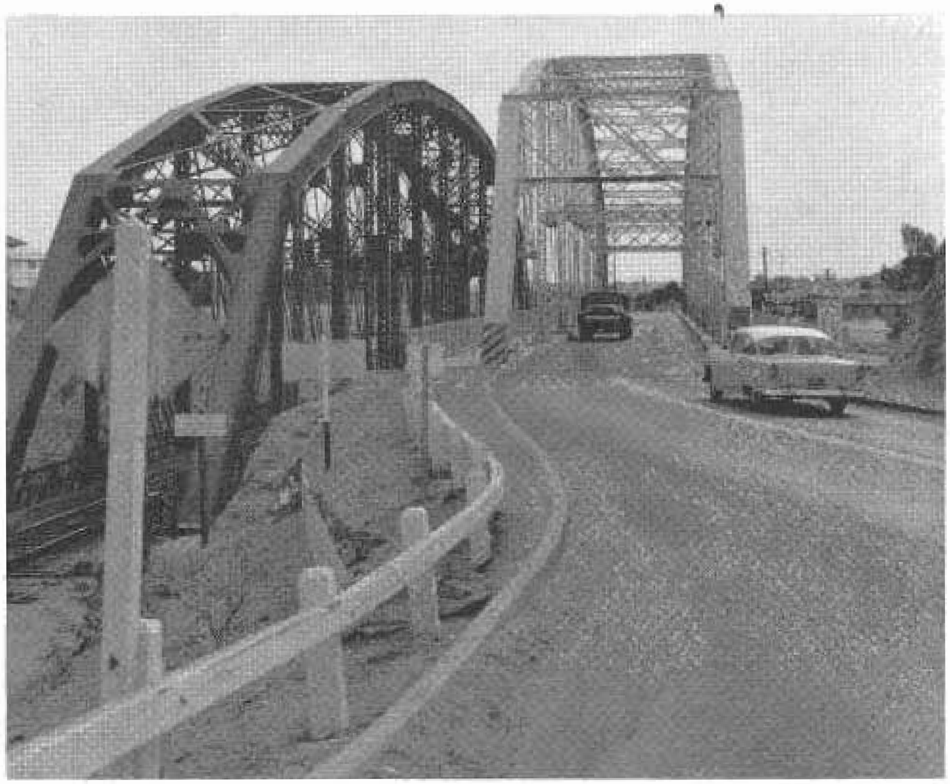
New Bridge Across Mighty Stream Nears Completion

By N. G. HALLIN, Senior Bridge Engineer

THE EARLY entrances to California proved to be very hazardous, what with the high mountains, wide deserts and large rivers to cross. Much of California's history lies in the routes of entrance to the State and not the least of these is the entrance at Yuma, Arizona. The first barrier to the westward traveler is the crossing of the mighty Colorado River.

A notable crossing of the river occurred in 1774 when on February 9th, Juan Bautista de Anza led a group of 32 people including 20 soldiers across the Colorado River bound for Monterey, California. The successful crossing was made a short distance upstream from the juncture with the Gila River and is reported to be the first made by soldiers of the King of Spain and was celebrated by the firing of a salute of musketry. However, the crossing could not have been made without incident had not Anza negotiated successfully with the Yuma Indians prior to entering their territory and attempting the crossing. Anza sought out the Indian chief and was hospitably received. Gifts consisting of tobacco, beads and toys were distributed among the Indians and in return the Indian chief offered to have his strongest braves assist in the crossings of the Colorado River.

In the year 1775 Anza led another party of 240 people across the Southwest bound for San Francisco. This crossing of the Colorado River was made upstream from the previous one because the latter crossing was found to be impassable.



Existing Yuma Bridge on right and railroad bridge on left

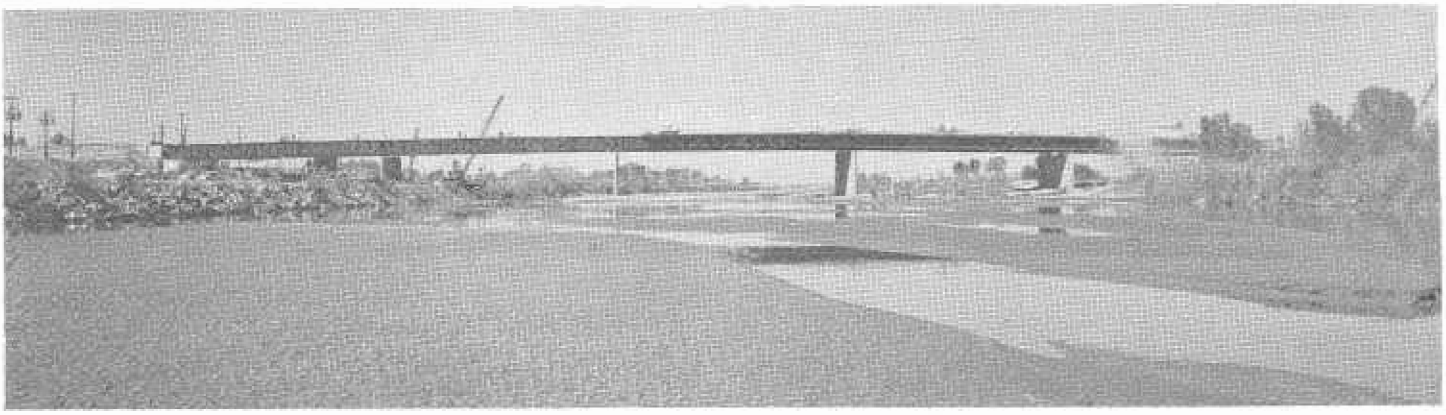
First Ferry at Yuma

Local tradition has it that the first ferry at Yuma was a raft built in Michigan and drawn across the continent on a prairie schooner and floated down the Colorado River to Yuma. A considerable portion of the '49ers took the route through Yuma and crossed the Colorado River by ferry. In the fall and spring of 1850-51 the ferry carried 60,000 people at $2 a head. In 1858 the Butterfield Stage started operations on the route through Yuma and crossed the river on a ferry at a charge of $5 for a four-horse team. The famous California Column ferried itself across the river at Yuma in 1866. During this period there were two ferries in operation, one operated by the Yuma Indians and one by Don Diego Jaeger. Service was interrupted from time to time due to Indian attacks and this was one reason for establishing an Army fort at Yuma.

Freight and transportation to and from Yuma and vicinity was provided to a considerable extent by boat and included a trip from Yuma to the mouth of the Colorado River by steamboat thence by sea-going vessel to San Francisco. Construction of Laguna Dam in 1909 stopped freighting up the river; however, the Colorado River is still classified as a navigable river and as such is under the jurisdiction of the Corps of Engineers, United States Army.

Railroad Builds Bridge

The first structure built across the river in this vicinity was the Southern Pacific Railway bridge constructed in 1878. There was no provision made for wagons and the ferries continued to operate until 1915 when the present highway bridge was designed and constructed by the U. S. Department of Interior, Office of Indian Affairs. This bridge is located about 1,500 feet upstream from the original railroad bridge and spans the river from the rocky hill on the Arizona side, which once housed the notorious territorial prison, now a museum, to a



New Yuma Bridge across Colorado River nearing completion

similar rocky point on the California side upon which stands a Catholic Mission to the Indians.

The bridge consists of a 336-foot steel curved chord subdivided panel through Pratt truss span and a 105-foot steel warren deck truss span on spread footings. It provides an 18-foot roadway with two five-foot sidewalks.

In 1916 the road across the Sand Hills area west of Yuma was improved in order to connect to the bridge across the Colorado. This improvement consisted of the wooden plank road, parts of which may still be seen along the present road, and was the first attempt to cross the area with a road. After considerable study of the movement of the sand dunes the present facility was constructed in 1926.

Present Span Inadequate

The present railroad bridge was constructed parallel to and immediately upstream from the highway bridge in 1922. The existing highway bridge was redecked in 1943 and it was necessary to close the structure for periods up to an hour while work was being performed. In order to reduce the delay and also to remove some heavy loads from the structure while it was being redecked, the Army constructed a pontoon bridge across the river immediately downstream from the existing bridge.

With the ever-increasing size and number of vehicles the present highway structure has become inadequate and by modern standards is lacking because of the narrow width, poor alignment, steep approach grades, and restricted sight distances. To correct these deficiencies the States of California and Arizona are jointly engaged in constructing a new highway crossing of the Colorado.

Design of Structure

Many of the problems involved in the design and construction of the new crossing have been lessened by the regulation of flow in the river by Hoover Dam, Davis Dam, Parker Dam, Headgate Rock and to a small extent by Imperial and Laguna Dams. Highest water on record is at elevation 137 on January 22, 1916, which is the apparent maximum since 1867. In spite of the regulation of flow, the under side of steel for the new structuce is set at elevation 150. The structure will provide two 28-foot roadways, divided by a 6-foot dividing strip, and one 5-foot sidewalk. The structure consists of five spans of riveted plate girders supporting a reinforced concrete deck and supported on solid reinforced concrete piers on steel pile foundations. The spans vary from 155 feet to 180 feet and total 837 feet from paving notch to paving notch.

Joint Venture

Many of the precrossing arrangements required of the pioneers and explorers were also required of the two states before a successful crossing

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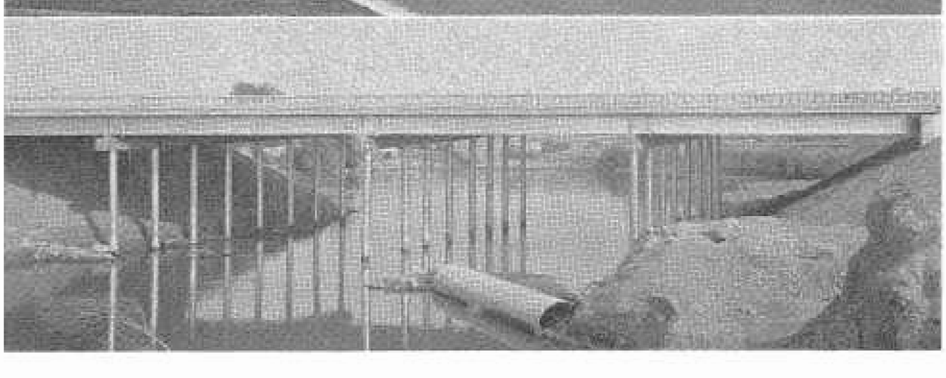
UPPER—Highway approach from existing bridge to new Yuma span.
LOWER—Approach bridge to new Yuma structure.



Freeway Development of US 99-5(

First Unit of Lodi to Sacramento Freeway

By JAMES E. WILSON, Project Design Engineer, District X

ANOTHER SECTION of California's Valley Highway, US 99, was brought to full freeway status recently by the completion of a project between Lodi and Sacramento. Local interests have long advocated relief from this traffic bottleneck, and this project marks the beginning of a series of improvements which will make this portion of US 99 one of the most modern in the State. The 3.45-mile project, just completed by M. J. B. Construction Company and Lord and Bishop of Stockton, is the first of several projects to be completed on this section. The limits are from Jahant Road in San Joaquin County to 0.5 mile north of the San Joaquin-Sacramento County line.

Coincident with the policy of the Division of Highways to make US 99 a full freeway, this project provides interchanges at Collier and Liberty Roads with full traffic movements at each. Approximately 18,700 feet of frontage roads are provided to serve residences and small businesses.

Geometric and Structural Features

The new northbound lanes were constructed to provide a 40-foot width of median. This allows for an ultimate development into a six-lane freeway with 16-foot median width. The existing traveled way, composed of 22 feet of pavement, placed in 1938, was widened and resurfaced with plant-mixed surfacing and is now being utilized as the southbound lanes. All travel lanes are 12 feet in width.

The new lanes are constructed of an eight-inch uniform thickness of portland cement concrete on four inches of cement-treated subgrade. A 12-inch layer of imported subbase material completes the structural section, giving a total depth of 24 inches. The native soil consisted of highly expansive material for which special treatment was necessary. The two feet of material directly below the structural section was removed and relaid with a moisture content in excess of optimum. Shoulders to the right and left of the driver are graded to a width of 10 feet and 5 feet, respectively.

Median shoulders consist of a two-foot plant-mixed surfacing border and three feet of untreated base. Outside shoulders are surfaced with plant-mixed surfacing on untreated base for a width of eight feet.

Widening and reconstructing the existing traveled way involved trenching out on the median side a width of 4½ feet and the placing of eight inches of Class "A" cement-treated base. Shoulder failures accompanied by high maintenance costs necessitated the reconstruction of the outside shoulder, which was removed and replaced with 10 inches of untreated base. The concrete pavement was then subsealed with asphalt to correct a pumping condition. A contact blanket of two-inch minimum thickness of Class "A" plant-mixed surface was placed on the old portland cement concrete pavement as a wearing course, and the shoulders were surfaced in the same manner as the newly constructed lanes.

Structures

Welded steel girder bridges were used for the Collier and Liberty Road overcrossing structures. Spans are supported by reinforced concrete bents and abutments. The

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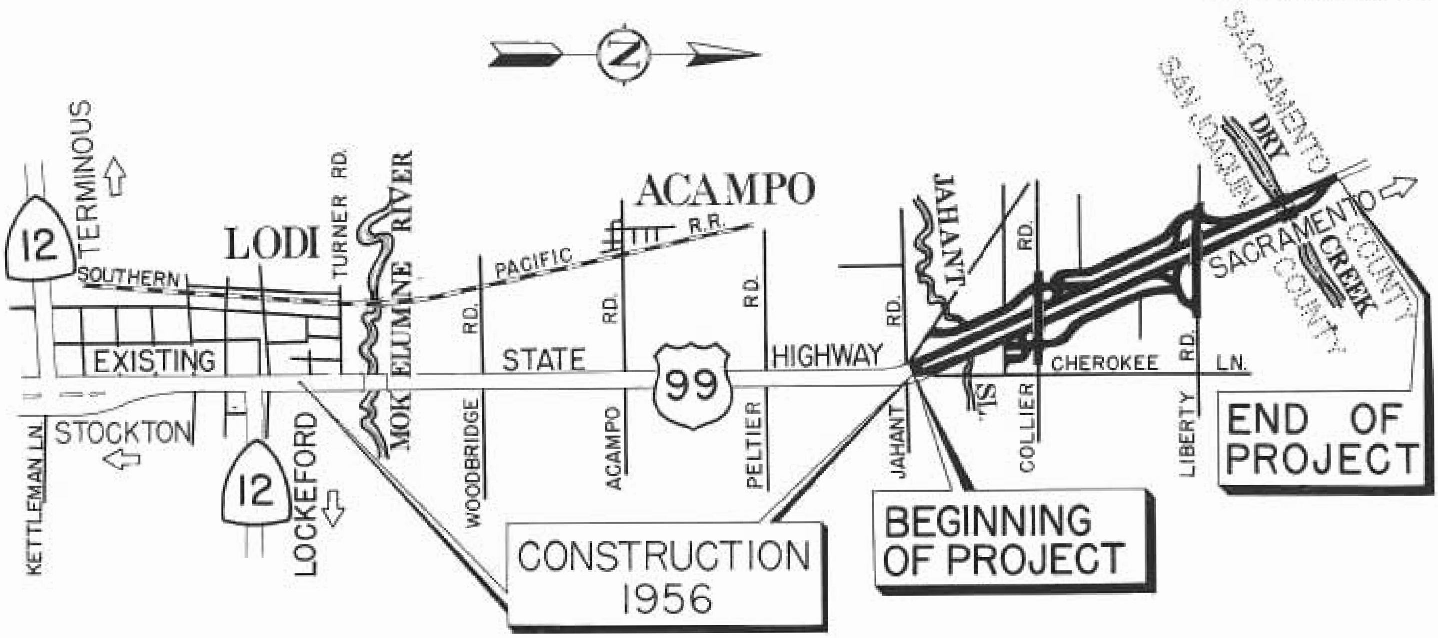

50 in Two Counties Moves Ahead

Progress of Freeway in Sacramento County

By P. C. SHERIDAN, Assistant District Engineer, District III

A 5.1-MILE SECTION of US 99-50 between 0.5 mile south of Elk Grove Road and 1.8 miles south of Florin Road is now under contract and is scheduled for completion about August of 1956. The Granite Construction Company is the contractor. Also under contract is the highway lighting for the project with Luppen and Hawley Company.

The existing highway, which is now a 20-foot concrete pavement, will be widened and resurfaced to effect a 24-foot traveled way for the future southbound lanes. The northbound lanes will be new construction of 24-foot portland cement concrete pavement. Frontage roads are being constructed the full length of the project on both sides. The freeway lanes are separated by a 46-foot median to provide for future development to six lanes.

Grade separations and interchanges are being constructed at the Elk Grove Road and Sheldon Road intersections. Two bridges are being widened and five new bridges constructed.

The normal right of way width is 234 feet to accommodate the frontage roads being constructed on both sides.

Second Unit Nearly Ready

Plans, specifications and estimates are ready for a second unit in Sacramento County which should be advertised within the very near future. This is a 7.1-mile unit and extends from near the San Joaquin County line to 1.6 miles south of the Cosumnes River. Like the unit now under construction, it will utilize the existing highway, widened and resurfaced, as the southbound lanes and a new 24-foot concrete pavement for the northbound lanes. There are about 8.25 miles of frontage roads, and like the first unit, the normal right of way width is 234 feet where frontage roads are to be constructed, and provision is made in the 46-foot median for future development to six lanes.

The structures include an underpass at the Ione branch of the Southern Pacific Railroad and grade separations and interchanges at C Street, Simmerhorn Road, Amador Avenue, State Route 34 Junction, and Arno Road. Four bridges are to be widened for the southbound lanes and parallel new bridges constructed for the northbound lanes.

Third Unit Is Budget Item

The preparation of plans is nearing completion for a 5.9-mile unit with advertising tentatively scheduled in November of this year. This unit will extend from 1.8 miles south of Cosumnes River to 0.5 mile south of Elk Grove Road. Again, the four freeway lanes will be developed similar to those on the two projects discussed above. There will be approximately 6.3 miles of frontage roads on a normal right-of-way width of 246 feet where frontage roads are to be developed.

The structures include an overhead for the northbound lanes at the Southern Pacific Railroad at McConnell, using the existing underpass for southbound lanes. Overcrossings and interchanges are planned at Dillard Road and Grant Line Road. The existing bridge at Badger Creek will be widened for the southbound lanes and a parallel new structure constructed for the northbound lanes, and a new structure for both sets of lanes are to be constructed at Cosumnes River and the Cosumnes River Overflows.

South Sacramento Freeway

Plans are in the design stage for the last section, which will extend for the 7.2 miles between 1.8 miles south of Florin Road and U Street in Sacramento. The complexity of this section is such that it will probably be constructed in several units. However, rights of way have been in the

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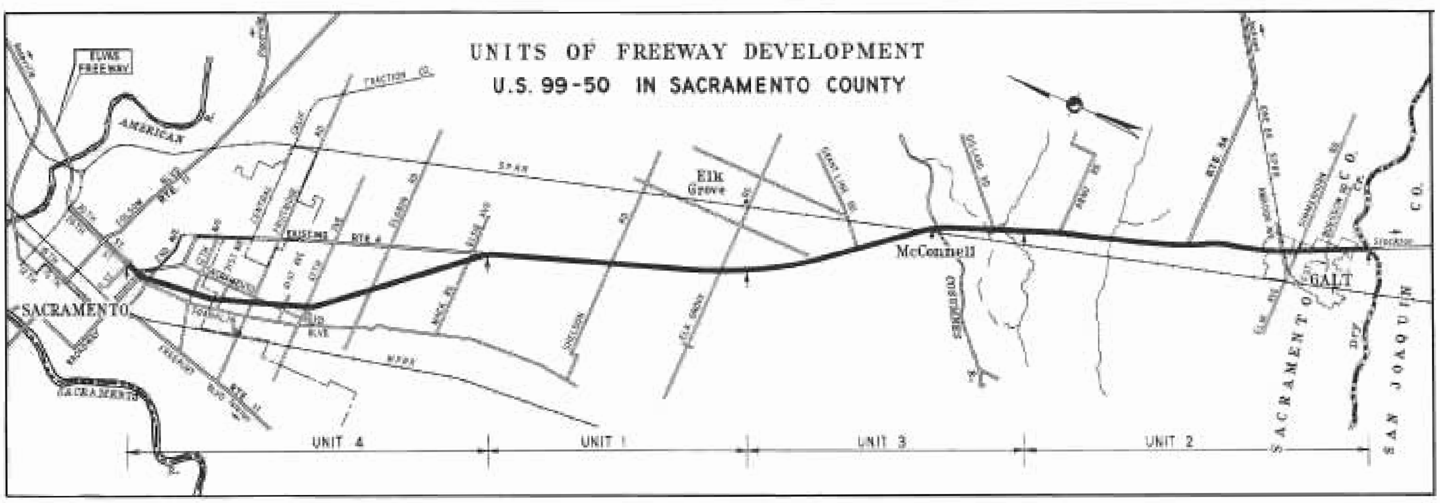

past 10 years there have come on the business horizon men who are skilled in analyzing which buildings can economically be relocated, the house buyer. These men have investigated the building codes and requirements of the many incorporated cities in the Los Angeles area as well as the requirements of the surrounding counties. They buy for cash at state auctions and sell the homes delivered to the lot of the final purchaser on credit. No bank or finance company will issue a long term real estate loan on improvements until the house is permanently affixed to the land, that is, the foundation put in, and all utilities connected. The house buyer finances the move and extends credit for a one-year period until the ultimate purchaser can get a real estate loan through normal loan agencies. The Division of Highways usually allows approximately ninety (90) days for improvements to be cleared from the right of way area. If the buyers have not sold their houses by this final clearance date, these houses are moved to storage lots and prospective customers can visit from 15 to 20 houses at each of these "used house lots."

A 16-unit apartment house was cut into five units to facilitate moving. This is a view of one of such units.

House Moving Industry

House moving is not a new industry in the area. However, it has undergone a tremendous expansion program since the close of World War II. Of the 23 recognized house movers in the area, six firms have come into existence in the last 10 years. Old established firms are now moving three and four times as many houses as were moved prior to the accelerated highway program. So far in 1955, the house moving industry has averaged moving 17 houses a night, five nights a week. In a year's time this will amount to 4,420 houses. This constitutes the housing for 22,000 people. That means each year in the Los Angeles area sufficient housing is relocated to house a city the size of Ventura. Sixty percent of all buildings being so relocated come from public works projects of which the freeway program is the major contributing operation.

Technological developments in the house moving industry have resulted in a greater efficiency. With the entrance into the house moving business of the hydraulic house jack, the use of pneumatic-tired dollies and powerful prime mover trucks, the industry has undergone a change equal to the industrial revolution in business.

Moving Is Cheaper

In fact, a house mover, hiring the same number of men as he hired in the late twenties, can move three to four times as many houses as he did then. This has resulted in keeping moving costs to a minimum. A five-room house can now be moved for approximately the same cost that it could be moved in 1930, in spite of the inflation that has taken place in the past 25 years. The distance that a house can be economically moved has been greatly extended. With present equipment a five-room house can move down the street at a rate of speed as much as 20 to 25 miles per hour. A house can now be moved from the central Los Angeles area to an outlying suburb in a matter of four hours while in the late thirties, this move ordinarily took approximately two days. Recently several houses have gone to San Bernardino, a distance of 62 miles, and some houses have been moved as far as Bakersfield, which is 119 miles. Ten years ago, such moves would not have been even considered.

Techniques Advanced

House moving techniques and know-how have also advanced greatly in the past decade. One technique that has been developed is the cutting of sprawling California style improvements into sections. These sections are then moved separately and the structure is reassembled on the new site. This technique has been used extensively on 2- and 3-story multiple unit apartment buildings and California ranch-style houses. The structures are reassembled so skillfully that it is im-

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USE OF ACCIDENT RECORDS IN HIGHWAY PLANNING AND DESIGN

By GEORGE M. WEBB, Traffic Engineer

Prepared for presentation at a meeting of the Advisory Committee on Freeway Traffic Control of the Assembly Interim Committee on Transportation and Commerce, at Los Angeles.

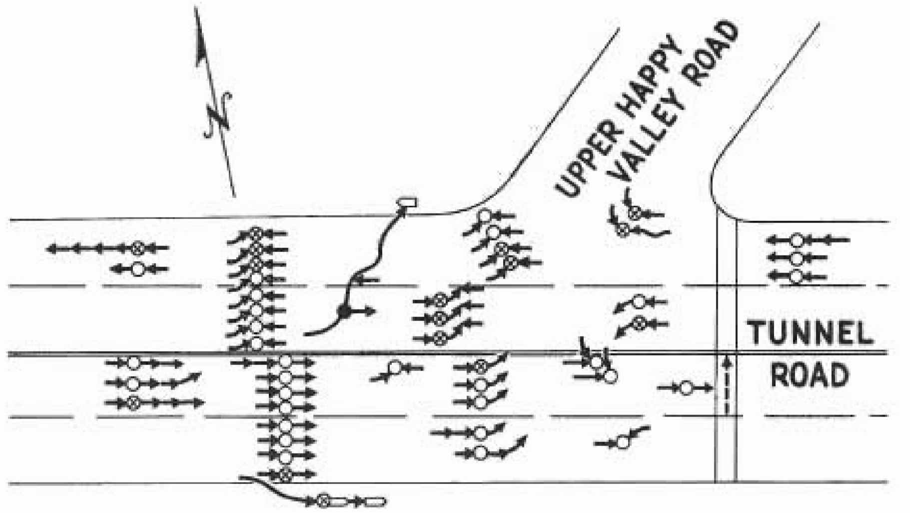
Accident reports furnish an important part of the basic information for the budgeting, planning, and design of highways. Accident studies point out the critical locations on the highway system, and analysis of the accidents provides the best clue to the proper corrective measures. Effective planning is based on the traffic volumes and accident rates, and progressive design is based on the effectiveness of highway features and designs, as shown by the accident experience.

California's full freeways are, and have continually been, the safest system of highways in the world. The 1954 fatality rate on California's full freeways was 27 percent and 29 percent lower than the comparable rates for the New York Thruway and the New Jersey Turnpike, respectively, the closest competitors. In California, freeway accident rates are approximately one-half and fatality rates less than one-fourth of those for conventional highways.

California Pioneered

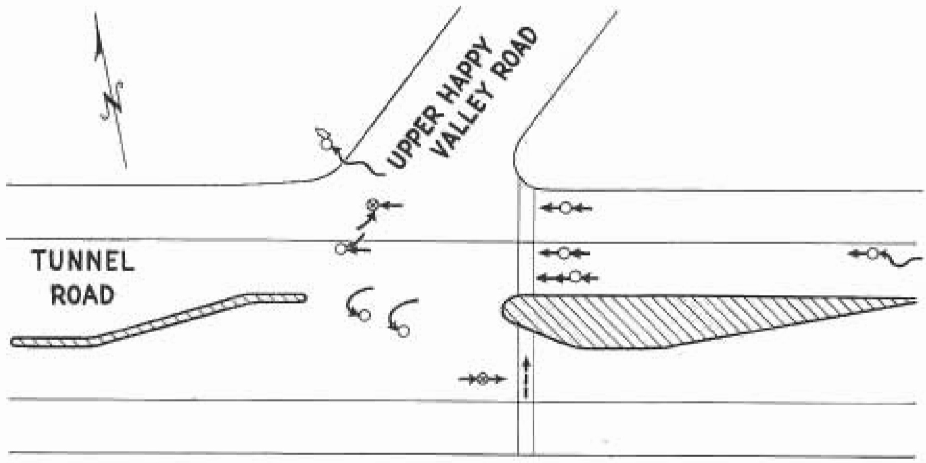
California pioneered the full freeway with the opening of the Arroyo Seco Parkway, now the Pasadena Freeway, in 1940. The Division of Highways has continuously studied freeway accidents and operation to provide the basis for improved design. Designs are not static, but freeway design is a proven safe design and changes must be approached with caution and supported by sound factual data.

Copies of all accident reports made by the California Highway Patrol are received by both the Headquarters Traffic Department of the Division of Highways and the appropriate Highway District. In addition, accident reports, as made out by the city police departments for urban freeways, are obtained from the city by the district offices and copies are forwarded to Headquarters Traffic Department. All accidents occurring on rural state highways and urban freeways are located to the point on the highway system at which they occurred. Within the districts and at headquarters, the accidents are spotted on sec-



Before

(SEPT. 26, 1950 TO SEPT. 26, 1952)



After

(SEPT. 26, 1952 TO SEPT. 26, 1954)

Simplified collision diagrams for State Sign Route 24 (Tunnel Road) in Contra Costa County at intersection with Upper Happy Valley Road for two years before and two years after channelization project. Follow-up study for the next two years showed that the improvement was successful in drastically reducing accidents. In studying such problem locations, accident reports are summarized for ready analysis on "detail cards," illustrated below.

IV-CC-75-A
Upper Happy Valley
Rd. intersection

L	DAYLIGHT	R	RARELY	P	PANEL OR PICKUP
D	DARK	F	FREQUENTLY	T	TRUCK
DA	DARK W/LIGHTS	PED	PEDESTRIAN	TT	TRUCK & TRAILER
NS	NOT STATED	C	CAR	M	MOTORCYCLE
N	NEVER	B	BUS		

4 1/4
(2)

ACC. NO.	DATE	TIME	LITE	SEVERITY F	SEVERITY NF	SEVERITY PDO	USE 1	USE 2	DESCRIPTION
1	9 16 49	1725	L			✓	F	N	C^1EB, det. brks, hit C^2EB in rear, no explanation, road under const.
2	9 14 49	1755	L		2		NS	F	C^1WB, excessive speed, applied brkes to avoid hitting V^3 making left turn, crossed double line hitting C^2EB head on, road under const.
3	10 15 49	1540	L			✓	R	F	C^5EB stopped, attempting left turn, $C^{4,3,2}$EB all stopped, C^2 hit in rear by C^1EB at excessive speed.
4	10 28 49	1650	L		3		NS	F	C^1EB swung over double line, hitting C^2WB head on
5	11 6 49	1715	D			✓	F	F	C^4EB stopped for traffic, resulting in a 4 car rear end (raining)
6	11 6 49	1717	D		1		R	NS	C^1EB stopped in E-1, resulting in a 3 car rear end (raining)
7	11 6 49	1717	D			✓	F	F	C^1EB in E-2 came upon previous acc. broadsided into W-2, hit C^2WB head on sideswipe (raining)
8	11 8 49	1725	D			✓	F	F	C^1EB in E-2 hit in rear as he stopped for V^3 making left turn, by C^2EB, both at excessive speed
9	11 27 49	0030	D		5		F	R	C^1SB making left turn out of U.H.V. road, hit by C^2WB (HBD ANI)
10	1 29 50	1400	L		1		F	F	C^1EB made improper left turn in front of C^2WB
11	2 20 50	0730	L			✓	R	F	C^4EB stopped for traffic ahead, hit in rear by C^1EB, 4 car rear end. caused by excessive speed.
12	2 26 50	1515	L		2		F	R	C^4EB stopped for traffic ahead, 4 car rear end.
13	4 16 50	1553	L			✓	N	F	✓ ✓ – – ✓ ✓
14	4 28 50	1200	L			✓	F	F	C^1NB making left turn hit C^2NB starting up from parked position
15	4 29 50	1930	D			✓	F	F	C^1EB, exceeding safe speed, hit C^2EB who stopped for traffic

tion profiles or section index cards which, in either case, represent a log of the highway showing the position of intersections, structures, city limits, and other identifying features. Developing concentrations of accidents at any one point can be readily noted. Such locations are studied and the accident pattern analyzed to determine corrective measures.

Accident Reports Coded

After the accident reports have been located, the accidents occurring on the rural state highway system are coded for punching on IBM cards. With traffic data also coded for punching, the accidents and the traffic factors are combined mechanically to develop accident rates and injury accident rates for each section or shorter segment on the State Highway System. In addition, many standard and special tabulations are obtainable from the punched data, including rates by each type of road as broken down by: (a) number of lanes; (b) degree of access control; and (c) type of division, if any. The punched data are also available as an aid in many special studies undertaken by the traffic department.

The Accident Analysis Section of the Traffic Department studies points of accident concentration and all points involving recommendations by the Highway Patrol. Accidents are plotted and analyzed to determine the accident pattern and the appropriate corrective measures. After correction has been made, the location is still watched to determine the effectiveness of the correction. Occasionally, it may be necessary to make further improvements to control the accidents at a specific location. These before and after studies, which are continually being made at points of highway improvement, generally provide a sound basis to determine the effectiveness of any specific type of corrective measure.

Accident Analysis

Accident analysis is a specialized phase of traffic engineering. It requires not only an engineering background, but also considerable training in the specific field as well as in analytical and statistical methods. Engineering judgment, developed to a high degree by experience in this field, is essential in determining the proper corrective measures. The apparently obvious answer, as often proposed by untrained observers, is often far from the correct solution to an accident problem.

Major Reports

A substantial portion of the work of the Accident Analysis Section involves studies to determine the effectiveness of specific design features. Some of these studies result in major reports which receive national distribution. The majority of the reports, however, are not developed to such a formal stage but are effective for the use of the Division of Highways in answering specific questions of design or effectiveness of highway features.

Among major reports issued by this department was the report "Median Study, 1952." This study was based on more than 12,000 accidents occurring over a period of two years on some 500 miles of four-lane divided or undivided rural highways. The formal report was presented before the Highway Research Board in 1953 and was republished by that agency. It has received national acclaim as the most comprehensive and complete study of median dividers ever attempted.

Record of Medians

Basically, this study shows that for rural highways and the range of traffic volumes encountered on such roads, medians *without* physical barriers have a substantially better safety record than barrier-type medians, even though the barrier is located in the center of a wide earth median. Briefly, the studies show that a positive divider is twice as safe as a traversable median in preventing approach-type accidents (head-on and head-on sideswipe), but for each such approach-type accident eliminated, there will be five additional single car accidents reported, primarily involving the barrier. In the over-all accident picture, medians with a physical barrier show approximately 10 percent more persons killed or injured than do traversable-type medians.

The "Median Study" did show, however, that barrier-type medians showed to better advantage as traffic volumes increased, and indications were that such medians might prove of advantage at traffic volumes in excess of those available in the report.

Pasadena Freeway

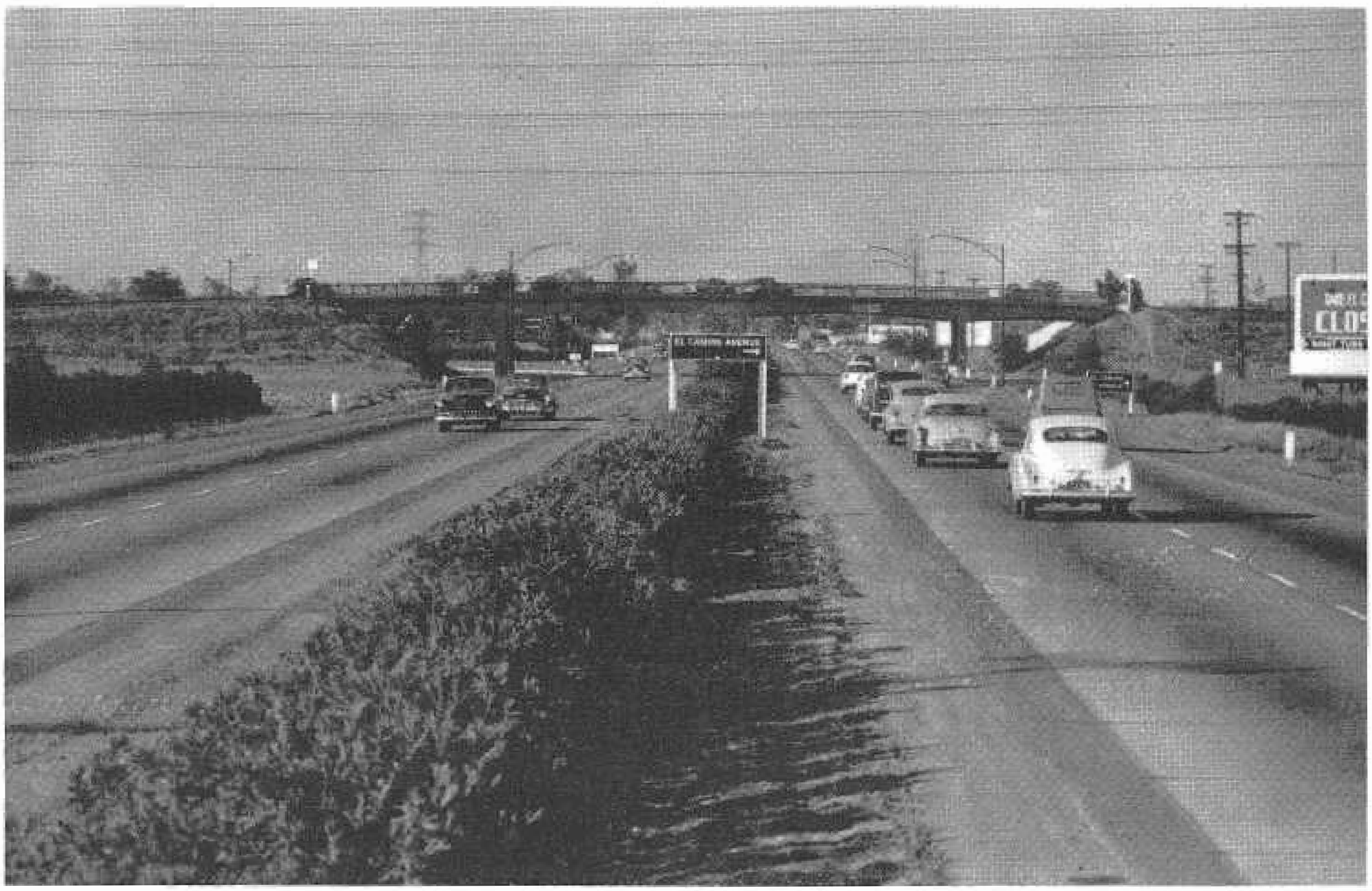
Although the Pasadena Freeway, the earliest freeway design, has what is now considered a substandard width of median, it does carry large volumes of traffic and the existing four-foot low curbed median offers little resistance to crossing. However, over some lengths of this freeway, the existing curb has been backed up by a high barrier curb or guard rail installed in the median. The rate of accidents involving the median is 31 percent higher for lengths with barrier-type median than for lengths with low curbed median, as shown by a study covering seven years of operation.

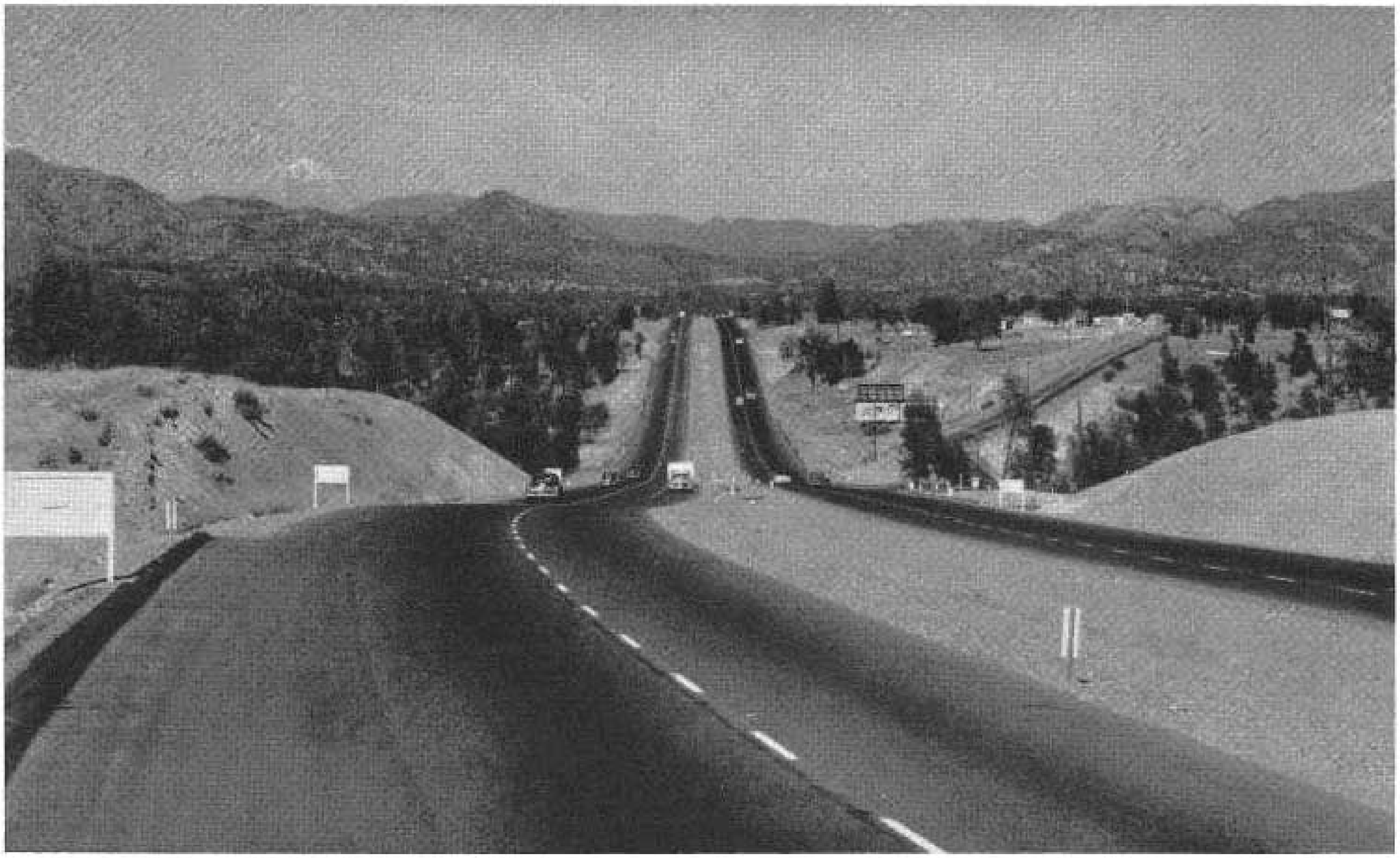
On the other hand, approach-type accidents are extremely rare on this freeway. This is due primarily to the fact that the majority of median crossings occur in peak hours and the highly directional flow results in very light traffic movements on the opposing lanes. Vehicles are forced across this narrow median but only rarely is one involved in an approach-type accident.

Guard Rail Installation

In spite of the fact that the Division of Highways has never experienced a reduced accident rate by the installation of a physical barrier within an existing median, a serious record of

Freeway design improves with experience, but basic safety features built into some of the earlier full freeways are still paying dividends in terms of saving life and limb. The North Sacramento Freeway, in operation since 1948, has an excellent record. Its seven-year accident rate (all types) is 1.56 per million vehicle miles and its fatality rate 1.84 per hundred million vehicle miles.





Accident records on rural expressways show that medians without physical barriers make for greater over-all safety. This recently completed section of US 99 north of Redding was designed with a wide traversable dividing strip.

crossed-median accidents has given cause to install back-to-back guard rail on a two-mile section of the San Bernardino Freeway. Bids for this improvement were opened November 25, 1955. The alignment and width of median on this section of freeway is no longer adequate according to present-day standards for high volume metropolitan freeways. This location has a better chance than any other location on the State Highway System of showing an improvement in traffic safety by the installation of a positive barrier.

Another major report issued by the department was a report on "Intersection Accidents on Divided Highways." This report was presented at the 1953 meeting of the Highway Research Board and reprinted in a bulletin issued by the board. It primarily sets forth the relation between accidents and entering traffic volumes at divided highway intersections and provides a basis for determining the accident savings that could be achieved by separation of any specific intersection.

Signalized Intersections

A recent report, "The Relation Between Accidents and Traffic Volumes at Signalized Intersections" was presented at the 1955 annual meeting of the Institute of Traffic Engineers. As the title implies, this report provides a basis on which future accidents may be estimated if an intersection is signalized, which information is of prime importance in considering the signalization of an existing intersection.

Other Accident Studies

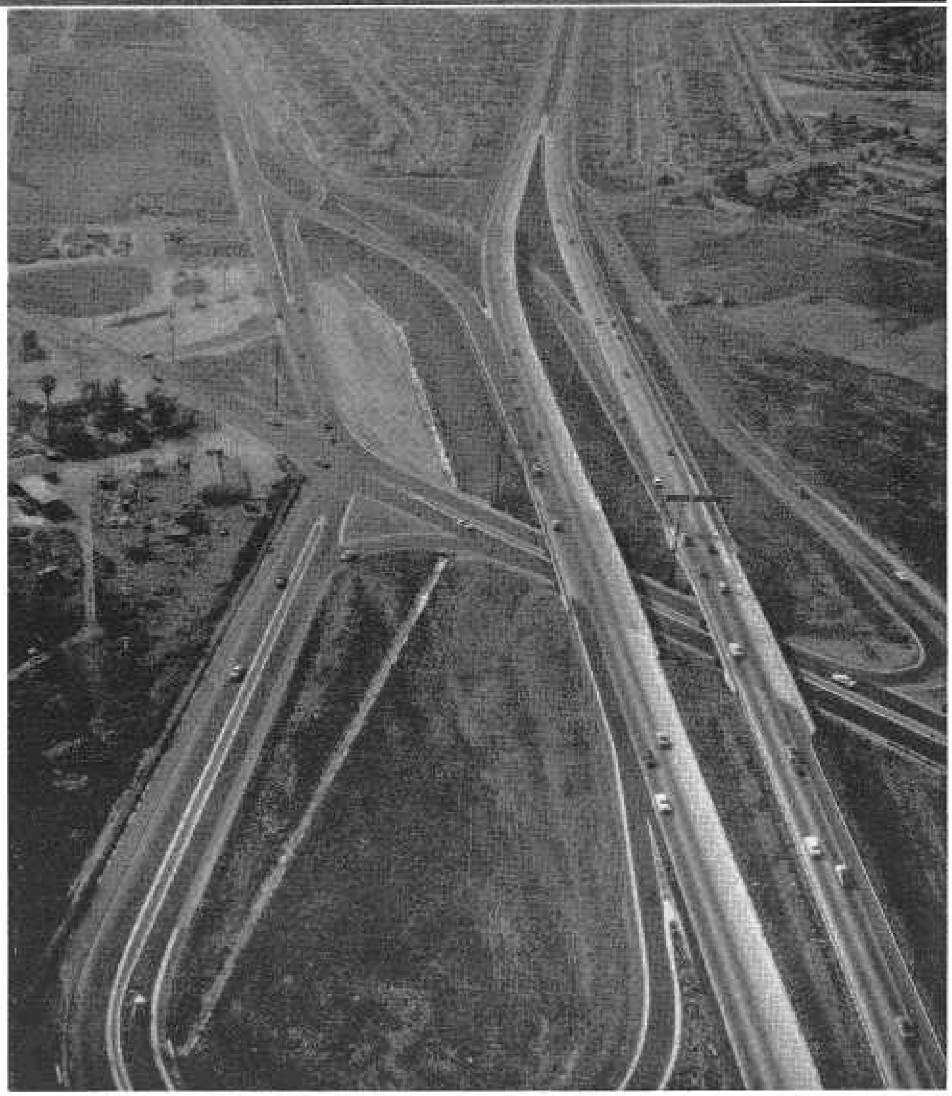
Among the many traffic studies undertaken by the department that did not result in a published report are the following:

"Urban Expressways" report. This report was for technical use and was circulated only within the Division of Highways. It pointed out that expressways with intersections at grade were not a satisfactory installation from the accident standpoint in urban areas. Safety achieved by the elimination of private access and the installation of a divider was offset by the excessive number of accidents at the intersections due to the wider intersections and the generally higher speeds of through traffic. This report had great impact on design policy in that it resulted in the establishment of a standard of full freeways with intersections separated for major highways in built-up areas.

Other reports for use in design were a study of the relation of sight distance to accident rates on two-lane highways and a study relating shoulder width to accidents, also on two-lane highways.

The study "Guard Rail at Bridge Ends," made for design information, was later published in the *California Highways and Public Works* and *Western Construction* magazines.

Other informal departmental reports covered, from the accident standpoint, the effect of increasing



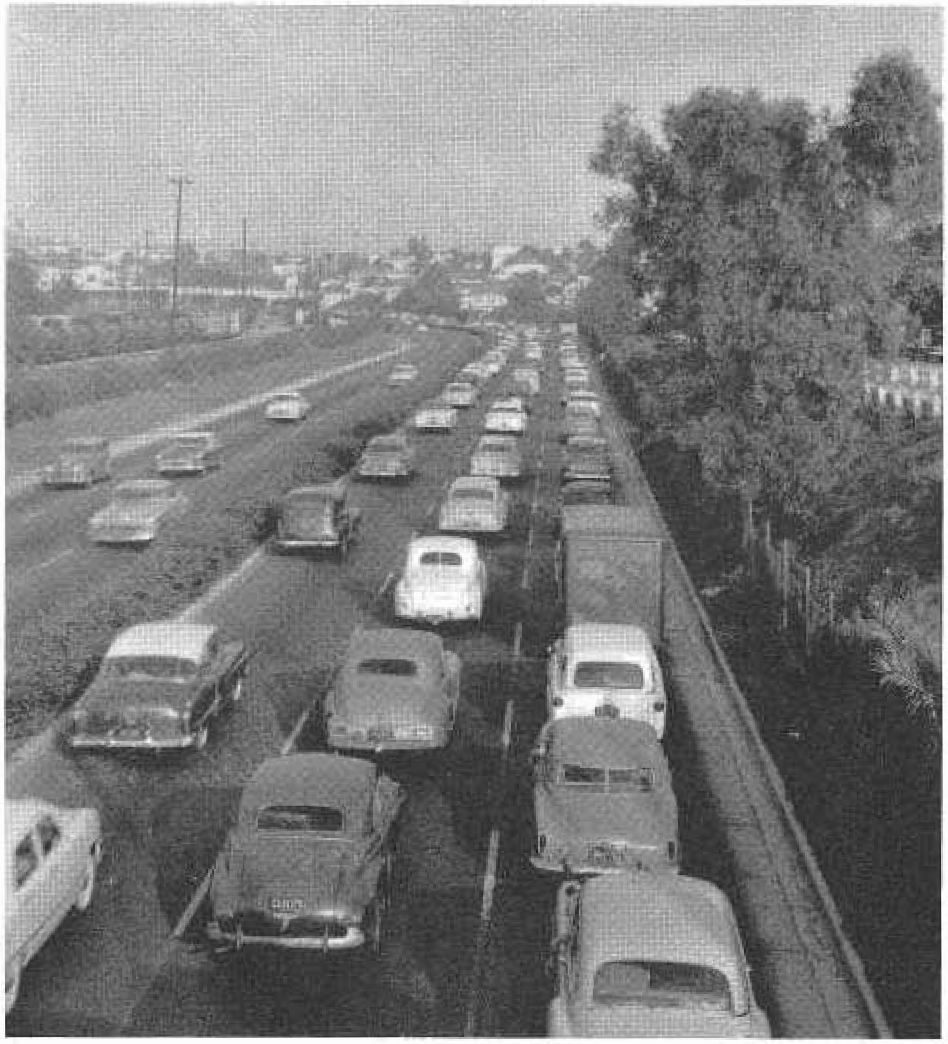
Analysis of accident reports showed clearly that in urban areas expressways with intersections at grade need to be replaced as soon as financially possible by full freeways with intersections separated by structures. UPPER—The Rosecrans-Firestone Intersection on the Santa Ana Freeway near Norwalk in 1952. LOWER—Aerial view of the same location completed to full freeway standards in 1955.

curve radius and the installation of stated (advisory) speed signs on curve accidents.

Proper Spacing on Off-ramps

A study of proper spacing of on- and off-ramps in freeway design was published in the September-October, 1955, issue of the *California Highways and Public Works* magazine under the title "Freeway Ramps—Proper Spacing Important in Preventing Accidents."

A two-year sample of accidents on the heaviest traveled portions of the Hollywood and Pasadena Freeways was very carefully analyzed from all angles in a search for the basic factors responsible for accidents on high-volume freeways. No formal report has been issued but data available in this study have been useful to the department. General findings include a factor that was previously known—that accidents rise sharply when a road is carrying traffic volumes in excess of the practical design capacity. Another item disclosed by this study was the high percentage of accidents involving on- and off-ramps and the fact that off-ramp accidents were three times as frequent as on-ramp accidents on high-volume freeways. This information was utilized in the ramp study mentioned above. The third item disclosed by this study was the fact that in spite of the low traffic volumes, the 2 to 3 a.m. accident peak



This picture (taken before installation of the guard rail) of evening rush hour traffic last summer on the San Bernardino Freeway near downtown Los Angeles indicates why back-to-back guard rail has just been installed in an effort to reduce crossed-median accidents on this section built in 1948. Subsequent sections of this and other heavily traveled metropolitan freeways provide a wider median, straighter alignment, adequate shoulders and other improved elements of safe design.

was as high as that during the morning peak hour and almost as high as that during the evening peak hour. The high percentage of "had been drinking" accidents occurring in these early morning hours definitely ties the accident peak to the closing of the bars at 2 a.m.

Although not directly related to design, the coding of accident information allows us to easily isolate reported causes of accidents. In the study of freeways, it might be interesting to know that 95 percent of reported causes involve driver violations or condition. Vehicle conditions, roadway causes, and miscellaneous causes combined to a total of only 5 percent. The table below shows a breakdown of accident causes for a one-year sample of freeway accidents in the Los Angeles, San Diego and San Francisco areas, as well as the composite rate of these three locations.

	Los Angeles		San Diego		San Francisco		Composite	
	No.	%	No.	%	No.	%	No.	%
Violations of rules of the road	428	69	95	75	31	45	554	68
Improper speed	35	6	4	3	5	7	44	5
Had been drinking	100	16	19	15	20	29	139	17
Other driver conditions	29	4.5	7	6	6	9	42	5
Miscellaneous (including condition of vehicle, road, etc.)	29	4.5	1	1	7	10	37	5
Totals	621		126		69		816	

Driver Responsibility

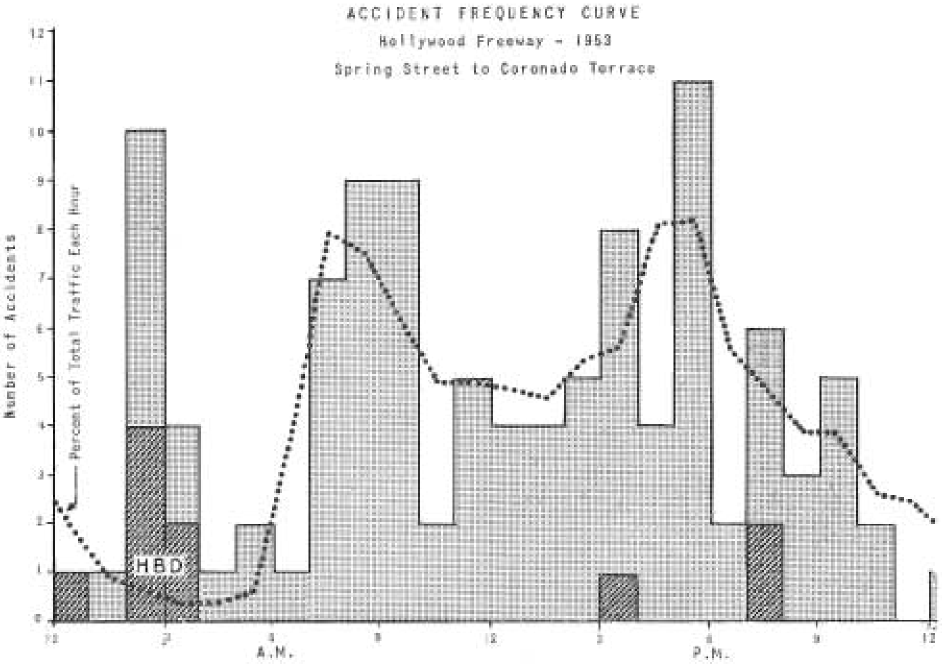
The extremely high percentage of accidents in which a driver failure or a driver condition was involved points out a tremendous field for traffic accident reduction. The performance of drivers and drivers' attitudes are things beyond the scope of the engineer's activities. It would seem that the high percentage of accidents which involve driver behavior or attitudes should be classed as a social problem. This approach to the prevention of traffic accidents opens up a field of great possibilities in accident reduction and points out the best line of endeavor for safety-minded citizens, citizens' groups, organizations, service clubs, and others who desire to do something constructive to improve traffic safety. The Division of Highways is eager to cooperate with all such efforts, and will continue to place its engineering knowledge and experience at the disposal of any group making an all-out attack on the traffic safety problem.

Influence on Planning

The accident and injury accident rates on highway sections are an important consideration in the planning and budgeting for future highway improvements. In addition, locations of accident concentration, the solution of which requires a major construction project, rate high in the competition for highway funds. The importance of accident rates in planning is emphasized in departmental instructions covering the preparation of planning programs. The accident rate for each project is studied in the selection of projects for inclusion in the planning program. Special consideration is given to those sections having a high or abnormal accident rate.

Influence on Design

The influence of accident studies on design has been rather thoroughly covered in the listing of various formal and informal reports, virtually all of which are aimed at the checking of existing designs and the improvement of design standards. No change in design standards is undertaken without



Accident analysis sometimes reveals a pattern beyond the possibility of correction by engineering measures. As this chart shows, accidents on the close-in section of the Hollywood Freeway are about as numerous in the 2 a.m.-3 a.m. period as in the morning and evening rush hours although traffic volume is much lower. The shaded portion of the vertical bars indicate the number of accidnets in which police reports noted "had been drinking."

referring to such accident information as is available to indicate the influence that such change will have on the safety picture.

From the standpoint of public benefit, there is no doubt that engineering use is the most important use of accident reports. Both the location for improvement and the type of corrective measure, as well as the basis for improved design standards, are obtained from analysis of accident reports. The cumulative effect of corrections at locations where accidents are happening and the expanding mileage of freeways and expressways are at present providing great improvement in safety on state highways.

It follows that the best use of the highway dollar for greatest public benefit is to build freeways based on tested and tried designs specifically developed to move large volumes of traffic expeditiously and with the maximum safety.

The world's heaviest-traveled highway—the close-in section of the Hollywood Freeway carries an estimated 180,000 vehicles per day, far in excess of its practical design capacity. Yet in 1954 it had one of the best safety records in history for a major trafficway—only 0.8 fatalities per hundred million vehicle miles of travel.

SIGN LIGHTING FIXTURE DEVELOPMENT IN DISTRICT IV

By VERNON H. WAIGHT, Associate Electrical Engineer, and
JOHN R. BRASS, Associate Highway Electrical Engineer

The ever-increasing number of miles of California highways built to freeway standards has brought into focus the need for adequate signing. Essentially, signs serve to guide drivers, especially those unfamiliar with the particular stretch of highway, in order that they might make the proper choice of direction at an interchange. When placed in advance of the interchange, signs serve to segregate traffic into proper lanes before reaching the point of divergence.[1, 2]

Need for Sign Lighting

Considering the above mentioned points, the necessity for adequate visibility of signs at night becomes apparent; clearly a sign without means for such visibility would be less useful at night than an automobile without headlights.

Originally all signs were small and low-mounted, and night visibility was provided by utilizing reflectorized messages activated by vehicular headlights. The increasing speed of freeway traffic has demanded larger signs,[2] signs which in turn have required greater mounting heights, in order that they might be located in narrow gores or above the roadway.[3] These larger signs are mounted on posts and bridges at heights of 15 to 17 feet. Some means should be provided for illuminating large overhead-mounted signs.

Early Sign Lighting Installations

The earliest single-post mounted directional signs in District IV were placed along the Bayshore Freeway between Colma Creek and Burlingame. The sign panels had black letters on a white background. Illumination was provided by incandescent lamps in porcelain enamel sign reflectors mounted along the top of the sign panel. This type of fixture and mounting resulted in lighting that was characterized by a bright reflected image of each fixture on the sign panel, an effect which resulted in poor night legibility of the signs.

In 1948 there was brought to our attention a fluorescent fixture of the showcase type, designed primarily for interior use. The unit was installed, top-mounted, as a replacement of the incandescent units on a sign at the Broadway-San Mateo Interchange on the Bayshore Freeway. Although in retrospect this fixture appears embryonic as compared to the latest fixture, it resulted in a much improved lighting job and in addition, clearly indicated the superiority of a line type light source for panel lighting.

Some time later a southern California manufacturer introduced a top-mounting sign lighting fixture with a trough-shaped reflector.

Principles of Good Sign Lighting

Fundamental principles[4] which should be observed to insure an efficiently and effectively illuminated sign are:

1. Provide uniform brightness of sign message. (Uniform illumination may not provide uniform brightness due to reflections.)
2. Make the brightness of sign panel sufficient so that it will stand out in contrast with its immediate surroundings.
3. Permit neither direct nor reflected glare.
4. Make the lighting equipment inconspicuous and so located that it will not interfere with the view of the message.

Comparison of Fluorescent and Incandescent Lighting

Before continuing any general discussion of fluorescent sign lighting fixtures, it is desirable to consider the reasons for selecting the fluorescent tube source over conventional incandescent sources.

1. The continuous line source, provided by fluorescent lamps, furnishes inherently superior uniformity of illumination horizontally across the sign panel.

2. Fluorescent lamps provide better uniformity of illumination from top to bottom of the sign panel. Illumination from a small light source decreases inversely as the square of the distance from the source. However, illumination from a line (fluorescent) source decreases inversely only as the distance from the source.

3. Considering top-mounted fixtures, the lower brightness of the fluorescent lamps causes less reflected glare on the sign panel from the source being "mirrored" in the sign panel.

4. The uniformity of illumination is less affected by burnout of one fluorescent lamp due to the overlapping light from other lamps.

5. Fluorescent lamps provide at least twice the lamp life.

6. Fluorescent lamps, including ballast losses, consume approximately one-half the power for equal light output.

Faults of Top-mounted Fixtures

One of the most disturbing effects from conventional methods of lighting porcelain signs from above, is that the light source is "mirrored" in the semiglossy surface of the sign into the drivers' eyes, especially on rainy nights. This effect causes black portions of the sign to appear very nearly as bright as the white portions, which reduces legibility, and accounts for the often heard remark that too much light is directed on the signs. Actually the measured illumination level on these signs is not high, and the same or much higher level produced by bottom-mounted fixtures is quite comfortable and produces excellent visibility. *(See Figures 1 and 2.)*

Due to the fact that any improvement in light control in bracket-arm, top-mounted fixtures will intensify the reflected image, any work done in this direction does not appear promising.

Top-mounted fixtures adjacent to the face of the sign (not on arms), produce glaring reflections only near the top of the sign. This glare has less

Bottom-mounted fluorescent sign lighting at the southbound Army Street off-ramp on the Bayshore Freeway in San Francisco. Photograph taken with K2 filter to correct for panchromatic film response and carefully exposed, printed and selected to match observed appearance of sign in field.

effect on visibility of the sign than the glare from bracket-arm, top-mounted fixtures, but is nevertheless undesirable.

During daylight hours top-mounted fixtures produce shadows on the sign panels which reduce legibility.

Advantages of Bottom-mounted Fixtures

The first bottom-mounted fluorescent fixtures were proposed and installed only to fill in the low light level at the bottom of signs over four feet high. These fixtures had little or no light control, they cut off light at the bottom of the sign and they were otherwise unsatisfactory in durability of reflector and in certain mechanical details. Because bottom-mounted fixtures do not have the faults of top-mounted fixtures mentioned above, a new design was proposed and a plan was drawn up for a fixture which would have sufficiently good light distribution to satisfactorily light, from the bottom, any sign size up to seven feet high.

In some localities, with severe dust and soot conditions, it would appear that only top-mounted fixtures would operate satisfactorily. However, a well designed bottom-mounted fixture will initially direct a much higher percentage of total lamp lumens on the sign than conventional top-mounted fixtures, thereby compensating for a possible poorer maintenance factor. It should also be pointed out that only the top glass in a properly designed bottom-mounted fixture will have the large deposits of dust and soot, and in addition to being easily cleaned, it is self-cleaning to some extent. Open top-mounted fixtures are not only difficult to clean, but in addition are not self-cleaning.

Features of New Design

The functional requirements of the new design were as follows:

1. The brightness of the sign panel should be as nearly uniform as possible.

Due to the greater distance of the top of the sign from the source and the unfavorable angle of the surface at the top with the light "beam," the light intensity toward the center of the top row of letters should be about three times the light intensity toward the bottom of the sign.

Top-mounted fluorescent sign lighting at the northbound South San Francisco off-ramp on the Bayshore Freeway in South San Francisco. Photograph taken and selected as for Fig. 1. The reflections are typical but slightly exaggerated due to limitations in latitude of currenly available photographic materials.

This figure is based on positioning the source of light one-half the sign panel height out from the bottom of the panel. Placing the fixture in closer to the bottom of the sign requires greater relative light intensity toward the top of the sign which is difficult to obtain. Placing this fixture further out reduces the relative intensity required toward the top of the sign but requires excessively long support arms. Since fixtures without any light control ability had been previously placed about one-half the sign height from the bottom of the sign, it was assumed that with a considerable degree of light control excellent uniformity could be obtained at this distance.

Light Output Factor

2. Most of the light output should be directed on the sign panel. Previous bottom-mounted fixtures had considerable light output vertically upward but relatively little output on the sign, due to the lack of control from the ineffectual bent metal reflector and the diffuse white enamel reflecting surface.

3. The reflectors should be housed in a corrosion-resistant, raintight and dust-tight enclosure with a sealed transparent window.

4. The housing should be designed to facilitate access for cleaning, removal of reflectors and lamp replacement. It was suggested by one manufacturer that it would be preferable not to hinge the glass window, as in previous designs, but to have the window fixed and provide one access door at the back of the fixture away from the sign. This position provides easy access to the lamps and reflectors and reduces the possibility of glass breakage. The reflectors (*see Figure 3*) may be easily wiped clean of dust and dirt and do not trap dirt at any point.

5. The fixture should be made up of lamp length units, which could be assembled to fit any length sign. (*See Table I.*) This standardization of sizes would reduce manufacturing costs, since fixture fabricators could concentrate on making two or three different size units. In addition, the shipping problems would be simplified. Previously the fixtures were made in one piece to fit each sign panel, the length

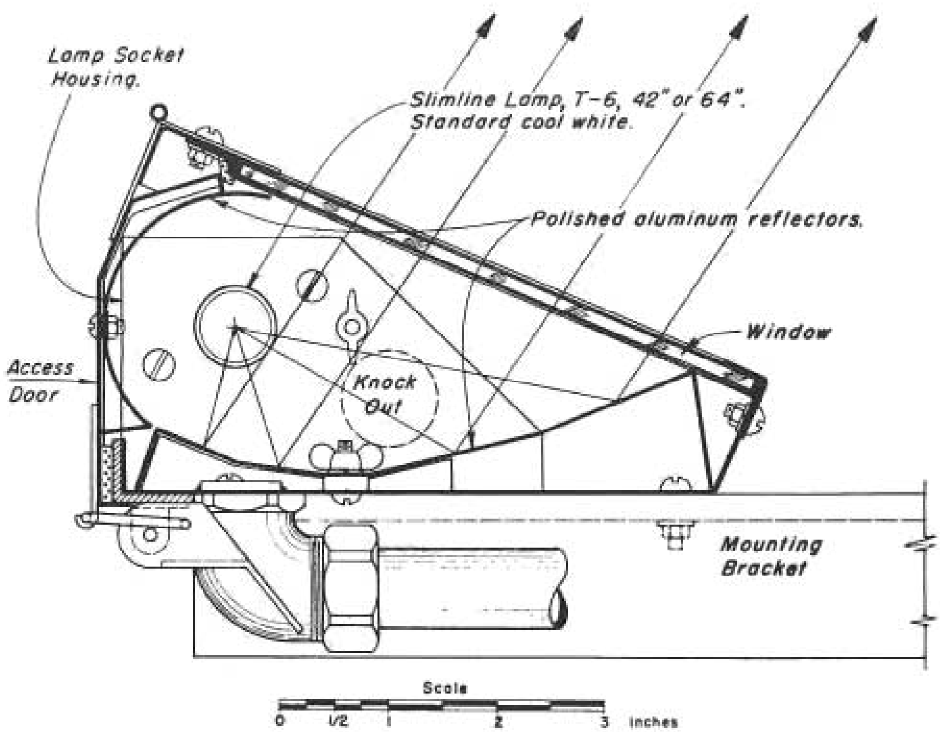


Fig. 3. Cross-section of bottom-mounted sign lighting fixture showing control of light "rays".

of which varied widely. Thirty-eight-foot-long boxes would have been required for some recent sign fixtures.

Special Reflector Required

The problem of obtaining light intensity toward the top of the sign equal to approximately three times the light intensity toward the bottom of the sign, without wasting light in any direction, was solved by the use of a polished metal reflector with a cross-section made up of a combination of a cylinder and parabola (*see Figures 3 and 4*). No other shape of reflector known to the writers will outperform the "paracyl" in these respects. A full parabolic reflector shape wastes much direct light toward the sky. Surfaces other than polished metal "mirror" surfaces, such as white porcelain or white enamel, do not provide any great amount of light control but act for the most past as secondary diffuse sources, emitting light in all directions.

The material used as the reflector consists of an aluminum sheet with a layer of special, high purity aluminum on one side. This layer presents a reflecting surface that is very smooth and specular but at the same time, by its very nature, is subject to both abrasion and corrosion. To protect this surface, the reflector sheet is subjected to an electrochemical process, consisting primarily of surface preparation of the metal, brightening, formation of aluminum oxide and sealing of the surface. The final result is a clear, smooth, hard, continuous coating of aluminum oxide, nonporous and resistant to abrasion and corrosion. The reflecting surface, with proper maintenance and use, should remain at or very near its original condition indefinitely.

Selection of Proper Fluorescent Lamps

The lamps used, 42-inch long and 64-inch long T-6 (¾-inch bulb diameter) Standard Cool White, were selected for the following reasons:

1. The small diameter of these lamps provides good light control. Theoretically the best control would be secured by using a thin line source. Larger tubes such as the 1½-inch T-12 when operated at 425 milliamperes, provide only about 15 percent more lumens per foot than a T-6 operated at 300 milliamperes; and the poorer light control will offset the higher light output.

2. The 42-inch and 64-inch lamp lengths provide sufficient flexibility to meet any of the standard sign sizes as may be seen in *Table 1*. This cannot be said of 72-inch and 96-inch lengths.

3. Before the cool white lamp was selected, both daylight and warm white were tried in sign fixtures, the latter primarily because of its high efficiency rating. From an appearance standpoint neither was satisfactory, the daylight appearing too harsh, the warm white, although it possessed the highest lumen rating, unexpectedly appearing dim. The cool white displayed neither of these bad effects and accordingly was adopted.

Illumination Levels

Field measurements of existing fluorescent sign lighting installations

TABLE I

SIGN LIGHTING FIXTURE ARRANGEMENTS AND ELECTRICAL DATA

Length of sign	Number and nominal size of fixture units	Lighting fixture bracket spacing	Total watts and series—multiple* transformer rating for various sign heights		
Feet-inches	Inches	Inches	40"	60"	90"
10′ (120)	1-43, 1-65 (108)	11.5, 20, 40.5, 31	65 (100)	90 (150)	123 (150)
12′ (144)	2-65 (130)	17, 31, 48, 31	70 (100)	99 (150)	133 (200)
14′ (168)	2-43, 1-65 (151)	11.5, 20, 37, 31, 37, 20	86.5 (100)	124 (150)	166 (200)
16′ (192)	1-43, 2-65 (173)	17, 31, 38, 20, 38, 31	96.5 (150)	137 (200)	184.5 (300)
18′ (216)	3-65 (195)	17, 31, 44.5, 31, 44.5, 31	106.5 (150)	152 (200)	202 (300)
20′ (240)	2-43, 2-65 (216)	11.5, 20, 36.5, 31, 42, 31, 36.5, 20	120 (150)	170 (200)	230 (300)
22′ (264)	4-65 (260)	17.5, 31, 35, 31, 35, 31, 35, 31	140 (200)	198 (300)	266 (350)
24′ (288)	2-43, 3-65 (281)	12, 20, 30, 31, 35.5, 31, 35.5, 31, 30, 20	156.5 (200)	223 (300)	299 (350)
26′ (312)	1-43, 4-65 (303)	17.5, 31, 36, 31, 30.5, 20, 30.5, 31, 36, 31	166.5 (200)	236 (300)	317.5 (500)
28′ (336)	5-65 (325)	16.5, 31, 37, 31, 37, 31, 37, 31, 37, 31	176.5 (300)	251 (350)	335 (500)
30′ (360)	2-43, 4-65 (346)	11, 20, 31.5, 31, 37, 31, 37, 31, 37, 31, 31.5, 20	190 (300)	269 (350)	363 (500)

120 ma, 200 ma, and 300 ma ballasts are used respectively for 40", 60" and 90" sign heights. The same 2-lamp ballast is used for 1-42" and 1-64" lamp as for 2-64" lamps.

* Where sign lighting is fed from a series circuit, the series-multiple transformer rating (in VA) to be used is indicated in parenthesis.

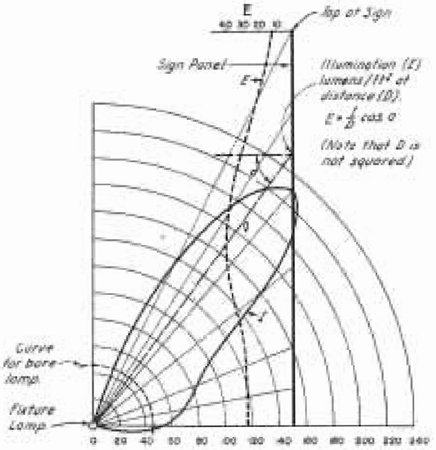


Fig. 4. Curve showing light distribution from typical sign fixture installation.

of the older type, taken by District IV in 1951, indicated an average illumination level of 8 to 20 foot-candles and a vertical maximum to minimum ratio of 5 to 1, up to 40 to 1.

Present average levels of illumination using the new fixture are in the range of 25 to 35 foot-candles with a vertical maximum to minimum ratio of 2 to 1 or less.

Approximately the same level of illumination is maintained on various size sign panels by using the following rule: "Fixtures for sign panels 40, 60 and 90 inches high shall use 120, 200 and 300 milliampere ballasts respectively." Light output per foot of lamp length is approximately 300, 430 and 520 lumens per foot for 120, 200 and 300 milliampere ballasts respectively. Therefore, the light level on 90-inch signs will be approximately 23 percent less thon on 40-inch signs, using the inverse relationship previously mentioned.

Ideally the light level on each sign should be determined for optimum contrast with the surrounding lighting conditions. This is an involved subject which would require considerable investigation and may lead to much higher light levels than are presently used in bright surrounds.

New Fixture Installed

The first bottom-mounted fixtures, as described above, were installed on two post-mounted signs on the Richardson Avenue off-ramp of the Golden Gate Bridge approaches. These fixtures were placed in service in August, 1952, and are still providing very satisfactory illumination. All sign lighting installed in District IV since August, 1952, has been of the new type, and these installations are providing excellent sign illumination. Since August, 1952, the design of this type of fixture has been improved in minor ways. No further changes are contemplated for the future, since standardization on the design indicated in the plan, as developed by District IV, will ultimately result in reduced cost of the units. Further refinements are certainly conceivable and will be incorporated as such improvements are developed and their value recognized.

SUMMARY

From observation of many existing sign lighting installations of different types and study of the factors involved, the following points become evident:

1. Top-mounted incandescent lighting of directional signs produces objectionable glare, in the form of reflected images of the fixture in the sign panel, and provides poor uniformity of brightness.

2. Top-mounted fluorescent lighting of directional signs produces less objectionable glare, in the form of reflected fixture images, than incandescent lighting, and provides fair uniformity of brightness.

3. Bottom-mounted fluorescent lighting does not produce glaring reflections of the fixtures. Therefore improvement in light control and intensities with this type of fixture will result in improved visibility of the sign.

Recent Innovations

The most recent improvement on the bottom-mounted sign lighting fixture has been the introduction of a light shield. The shield was devised to eliminate light seen when the sign is approached from the rear. By using 16 gauge metal for this shield and splicing it together between fixtures, it serves the additional functions of lining up the fixtures and practictally eliminating the strain on the ends of the fixtures where the connecting conduit attaches.

REFERENCES

1. *California Highways and Public Works,* Jan.-Feb., 1951, pp. 6 ff.
2. *California Highways and Public Works,* Mar.-Apr., 1951, pp. 53, 54.
3. *Planning Manual,* Part 8, Index 8-504.4.
4. *I.E.S. Lighting Handbook,* Second Edition, pp. 11-19.

SANTA CLAUS

Continued from page 26 . . .

businesses on a frontage road with restricted access into the through traffic lanes of the highway.

This roadside merchant's letter has revealed the principal conclusions to be made in analyzing the effect of placing the roadside businesses at Santa Claus on a frontage road.

1. Safe parking and accessibility for the motorists patronizing roadside businesses are factors inherent in the frontage road that do not exist on the heavily traveled thoroughfare.
2. Spectacular increases in gross sales among existing businesses, and the volume of business performed by new retail outlets, indicates the monetary effect of the frontage road at Santa Claus upon retail business.
3. The modernization of existing improvements and the sizeable investments made on new retail outlets are visible evidence of the enhanced property value along the Santa Claus frontage road.
4. The frontage road has provided a stability in highway design which has given confidence to the property owners that improvements can be made with assurance and that the traffic flow for which the new highway was designed will persist for the life of the facility.

A total of 592 state highway construction contracts were awarded during the 1954-55 Fiscal Year. These contracts had a value of $263,770,000, including construction engineering and right-of-way acquisition, and covered improvement to 2,203 miles of highway and 352 bridge and grade separation structures.

EXIT BOTTLENECK

Continued from page 24 . . .

The area traversed by the road is composed of low hills having very steep slopes and supporting a light cover of foothill vegetation. The formation is of a sedimentary origin with heavy stratifications, some of which approach the vertical. At about Station 70, the road crosses the San Jacinto Fault. Many of the clay strata have, through heavy pressure, become very dense and hard.

The contract for the construction was awarded to Matich Brothers and Matich Brothers Paving Company of Colton on January 27, 1955, with work starting February 21, 1955, and proceeding without interruption to its completion, except for a 10-day delay because of strike conditions. During construction, traffic was carried through the first mile, which was in comparatively open country, without interruption. At the junction with State Sign Route 79, it was routed over this road to its junction with the Old Jack Rabbit Trail, thence over it until it connected with U. S. Highway 60, about a mile beyond the end of the proposed project. To accomplish this, it was necessary, under agreement with Riverside County, to repair and widen the trail. Under this arrangement, and in view of the heavy traffic, the inconvenience to travel was slight, and very few accidents were reported. Closing the project to travel shortened the construction period by four months.

Extensive Excavation

The heavy and modern equipment used by the contractor was able to handle all material without recourse to blasting. While some of the cuts were 150 feet in depth with corresponding fills, the contractor experienced no difficulty in their construction. Roadway excavation involved the removal of 595,000 cubic yards, with an overhaul of 6,000,000 station yards. The 187-foot cut at the summit involved 95,000 cubic yards of excavation alone. The project developed an excess of roadway excavation on the westerly end which was used to construct embankment for the future freeway extension beyond. One hundred twenty-three thousand tons of imported base material were brought in, with an average haul of 4.9 miles. Seven thousand three hundred sixty barrels of cement were used to stabilize the top eight inches of the imported base subgrade. Thirty-one thousand tons of mineral aggregate used in the asphalt paving operations were obtained from the contractor's commercial plant in Redlands.

Because of the rough terrain, many drainage structures were required. On the westerly end of the job, in order to minimize inconvenience to traffic, the reinforced concrete box culverts were precast in 10-foot sections and swung into place with a crane. Corrugated metal pipe ranged in size from eight-inch side drains to double 72-inch cross drains. In all, there were approximately 110 structures involved, some of which required stone riprap.

J. N. Matich of Matich Brothers acted as general superintendent for the contractor. The State was represented by H. C. Prentice, District Construction Engineer, and K. B. Stone, Resident Engineer.

SACRAMENTO COUNTY

Continued from page 38 . . .

Avenue, 41st Avenue, Sacramento Boulevard, Fruitridge Road, 21st Avenue, 12th Avenue, Fifth Avenue, Second Avenue, and a viaduct at Broadway, which will also separate the California Traction Company tracks on X Street. In addition, pedestrian overcrossings are planned at 34th Avenue, 27th Avenue and Eighth Avenue.

This unit in part is within the "built-up" area of Sacramento and will tie in with the 29th-30th Street one-way couplet which connects on the northerly end with the Elvas Freeway, US 99E to the north, which was completed in May last year.

The final unit to complete US 99 in Sacramento County to connect the South Sacramento and Elvas Freeways will be the north-south crosstown freeway located between 29th and 30th Streets which with the east-west crosstown freeway is now in the advanced planning stage.

ENGINEER SHORTAGE

Continued from page 33 . . .

techniques; and shorter, more concise engineering reports are all saving engineering time and manpower.

5. *Manuals* governing and guiding the work of each department are in use throughout the division. These manuals are recognized as being among the most complete and up to date in the Nation. With these guides, less experienced engineers can perform more difficult types of work and newly recruited engineers can be rapidly trained.

6. *Communications* by two-way radio and teletype, for some time a valuable time-saving tool in highway administration and maintenance, is becoming an engineer-saving factor in the field. Radio has been used in establishing and checking triangulation for bridges across large bodies of water; members of survey parties relay positions and data by walkie-talkie; and the use of two-way radio in automobiles to conserve the time of resident engineers and assistants on large construction jobs is being explored.

Ideas and Devices of Future

These are some of the present ideas and devices to combat the engineer shortage. In the near future are, of course, further improved techniques: bigger and better electronic data processing machines; teletyping of figures and computations instead of mailing them; and expansion of photogrammetry into more and more detailed highway planning.

When the Legislature enacted the present level of highway user taxes in June, 1953, the Highway Commission and the Division of Highways translated more than $87,000,000 in added revenues into construction projects and right-of-way allocations without a moment's delay. This was because the plans were ready, or nearly ready, in advance. By using all modern methods available to combat the engineer shortage, and developing new ones, the Division of Highways is still able to keep its planning far enough ahead to handle additional construction if and when it is assigned.

Road Restoration

District I Performs Big Job in Flood Areas

By RUDOLPH BERGROTH, District Office Engineer

The sequel to the story of the high water, floods and resultant damage to highways in District I during the 1955 Christmas week floods is the account of restoring the many miles of severely damaged highway facilities: first to the ability to carry emergency traffic, and then to normal traffic.

When December 22, 1955, dawned, radio communication between the district office, field offices, and mobile units was almost continuous reporting on road closures and such conditions as could be determined. As the data was compiled, it was evident that the district was confronted with an unprecedented situation as to the extent of road closures and damage to highways, coupled with the extreme necessity of providing access into the flooded areas, towns, and communities as soon as possible.

Damage Inestimable

The South Fork of the Eel River, the main Eel River, and the Klamath River, as well as other streams in the district generally, did not crest until late in the day of December 22 and many portions of the highway routes were inaccessible so that the real extent of the damage to highway facilities was yet unknown as December 22 terminated with the definite promise of further damage as waters receded.

On December 23, as more detailed reports were received from the field and flood waters were receding, it was revealed that all the state highway routes in the district, with few exceptions, were closed to through traffic by reason of damaged or destroyed bridges, slides, slipouts, washouts, silt and debris on traveled ways, pavement damage, fallen trees, and even buildings that had been floated and deposited on the roadway. The only excepted routes were those in Lake County and southern Mendocino County where damage was comparatively minor and traffic was able to proceed as soon as flood waters receded.

Areas Isolated

The Eureka-Humboldt Bay area and the towns and communities throughout the district were isolated in varying degrees. Roads and highways were impassable, telephone facilities were destroyed, and the Northwestern Pacific Railroad was out of service for an indefinite period. Radio and aircraft were the only remaining means of communication with the rest of the State and these facilities were taxed to their capacity. Before access to the outside was re-established, the Humboldt County Airport at McKinleyville experienced the greatest activity in its history as a commercial airport as aircraft of all descriptions endeavored to serve the normal and emergency passenger and freight needs of the area.

It was readily realized that US 101, the main line in the district south from Eureka, was closed for some indefinite period. North of Eureka, two locations damaged by other than high water caused closures. In the Mad River area just north of Arcata, washed out approaches to overflow channel structures and the completely demolished north approach span of the Mad River Bridge closed US 101; however, a detour route over a narrow county road was available. The real closure preventing access to the outside was the washed-out north approach embankment to the Douglas Memorial Bridge spanning the Klamath River. The balance of US 101 to Crescent City was open and US 199 to Grants Pass and US 99 presented only some comparatively small slides which were cleared without undue difficulty.

High Priority

It became imperative to provide access from the Eureka-Humboldt Bay area to the rest of the State and, accordingly, the replacement of the washed-out embankment approach to the Douglas Memorial Bridge received high priority in the first roadway restoration activities. Construction equipment was rushed from Eureka to the south end of the bridge, other equipment was mobilized at the north end, and work started on replacing the embankment as soon as high water receded to such an extent that replacement material would not be washed away. During the late afternoon of December 25, US 101 and US 199 were opened to emergency traffic from Eureka to Grants Pass with restrictions on load limit on that portion of the route in our neighboring State of Oregon where the storm also resulted in damage to highways.

The other closed highways in the district were receiving immediate attention, with no priority set on any particular sector as opening of all routes was of vital importance and openings were only dependent upon the magnitude of the road closure elements and the extent of the problems involved in the road restoration activities.

During the height of the flood, US 101 was closed to through traffic from Little Lake Valley, just north of Willits, to just north of Alton. As these limits of closure were to a great extent the result of flooding of the highway, with no damage of serious consequence, the recession of flood waters reduced the limits from near Cummings to South Scotia Bridge, a distance of approximately 92 miles.

Access Imperative

This record-breaking length of severely damaged and closed main line state highway involved numerous communities and peoples, and a number of flooded towns and areas. It was therefore imperative that some semblance of a road be provided as soon as possible. The imperativeness was accentuated by the need of relief agencies to gain access to the flooded areas of Myers, Weott, Pepperwood, and other places in the South Fork of the Eel River Canyon.

The first stage in road restoration was to provide a "pioneer" or emergency road to all areas sufficient to accommodate emergency vehicles, and also to gain access to the various severely damaged locations and appraise the extent of the damage to immediately formulate plans for full-scale roadway restoration at the earliest possible moment.

The pioneer road work was immediately undertaken by state forces and equipment, supplemented by extra personnel hired on the spot and privately owned equipment as available in the damaged areas.

It was interesting to note that the intense and widespread development of the logging and lumber industries since World War II throughout the area comprising District I was of considerable benefit during the emergency. The utilization by the industry of similar equipment, such as tractor-dozers, graders, loaders and dump trucks as used in highway construction and maintenance, and the wide dispersal of such equipment proved to be an important factor in the road opening work. Equipment was made available to the Division of Highways without hesitancy and was generally in close proximity to the damaged sections of highways throughout the district. The equipment, ranging from chain saws to the largest tractor-dozers and loaders, together with operators, rendered valuable assistance in the opening of roads.

Flood damage repair work to the Smith Point Bridge across South Fork Eel River on US 101, six miles south of Garberville. Note damaged north approach span.

Repairs Rushed

The pioneering started and progressed in both directions from many locations between points of closure and wherever equipment was available, together with Division of Highways personnel, to instigate the work and provide supervision. Field forces were authorized to procure additional personnel and equipment as necessary. As flood waters receded, advancement north from Willits was not too difficult. A washed-out approach to a small bridge spanning Long Valley Creek at Longvale was the only serious situation, but the comparatively small embankment was soon replaced and the route was opened to restricted traffic as far north as Leggett during the afternoon of December 24. In the north, receding waters permitted opening of the highway to normal traffic as far south as Scotia after removing debris and drift from the traveled way. South of Scotia in the Pepperwood area, which had been completely inundated, opening the road presented a little more difficult problem. Buildings had been floated onto the highway and a two-foot depth of silt prevented passage of any type of vehicle other than a high-powered grader. Some small cottages almost completely demolished were bulldozed off the traveled way and graders pioneered a one-way track through the silt and around larger houses almost intact but reposing on the roadway.

Emergency Traffic Moved

In the evening of December 24 the pioneer road had penetrated as far south as Weott, another community that suffered complete inundation of its main level. Work had also been progressing northerly from Cummings, both ways from Garberville, and southerly from the Weott area. By December 27, the route had been traversed for its entire length and emergency traffic was negotiating the badly damaged 100-mile section.

The pioneer road then permitted transport of heavier and more proper equipment into the most troublesome areas to supplement that already in use. Such equipment as four 1½-cubic-yard shovels, together with other incidental equipment, was brought in to work on the several most troublesome areas of damage and to widen and strengthen the existing facility in order to permit passage of all traffic.

By December 30, the work in the South Fork Eel River Canyon had restored US 101 to a condition where two-axle trucks were permitted to travel the Cummings-Scotia sector. On January 5, the section was open to all traffic.

Indescribable Damage

The damage confronting the crews was of every description imaginable:

washouts, slipouts, undermined pavements, settlements, slides, debris on roadway ranging from saw logs to brush and down trees, and plugged culverts. Fortunately, with the exception of the Smith Point Bridge spanning the South Fork Eel River approximately six miles south of Garberville, no major structure damage occurred within this severely damaged portion of US 101. At the Smith Point Bridge, settlement of the northerly approach span occurred and finally the driving of steel "H" piles into the unstable foundation area had to be resorted to as a means of supporting that end of the structure.

Personnel, regular and emergency; equipment, both state-owned and private, were concentrated within the 100-mile limits in unprecedented numbers.

The magnitude of the work and equipment and personnel being used was beyond the scope of the normal Maintenance Department supervisory personnel to properly direct, and engineers were separated from their regular duties and assigned to the restoration work to assist in the supervision.

Ten Areas on US 101

As the restoration work progressed, and general cleanup and repair of damage was done, locations of major slides, settlements, slipouts and washouts failed to respond to immediate road opening treatment. In general, there were 10 areas on US 101 between Cummings and Scotia that constituted major problems and, in many locations, it was obvious that retreats into hillsides would have to be resorted to in order to establish a stable roadway with sufficient width to accommodate normal traffic.

At this stage, contracts were made with contracting firms with proper and adequate road building equipment and experience. Tractors with steel tracks and other equipment of the logging and lumbering industry, as used in pioneering the road restoration and proper for the use intended, was improper for more detailed highway work. Organized contracting firms with experienced supervisory and other personnel finally rendered extraordinary service.

Rains Continued

The restoration activities were hampered by rains, ranging from intermittent to heavy lengthy downpours. River bars, as a source of material for backfill of slipouts, washouts, settlements, and as a surfacing material, were inundated by recurring high water in streams, delaying many phases of the work. Slides, settlements, and slipouts already supersaturated were made continually active by further rains, closing the road for intervals and necessitating additional work.

During the period December 29 to January 5, wherein first emergency traffic was permitted and then light general traffic and finally two-axle trucks, road blocks and convoys were utilized to screen and conduct traffic through this lengthy damaged portion of US 101 and where the extreme activity was taking place to restore the highway to normal traffic. As work progressed and road conditions improved, traffic volumes increased and lengthy convoys had to be abandoned as undesirably long shutdowns occurred at the various locations of activity in order to permit passage of the convoys. Traffic was finally allowed to proceed on their own, but subject to delays at various points. The traveling public can be commended for their forbearance in accepting such delays with little or no complaint.

The continuing rains made necessary major activity well into February, and slides and settlements were aggravated causing isolated short closures. US 101 north of Eureka, which was virtually trouble free, had heavy rains on January 14 and 15 that resulted in partial washout by the again swollen Klamath River of the north approach to the Douglas Memorial Bridge, closing the road until the forenoon of January 16. Heavier than normal rain on February 19 to 23 caused further damage and road closures on US 101 and other routes, and concern to district personnel with the picture of the Christmas week catastrophe still very vivid in the minds of all.

Other Routes Affected

It is possibly noted that the account of the US 101 situation has been dwelt on for some length. It is not the intent to minimize the closures and road openings or restoration activities on the other routes in the district, where, at various locations, conditions and difficulties encountered were of the same description as on US 101. During the period of major activity on US 101 to the south of Eureka crews of both state and contracting firms were carrying on similar activity at various separated locations on US 101 to the north as well as all the other routes that suffered damage.

The major restoration project on US 101 north of Eureka was the replacement of the northerly timber approach spans of the Mad River Bridge and replacement of washed-out approaches to the overflow channel structures just southerly of Mad River.

State Sign Route 1 in Humboldt County, between Ferndale and Fernbridge, on US 101, a distance of approximately four miles, incurred extensive and severe damage to roadway and structures. The west-end approach spans of the Fernbridge Bridge across the Eel River were severely damaged and were replaced by embankment. Complete washout of embankment approaches to bridges across overflow channels and washed-out embankments and undermined pavement had to be replaced. At Arlynda Corners a large concrete box culvert was completely demolished, and the chasm was bridged by a timber bent trestle.

Washouts Damage US 299

US 299 suffered considerable damage, especially from Berry Summit easterly. On the portion between Berry Summit and Willow Creek, where two contracts were under way by the U. S. Bureau of Public Roads, slides, slipouts, and washouts were prevalent and these, together with the rugged terrain, caused considerable difficulties in opening and maintaining a roadway of sorts. From Willow Creek easterly and especially from Cedar Flat easterly, where US 299 follows the Trinity River, high water did considerable damage in the form of washouts. Opening the road to one-way traffic was not unduly difficult, but activities to restore a full two-lane roadway were considerable.

State Sign Route 36 received its share of damage, including a serious washout in the Grizzly Creek area which hindered opening road to through traffic at least to Bridgeville, the comparatively sizable community of the area. On this route also, near Carlotta, the bridge spanning Yager Creek was in jeopardy when one of the piers was undermined and partially tipped, leaving continuous steel beam spans without support. Through the fine cooperation of the Northwestern Pacific Railroad, their adjacent railroad bridge was made available and it was planked, enabling the passage of light traffic during the period the highway bridge was under repair.

Hoopa Bridge Lost

On the Willow Creek-Weitchpec highway, in addition to closures by slides and washouts, the complete destruction of the 440-foot bridge spanning the Trinity River delayed opening the Willow Creek-Orleans-Yreka route to through traffic. It was necessary to construct a low level, temporary, pile bent bridge downstream from the destroyed bridge, which construction was delayed by further high water in the Trinity River. The temporary structure was open to all traffic on February 7; its use, however, was shortened as heavy rains of February 20 and 21 caused further high water in the Trinity River and 216 feet of the temporary structure was washed out. Arrangements for repair were made immediately by the Bridge Department and work proceeded without hindrance and the structure was again opened to traffic on March 9.

At Bluff Creek, on State Sign Route 96 between Weitchpec and Orleans, the approach span to the bridge spanning that stream was completely washed out. A temporary log bridge was rushed to completion and opened to traffic on January 11. The south half of this temporary structure was again washed out by high water in the creek on January 15. Repairs were again undertaken and, on January 25, traffic was allowed to cross the new temporary structure.

US 101 near Piercy, Mendocino County; removing slide after Christmas week storm and floods

Tremendous Job

A few statistics might be in order to indicate the magnitude of the road opening and restoration work that was carried on. During the period December 19, 1955, to January 31, 1956, 416 pieces of privately owned equipment were engaged by means of service agreements to participate in the work throughout the district. In addition to this equipment, there was the state-owned equipment and contractors' equipment that was working on restoration projects covered by emergency, cost-plus contracts. Construction equipment of all descriptions was represented, ranging from the smallest one-man chain saw to large track-laying power shovels. Emergency help was hired throughout the district by the field offices to supplement the regular state forces and these totaled 177 men in the laborer and equipment operator classifications. The bulk of this help, 124 men, was used in the Garberville territory.

As previously stated, when pioneer roads were put through and as restoration work progressed it became obvious that organized construction firms with adequate and proper personnel and equipment could better handle various phases of the work under contract. Change in procedure from equipment rental basis to contractural procedure resulted in additional capable personnel and supervisory employees, such as superintendents and foremen, to the end that over-all efficiency was increased. At this writing, 31 emergency contracts were entered into to perform the restoration of roadway and bridges. These contracts covered work of all kinds, bridge building and repair, culvert rehabilitation and new installations, removing major slides, backfilling settlements and washouts, and even placing new pavement in the Ferndale and Arcata areas during a break in the weather.

Supervisory Work Divided

The highway facilities within the Garberville maintenance territory suffered the greatest and most widespread damage, including the lengthy closure on US 101 and the severely damaged State Sign Route 1 between Ferndale and Fernbridge. The restoration work being of such magnitude, it was necessary to divide the supervisory work. E. J. "Al" Smart, highway superintendent at Garberville, handled the state crews and directed work of rented equipment. H. W. "Hod" Benedict, of the district's engineering staff, served as resident engineer on the many emergency contracts. These men were ably assisted in the field and office by many other maintenance personnel and engineers too numerous to list.

Highway Superintendent J. A. Brown, of the Eureka territory, had his territory extended to include the Ferndale-Fernbridge route and he was assisted at this location and at other locations within his territory by a number of the engineers.

Crescent City Area

The Ukiah territory Highway Superintendent, C. H. Sackett; R. W. Sorin, Superintendent at Boonville, and H. L. Nelson, at Crescent City, territories in which highway damage was not as severe as in other areas, nevertheless had more than the ordinary winter maintenance problems to cope with.

In addition to the engineering help, the Garberville maintenance forces were supplemented by five state foremen and seven equipment operators. These men were temporarily transferred from areas where highway damage was not overly severe.

The Bridge Department assigned numerous personnel to operate under the supervision of "Al" Lernhart, Alton Kay, and W. Langenbach, to help in the district to assess bridge and other structure damage to determine and supervise necessary restoration and repair measures.

Contractors Cooperate

The local and other contractors deserve high commendation for their splendid cooperation in assisting in review of damage, organizing repair crews, and rendering over-all exceedingly fine cooperation in making available their equipment, dispatching it to trouble areas, and in performance of work on the emergency contract basis.

The over-all direction of the work at district level was by Alan S. Hart, District Engineer, assisted by C. P. Sweet, Assistant District Engineer, Operations, and C. G. Ure, District Maintenance Engineer.

It is realized that many details of damage, restoration measures, problems encountered and equipment utilized, are missing; details that would prove to be of interest to engineers, construction men, and others. A full account, including all details, would be a book.

In retrospect and with all due respect for the losses suffered by all, lessons were learned by bitter experience, features of highway design were proved and disproved, and we can therefore derive some measure of consolation from the not soon to be forgotten experience.

COLORADO RIVER

Continued from page 35 . . .

could be attempted. The new alignment swings to the south just west of Winterhaven, California, and crosses the river on tangent to line up with Fourth Avenue in Yuma, which becomes US 80 to the east. This alignment crosses Indian property about 3,000 feet downstream from the existing highway crossing and it was necessary to negotiate with the Quechan Indian Reservation tribal council for the required right of way. These arrangements differ only in degree from those made by Captain de Anza and actually consumed considerably more time. Application was made jointly by California and Arizona to the Corps of Engineers, U. S. Army, for a permit to construct the bridge.

Some local objections were voiced in regard to the alignment of the new road, but most of the objections were satisfied when it was decided to leave the existing structure in place to serve the Indian school on the north side of the river and the Bard agricultural area on the California side. This also provides an auxiliary crossing in case of emergency.

Completion This Spring

While most of the concrete aggregate is obtained in the vicinity of the structure, the structural steel was fabricated in Gary, Indiana, and hauled across the continent by rail to the site. This could be compared to the first ferry raft which was constructed in Michigan as previously noted.

The contract for the new bridge is financed by Arizona Federal Aid funds, State of Arizona funds, California Federal Aid funds and State of California funds. Fred J. Early, Jr., Co., Inc., of San Francisco holds the contract for the amount of $1,236,765. California has recently completed a contract for its approach in the amount of $386,886 by Silberberger Constructors and J. B. Stringfellow of Riverside, California, and Arizona has an approach contract under way by Heuser and Garrett of Phoenix for the amount of $302,675.

The design for the new structure was done by the Bridge Department of the California Division of Highways and construction is being handled by the same agency with A. K. Gilbert, one of California's veteran engineers, as the resident engineer. Completion of the new crossing and approaches is scheduled for spring, 1956.

Mrs. Mabel A. Vance

After 25 years of state service, Mrs. Mabel A. Vance of the Division of Contracts and Rights of Way of the Department of Public Works retired on January 27, 1956. On that date she was tendered a luncheon at the Elks Club in Sacramento by fellow workers and former associates.

At her luncheon her boss, Robert E. Reed, Chief Counsel of the Public Works Department, handed her two photographs that puzzled her no end. They were pictures of a 21-inch television set. Mrs. Vance couldn't figure out the significance of the photos until Reed explained to her that the television set was in her own living room. Reed then told how Harry L. Fenton of his staff gained entrance to Mrs. Vance's apartment after she left for work Friday morning, had the set moved in, and took photographs of it. He naturally had to rearrange the furniture somewhat, so she did not recognize her own living room.

The set was a gift to Mrs. Vance from her friends who attended the luncheon.

Traffic Safety Committee to Intensify Work

The solution of the traffic accident problem is a joint responsibility involving both public officials and the general public — GOVERNOR KNIGHT.

In recognition of the responsibility incumbent on the public officials in California, Governor Knight has requested his Traffic Safety Committee to intensify its efforts to coordinate and render more effective the combined forces of all state agencies in the fight against traffic accidents.

The Governor's Traffic Safety Committee was first organized in 1946 pursuant to a recommendation of the President's Highway Safety Conference, which called for joint public and official action. The California group was the first one formed; but up to this year, it has not conducted a full-time program. It has been a coordinating agency; and now the coordination of official action is linked with an extensive program embracing all phases of traffic accident prevention.

Governor Knight's traffic safety committee in session. Left to right: Theodore H. Jenner, Departmental Secretary to Governor Knight; Director of Public Works Frank B. Durkee; Bernard R. Caldwell, Commissioner, California Highway Patrol; Ernest B. Webb, Director of Industrial Relations; Paul Mason, Director of Motor Vehicles; Peter E. Mitchell, President, Public Utilities Commission; Heman Stark, Director of Youth Authority; W. A. Huggins, Highway Patrol. Seated: Roy E. Simpson, Superintendent of Public Instruction; Governor Goodwin J. Knight; Director of Finance John M. Peirce.

The objectives of the committee are:

1. Reduction of traffic accidents, deaths and injuries on California streets and highways.
2. Safe and efficient movement of traffic in every section of the State.
3. An adequate system of highways, designed, constructed and maintained to meet the challenge of California's constantly increasing traffic.
4. A California Highway Patrol sufficiently large to provide protection for all sections of the State, with adequate equipment and facilities in keeping with modern enforcement demands.
5. A court system with sufficient number of judges and prosecutors, together wtih staff and facilities, to provide uniformly high standards in the hearing and adjudication of traffic cases.
6. Highest standards in school safety education programs, designed to prepare our youth to safely cope with the dangers of today's traffic.
7. Personnel and equipment to provide for driver licensing and regulating procedures which will make certain that only those who are competent and properly prepared are permitted to drive.
8. Full provision for coordination of State's official traffic safety program with organized nonofficial activities, emphasizing development of public understanding of and support for official efforts.
9. Proper recognition, encouragement and support of traffic safety programs of citizen support groups and others interested in safety.

The administration of the committee's program is the responsibility of W. A. Huggins, executive secretary, and his staff. Mr. Huggins has served with the committee since its formation in 1946.

The committee has sponsored and directed six state-wide meetings of the Governor's Traffic Safety Conference. A recent three-day annual conference called together recognized experts in the traffic-safety field, leaders of industry and government, and interested laymen, all sharing a sincere desire to reduce the tragic traffic tolls. Robert Mitchell, president of the Consolidated Rock Company of Los Angeles, was general chairman of the 1955 conference.

This conference is typical of the many activities participated in or sponsored by the Governor's Traffic Safety Committee, and to pinpoint the problems, has these divisions: commercial vehicle, driver licensing, education, engineering, enforcement, public information, and teen-age division.

In addition, 19 regional safety clinics were held and numerous local safety activities sponsored or supported. The Governor's Traffic Safety Committee, through its staff, has aided in the organization of local safety councils, participated in school and college safety programs, and has had a prominent part in many commercial vehicle fleet safety programs.

All national safety programs have been given support; and this year, the committee is co-sponsor of a regional traffic court conference being held at the University of Southern California. Other sponsors are the American Bar Association and the Traffic Institute of Northwestern University.

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Some Job

Official Records Salvaged From Flood-swept Maintenance Shop

By J. C. TIBBITTS, Chief Clerk, Equipment Department

THE EQUIPMENT DEPARTMENT'S Shop 3 and office in Yuba City, at the confluence of the Feather and Yuba Rivers, were practically wiped out in the December disastrous floods. After the waters receded the water line on the office wall was a little over nine feet above the floor.

The entire front of the office had been glass. Both of these large windows were broken out. A few Christmas decorations above the nine-foot mark fluttered forlornly. Two wooden desks and their contents, including typewriters, were missing. A few days later they were located in nearby vacant lots among other debris. One other wooden desk was perched crazily on top of some filing cabinets; all other desks, chairs, tables, counters, etc., were misplaced wherever the surging current had pushed them.

On December 27, 1955, we took a crew from Headquarters Shop, Sacramento, to salvage what was possible of the Shop 3 records and papers. The water had come back in a little during the previous night and there were 12 inches of "thick" water on the floor. Much important current work that had been in desk trays or in binders was floating or submerged in this water.

With the back of a truck inside the office the loading started. The floating and submerged material was picked up first; we picked up anything we saw or tripped over.

Next, all desks were opened and all paper work removed. All wooden desks had to be forced open. Unused stationery and forms were left wherever stored except for press-numbered bills, receipts, and revolving fund checks.

Next, all filing drawers were loaded. Some cases had to be loaded with two or three drawers in them as the drawers would not open because of swollen papers. It was impossible to sort the material at this point as a thick layer of silt on, in, and over everything called for a thorough wash job first.

Yuba City on Christmas Eve. Shop 3 is in circle in left background. Thirty cars are in adjoining parking lot.

Finally all the miscellaneous records were loaded. These included a safe ledger, a Cardineer wheel, Kardex cabinets, etc.

Back in Sacramento these records next went through our wash rack. The mud and silt were washed off the surface of each binder, bundle, file drawer, Kardex tray, and the records in special equipment.

Now it was possible to "roughly" sort the material into records we wanted (and had space and time to save), and a discard pile. The records discarded were probably three to one, compared to those saved. The swollen material had to be pried out of many of the file drawers with bars. Every paper and every record could have been salvaged in fair shape had there been the need, the space, and the time.

From this point on it was a matter of spreading, drying, turning, picking up and resorting the material. For drying, a large section of one of the large shop buildings was cleared and heat left on night and day. Folders of material were spread open over all the floor of this area. One of the paint stalls, with its forced heat and heat lamps was pressed into service. The use of two large ovens in an adjoining laboratory building was a lifesaver in drying all records on ledger card stock and other hard-to-dry materials.

After the dried material had all been picked up, it had to be sorted and put in filing order. It had been impossible to keep the folders in much semblance of order. New folders were prepared, the material was re-

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New Army Reserve Program Attracts State Employees

State employees are discovering unprecedented financial and career benefits for entire families under the new Army Reserve program.

A recent survey of personnel in the 311th Logistical Command, headquarters Los Angeles, largest headquarters reserve unit in the Nation, reveals that over 22 percent of the organization are state, federal, county and city employees.

This percentage of a single reserve organization receives career training and full pay and promotion benefits, adding to the family income while serving the country in the highest tradition of the citizen-soldier. Further, the retirement feature, if put in terms of a private insurance benefit, could not be purchased by the individual for less than $35,000 to $45,000. Still more advantages accruing to countless state employees include various military schools available throughout the year with personnel receiving full pay and allowances for attendance in addition to state pay which is authorized for military leave.

The 311th is a high echelon headquarters organization which conducts primarily civilian-type training throughout the entire year including summer camp and under leaders who rank among the top professional, industrial, educational, financial and civil service leaders in the Southern California community.

UPPER—CDR F. T. Pritchard, CEC, USN, Officer in Charge of the U. S. Naval School, Civil Engineer Corps Officers (CECOS) at the Naval Construction Battalion Center, Port Hueneme, welcoming a group from the engineering staff of the California Division of Highways, Sacramento, to the school. They graduated February 20, 1956. The group included, left to right: LCDR Richard N. Doolittle, CEC, USNR; CDR Claude H. Darby, CEC, USNR; Capt. Charles M. Herd, CEC, USNR; LCDR Edwin Jensen, CEC, USNR, and CDR Pritchard. LOWER—Division of Highways employees in Active Army Reserve: Warrant Officer Herman Behrens, left, points out a new training area designated for young reservists of the 311th Logistical Command, to Major Andrew Lynn.

TRAFFIC SAFETY COMMITTEE

Continued from page 58 . . .

California has won outstanding national honors in these related traffic safety fields:

First place—
Traffic engineering .... Last 5 years
First place—
Enforcement .... Last 5 years
First place—
Driver licensing .... Last 3 years
First place—
Public information .... Last 4 years

California has won the honor award in school safety education, and a plaque from the National Association of Surety and Casualty Companies for high school driver education.

Through the programs sponsored, supported, or participated in by the Governor's Traffic Safety Committee, it is hoped that California will be made safer by making traffic safety everybody's business.

SOME JOB

Continued from page 59 . . .

moved from the old folder, shaken down in an Electro-Jogger, and placed in the new folder.

Everything saved is legible, even though it may be dirty and rumpled. Some of the important records saved were: job files, recent correspondence, all personnel records, stock cards, control and subsidiary ledgers, recent accounting records and claim schedules, recent purchase orders, property records, survey reports, and loss reports.

There were some 66 units of equipment which were submerged in the muddy waters. These were transported to Sacramento Headquarters Shop, where they have been thoroughly inspected and those worth salvaging placed in the process of reclaiming, the others surveyed and preparations made for their disposal.

Reflection Cracks

Wire Mesh Reinforcement In Bituminous Resurfacing

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INTRODUCTION

The problem of what to do about reflection cracks occurring in bituminous resurfacing blankets placed over old portland cement concrete pavements has been a subject of much concern and paving engineers have long been seeking a satisfactory solution. These cracks not only present an unsightly appearance, but often develop subsequent spalling which presents a difficult maintenance problem. The cracks may appear at any time from a month up to a few years after construction, depending upon the condition of the underlying concrete pavement. Vertical movement of the slabs, commonly referred to as rocking slabs, is the most common cause. Other contributing factors are the type and volume of traffic, particularly heavy truck traffic, the thickness of the new blanket and probably to a lesser degree, at least in California, the temperature differential of the seasons. *Figure 1* shows typical reflection cracking of a thin bituminous blanket placed over old concrete pavement on one of our main roads. This picture bears out the fact that reflection cracking is not entirely due to horizontal movements caused by temperature changes in the underlying concrete, as evidenced by the absence of cracking in the lighter-traveled passing lane. In this case it is obviously caused by vertical movements of the slabs under heavy traffic.

Number of Methods Used

A number of methods have been used in an attempt to prevent or at least retard reflection cracking. Subsealing or mud jacking of the old concrete pavement slabs prior to blanketing has been tried and although this process greatly reduced the amount or intensity of cracking, it has not completely eliminated the trouble.

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FIG. 1

Typical Reflection Cracking. Both lanes resurfaced June, 1954, with 1-in. thick bituminous mix. Note absence of cracks in passing lane at left. Cracks began to appear after one month. US 40 near Fairfield.

In many cases, particularly when the old concrete pavement is badly faulted or broken and structurally inadequate to carry the traffic loads, a blanket of granular material 4 inches to 8 inches in thickness is placed and covered with 3 inches to 4 inches of new surfacing. However, existing curbs and gutters or structures and the additional cost of raising shoulders very often do not permit such a substantial increase in thickness.

In other instances, the thickness of the new asphaltic surfacing has been increased in an attempt to eliminate or minimize this cracking. Even the so-called open graded mixes of the macadam type possessing somewhat more flexibility than dense mixes have been tried but still have not completely solved the problem.

Varying Degree of Success

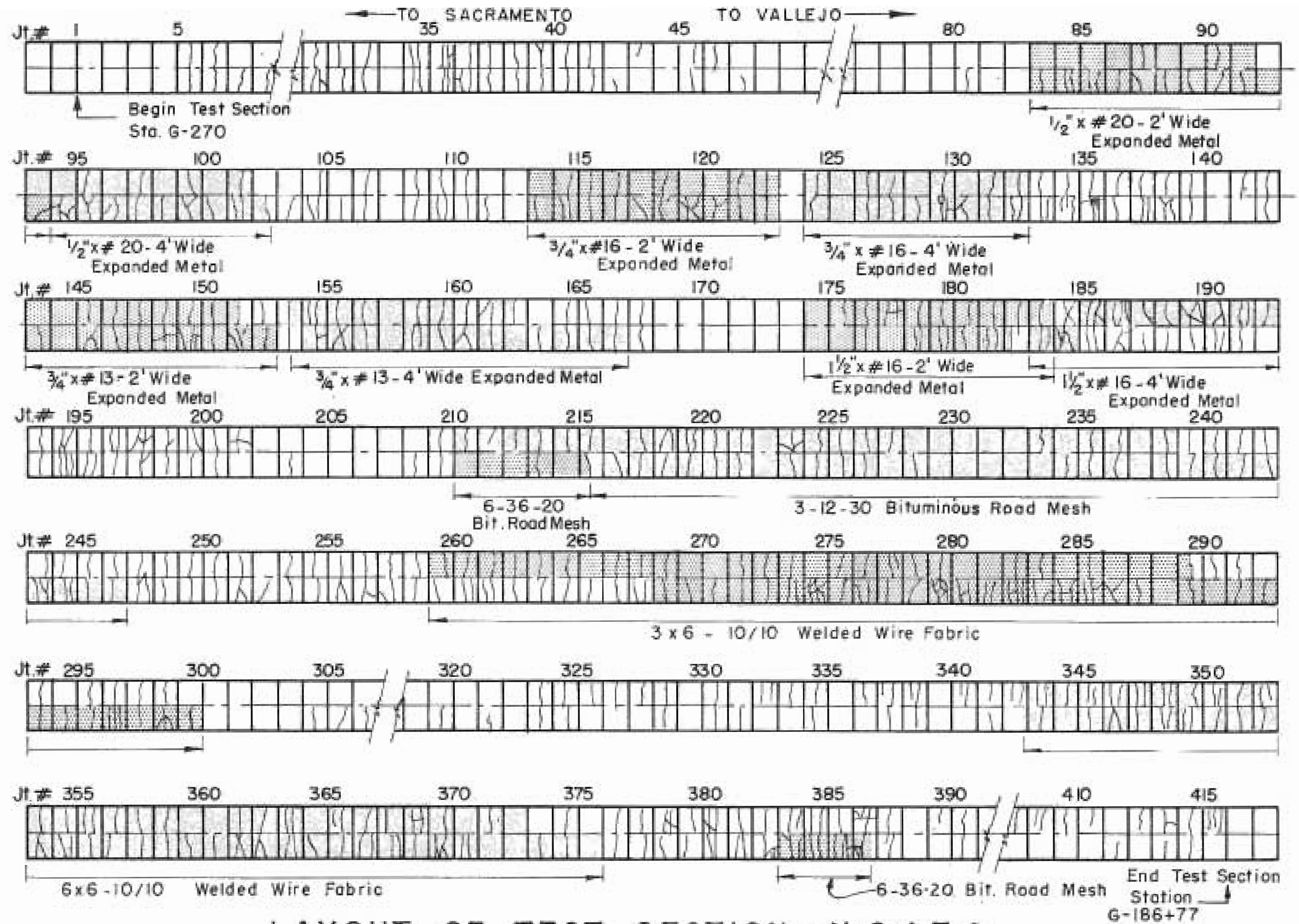
From the varying degree of success obtained by any of the above-mentioned methods it appears that prevention of the vertical movement of slabs caused by the passage of heavy trucks is the most important step towards eliminating or delaying the appearance of reflection cracks. In recent years it has been the standard practice of the California Division of Highways to subseal with asphalt before blanketing any concrete pavements showing signs of movement or pumping of the slabs.

It is of interest to note that bituminous blankets placed on many miles of old broken concrete pavements which were built in the early twenties without expansion or contraction joints (but which during the years of service have developed random cracks) are usually free from reflection cracking. This is also true of the pavements covered with the granular cushion courses.

One of the more recent and promising proposals for eliminating or diminishing the number of reflection cracks is the use of some type of wire mesh reinforcing laid directly on the concrete slab or placed between the leveling and surfacing courses of the bituminous blanket. Although the first attempt to use such material was apparently made in Michigan in 1937, it was not until after the last world war that the use of some form of wire mesh became more widespread. In 1946 the State of Texas placed two projects involving the use of so-called wire fabric and reports from Texas engineers indicate that this method apparently reduced crack formation. Since that date numerous experimental installations of welded wire fabric have been placed in various states and reports in general indicate favorable results in crack suppression.

Types of Wire Mesh

Another form of wire mesh is expanded metal sheets of small diamond size mesh which are used to cover



LAYOUT OF TEST SECTION - X-Sol-7-G

Fig. 3

Fig. 3—Layout of test section. Fig. 4—Comparative sizes of the various types of metal used.

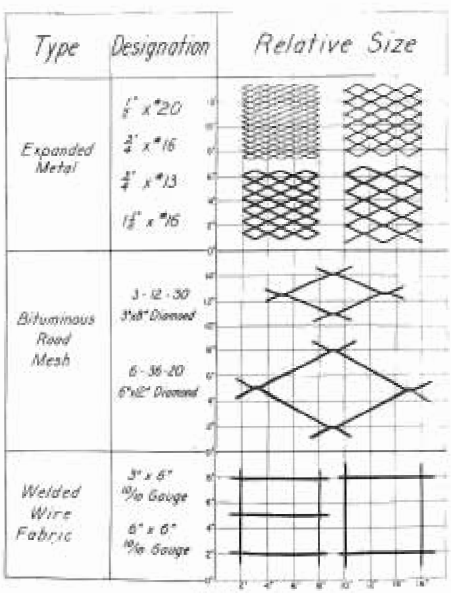
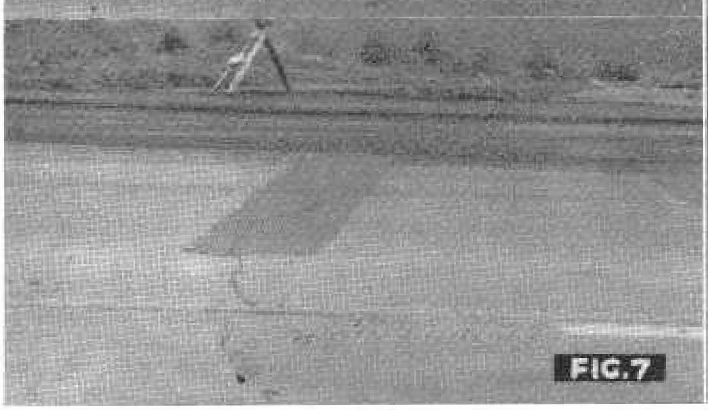


FIG. 4

only the individual joints and cracks in the existing concrete pavement. This method of treatment was developed in England, where a number of test sections were placed in 1951. Reports received in 1953 indicate that this application shows a definite promise of delaying or materially reducing the amount of cracking.

It might be well to outline briefly the types of wire mesh that have been used in the various trial installations both in the United States and England.

The two primary types of wire mesh are known as expanded metal mesh and welded wire fabric. The expanded metal mesh is produced by feeding stock sheets into a machine which cuts and expands the solid sheet into a diamond-shaped mesh. The diamonds vary in size from one-fourth by 1 inch to 6 by 12 inches and the gauge of metal can also be varied. The sheets with the smaller-sized diamonds are usually cut into 4- by 8-foot size and are used in building construction for open partitions, door panels, shelving, etc. The larger-sized diamond mesh is used for reinforcement in concrete construction work and may be secured in sheets as large as 12 by 16 feet. The small diamond mesh sheets are normally produced with the long dimension of the diamond parallel to the long axis of the sheet, whereas the large diamond mesh is produced with the long dimension of the diamond at right angles to the long dimension of the sheet. Welded wire fabric is produced by spot weld-



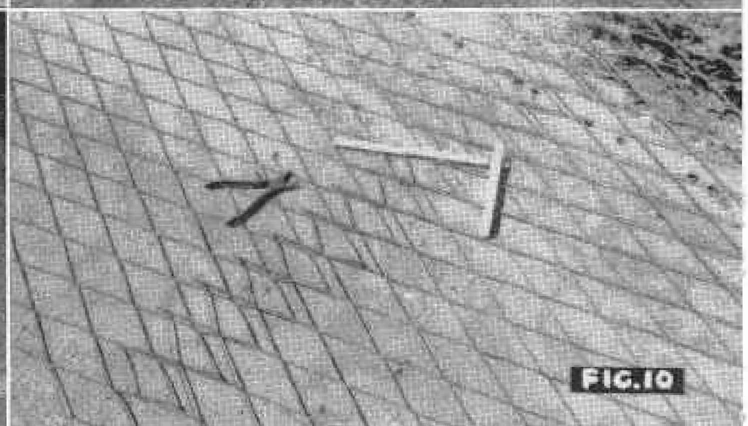


Fig. 2—Condition of old concrete pavement random cracks.

EXPANDED METAL. *Fig. 5—Stud driver used in fastening sheets to P.C.C. pavement. Fig. 6—Two-foot wide sheet fastened along leading edge. Paver approaches from left. Fig. 7—Two-foot wide sheet placed over random crack. Fig. 8—Typical expanded metal test section just prior to paving. Short section of longitudinal joint covered.*

BITUMINOUS ROAD MESH. *Fig. 9—Test section with 3- by 8-in. diamond mesh. New centerline will be at inner edge of wire. On left, sheets cover four feet of cement treated base. Fig. 10—Lapping of sheets. Wires are tied with hog rings about every fifth diamond. Fig. 11—Sleds used to hold down road mesh and welded wire fabric.*

ing wires to form rectangles. These sheets may have openings of 3 by 6 inches or 6 by 6 inches or any other dimension desired by the consumer. The gauge of the wire may also be varied, and rolls containing up to 300 feet are available. However, the majority of the installations have been laid with sheets 11 feet 6 inches wide by 8 feet long.

The California Division of Highways has constructed three experimental projects in which various types of metal reinforcement were used. Two of the projects, one in District V and one in District VI, were of a somewhat minor magnitude and involved the use of welded wire fabric only.

These two projects are described rather briefly in the paper presented before the Highway Research Board in January, 1956, and will not be included here.

This article will describe the major installation which was placed in District X and involved the placing of eight different types of metal reinforcing.

US 40, SOLANO COUNTY

The test section is located near the town of Vallejo on US 40, the main arterial between Sacramento and San Francisco, a four-lane heavily traveled highway. The average daily traffic count is about 20,000 vehicles with about 15 percent of heavy truck traffic.

This installation was completed in June, 1954. It is a rather complete test section in that all of the recommended types of wire mesh were placed under similar construction conditions and in areas where the existing pavement was of the same general nature in respect to amount and severity of cracking. The test sections involved the travel and passing lanes of the westbound travel way only.

The existing 20-foot wide concrete pavement, constructed in 1935, had been mud jacked and later subsealed with asphalt and some bituminous patches had been placed by the Maintenance Department in past years.

As the old pavement showed signs of vertical movement, the contract provided for subsealing the existing slabs again with hot asphalt. Before resurfacing, the traveled way was widened with cement-treated base to provide a standard 24-foot cross-section with full paved shoulders. This widening resulted in a two-foot shift of center line. The resurfacing consisted of three inches of plant-mixed surfacing, one-half inch maximum size aggregate, placed in two layers and topped with one inch of open-graded mix, one-half inch maximum aggregate. The grading of the bituminous mix conformed to the specifications shown below:

	Percent Passing	
Sieve Size	*Dense Graded*	*Open Graded*
½ in.	95–100	100
⅜ in.	75–90	90–100
No. 4	50–70	35–50
No. 8	35–50	15–32
No. 16	....	0–15
No. 30	15–30	....
No. 200	4–7	0–3

A careful crack survey of the existing portland cement concrete pavement was made and the location of the various test sections laid out. Alternate control sections without reinforcement but showing similar cracking were provided so as to permit ready comparison with each test section. *Figure 2* is typical of the condition of the old concrete pavement and *Figure 3* shows the general layout of the test sections.

The following forms of wire mesh were used in the test sections:

Type	*Mesh Size*
Expanded metal	½ in. by No. 20
	¾ in. by No. 16
	¾ in. by No. 13
	1½ in. by No. 16
Bituminous Road Mesh	3-12-30 (3- by 8-in. diamonds)
	6-36-20 (6- by 12-in. diamonds)
Welded Wire Fabric	3- by 6-in.—10/10 gauge
	6- by 6-in.—10/10 gauge

Figure 4 illustrates the comparative sizes of the various types of metal used.

Expanded Metal

The expanded metal was delivered to the job site in 2-foot and 4-foot-wide strips by 8 feet long. As the expanded metal is rather expensive the two- and four-foot-wide sheets were being tried in order to determine the most economical size which would prevent crack formation. The 8-foot long sheets were satisfactory for the passing lane as 8 feet of old concrete pavement remained due to a shift of the center line. For the 12-foot-wide travel lane some sheets where cut in half and an 8-foot and 4-foot long sheet used, allowing an overlap of about three inches. All joints such as expansion and contraction joints and random cracks of the slabs were covered with the metal. Short sections of the longitudinal joints between the old concrete and new cement-treated base were also covered with 2-foot and 4-foot-wide sections of the metal. (See *Figure 8*.)

The variation in the random crack patterns, encountered mainly in the travel lane, required a great deal of fitting and cutting of the sheets. In a number of cases, a random crack could not be entirely covered with a 2- by 8-foot sheet and required the use of 4- by 8-foot sheets.

The sheets were securely fastened to the old pavement by means of a standard stud driver, see *Figure 5*. In this operation a stamping disc, two inches in diameter was laid on the metal mesh, taking care to center the disc approximately in the center of the diamond. The operator, after loading the gun with the correct stud and cartridge, placed the gun over the disc and fired the charge. The stud penetrated the disc and concrete, and pulled the mesh into tight contact with the pavement. After a few trials it was decided that a stud having an over-all length of 1-15/32 inch was best suited. A heavy charge cartridge No. 832 was used in order to secure the required penetration. Satisfactory anchorage was obtained in the cement-treated base by using a stud having an over-all length of 2-31/32 inches and a light No. 232 powder charge.

The one-half inch by No. 20, two-foot-wide sheets were placed first to determine proper stud spacing. The eight-foot-long sheet was fastened at both the leading and trailing edges with about five studs and also at a number of spots on either side of the joint.

On passage of the paver over the sheets it was noted that a definite vertical bow appeared in the sheet immediately after the paver treads moved onto the leading edge. It was not possible to determine if the sheet returned to its original shape after the paver moved past. There were no indications of distress caused by failure of the studs to hold the wire in place, as far as longitudinal movement was concerned.

Transverse Cracking

Immediately after the first roller pass, transverse cracking appeared in the mix over the expanded metal sheets. This cracking became more severe on the final roller pass, although the metal was tight against the pavement as determined from the protruding edge of the sheet. On a number of sheets a very definite bump was present, mainly at the leading edge. Generally cracks appeared over both the leading and trailing edges and in a number of cases there also were three or four transverse cracks spaced about five inches apart. However, the next morning after approximately 15 hours of traffic most of the cracks had healed, although the leading and trailing edge cracks were still noticeable.

It was then decided to fasten the sheets only at the leading edge and to determine the least number of studs necessary to hold the sheet in place. Various numbers of studs were used including the absolute minimum for an eight-foot-long sheet, one at each corner and one in the center of the leading edge, *see Figure 6*. This proved to be satisfactory and resulted in a considerable saving as each stud in place costs about 25 cents.

Stud-driving Operations

Stud-driving operations proved quite successful in the passing lane, with very few failures due to shattering or excessive penetration. Some difficulties were encountered in the travel lane where the concrete appeared to exhibit marked variations in degree of hardness. In numerous instances the stud would penetrate only one-half of its normal distance, or would bend and shatter the concrete, or the charge would drive the stud completely through the disc necessitating the driving of additional studs.

There was no difficulty in the paving operations in any of the expanded metal sections. None of the sheets, including those fastened at the leading edge with only three studs, were torn loose by either truck or paver movement. It was noted that some longitudinal movement on a large number of sheets occurred under the traction stresses of the paver. This movement was in the same direction as the forward movement of the paver and was about ¼ inch to 1 inch for the ¾-inch diamonds and 1 inch to 1½ inches for the 1½-inch diamonds. This movement undoubtedly was caused by the forward shifting of the entire sheet, until the studs which were fired in the center of the diamond encountered the edge of the metal.

The rather severe cracking following rolling as noticed in the beginning, where both leading and trailing edges were fastened, was not noted where only the leading edge was fastened. Paving and rolling operations were normal and very little cracking, following rolling, was noted.

The best size of diamond, from the construction viewpoint, appears to be either the three-fourths by No. 16 or the three-fourths by No. 13. The lighter stocks were harder to handle and more difficult to fasten securely. The three-fourths by No. 13 in both 2-foot and 4-foot-wide sheets was easiest to lay and showed the least movement under paver traction forces. However, the 1½ by No. 16 can be laid and if it retards the cracking as efficiently as the three-fourths by No. 13 then the lighter metal would be the most advantageous from an initial cost standpoint.

Bituminous Road Mesh

The bituminous road mesh was delivered to the job in sheets measuring 11 feet 6 inches in width and 8 feet in length. The sheets (3- by 8-inch diamond) were laid along the median strip at various locations in the 600-foot test section and placed continuously on the pavement as needed. Due to widening of the pavement, as mentioned before, the wire mesh extended four feet over the cement-treated base in the passing lane. Only 20 sheets of the large 6- by 12-inch diamond mesh were laid.

The leading edge of the first sheet was securely fastened to the pavement through the use of the stud driver, at about one-foot intervals. All succeeding sheets were lapped one diamond, taking care that the sheets in place always overlapped the sheet being laid. The next operation was the fastening of the individual sheets to each other. This was done by two men, each equipped with a supply of medium-sized hog rings and a hog ring clipper. About four to five rings were used at each lap, the wires being tied along the length of the diamond. The first diamond on each edge of the sheet was always fastened as well as two or three diamonds in between. The hog rings, when crimped into lock position, do not rigidly clamp the wires together and the rings could be freely moved in a longitudinal direction. Vertical movement, however, is restricted to a large extent. The 3-12-30 mesh laid very flat against the pavement and there was very little curl or raised areas along the entire 600-foot section.

Sleds Used

In order to pave over the large sheets it was necessary to provide sleds which forced the sheet to remain flat during movement of the paver. These sleds were fastened to the front of the paving machine and dragged over the sheets just in front of the auger feed. *Figure 11* shows the sleds just before being attached to the paver. A total of five sleds were used, each nine feet long. The sleds used on the outside of the Barber-Greene tracks consisted of regular 60-pound railroad rails. The three sleds placed between the tracks were especially constructed from heavy bar stock to a total height of two inches in order to fit under the paving machine.

No particular difficulty was encountered with paving over the bituminous road mesh, except on a curve when due to the uneven traction of the paving machine a slight shifting of the mesh occurred and in one instance some of the wire for a distance of about 30 feet lifted suddenly out of the leveling course and had to be removed. After proper coordination of the truck driver and paving machine operator no further trouble was encountered. Occasional transverse cracks formed almost at once following the paver and in some cases after the first roller pass. Most of these cracks appeared at the laps of the sheets but were ironed out in the final rolling. However, the few that remained on opening the level course to traffic, had healed after overnight traffic. Some of the leveling course mixture was removed, after the rolling, in order to determine the location of the wire. The mesh in all cases was within one-fourth inch of the concrete pavement.

Welded Wire Fabric

This material was delivered to the job in sheets measuring 11 feet 6 inches wide and 8 feet long. Laying operations were the same as previously described for the bituminous road mesh. The fabric was laid so that for the 3- by 6-inch mesh the 3-inch spaced wires were transverse to the direction of travel and the longitudinal wires were uppermost. The first sheet was securely fastened to the pavement at about one-foot intervals. Each sheet was overlapped six inches and tied on the longitudinal wires only with hog rings. These sheets, having a one-inch projection of wire, seemed easier to lap than the bituminous road mesh and had less tendency to catch. Generally, the wire laid quite flat, although in some areas the sheets were raised from three inches to four inches, due to warping of the wire, above the pavement prior to paving operations. While laying this first section of welded wire fabric it was believed that the movement of the wire ahead of the paver would begin to accumulate enough forward longitudinal movement to cause buckling of the sheets. Therefore, as an experiment, it was decided to secure the leading edge of a sheet about every 150 feet. The overlapping sheet at this point was left free. The idea here was to take up all longitudinal forward movement of the previously laid sheets at this free joint. Close observations during paving operations did not disclose any marked movement of the sheets and any such small movement as occurred was taken up at the individual laps. We, therefore, concluded that this precaution would not be necessary in any future operations.

There were no difficulties in laying the mix over the section and the sleds appeared to iron down the mesh in an excellent manner. Cracking of the mix was very similar to that encountered with the bituminous road mesh. There were occasional transverse cracks, mainly at the laps, which appeared immediately after the mix was laid. Most of these tended to iron out after the final roller pass and the remaining ones had healed after overnight traffic. Removal of the mix in numerous locations along the 600-foot section indicated that the fabric was about one-half inch to three-fourths inch above the concrete pavement. The surface course was placed without any difficulties and no cracks of any kind were noticed.

Crack Survey

Three detailed surveys have been made of the job since its completion in June, 1954. The first, in January, 1955, revealed a few fine short transverse cracks in the nonreinforced control sections and none in any of the

BITUMINOUS ROAD MESH. *Fig. 12—Close-up of paving operations. Note sled attachment on left. Fig. 13—Position of mesh after placing leveling course.*
WELDED WIRE FABRIC. *Fig. 14—Fastening leading edge of first sheet. Fig. 15—Laying 3- by 6-in. wire fabric. Left edge covers 4 ft. of cement treated base.*

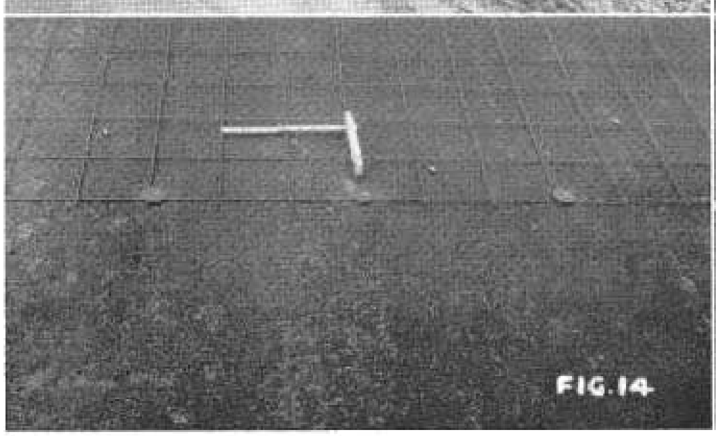


TABLE 1

Cost Analysis for Wire Installations on Contract 55-10TCF, [illegible]

Type of Metal	Expanded Metal		Expanded Metal		Expanded Metal		Expanded Metal		Bituminous Road Mesh		Welded Wire Fabric	
Size	1/2"x#20	1/2"x#20	3/4"x#16	3/4"x#16	3/4"x#13	3/4"x#13	1-1/2"x#16	1-1/2"x#16	3-12-30	6-36-20*	3"x6"	6"x6"
Width or Width and Length	2'	4'	2'	4'	2'	4'	2'	4'	11'-6"x8'	11'-6"x8'	11'-6"x8'	11'-6"x8'
Materials Costs												
Metal Sheets $	138	236	143	286	203	406	115	230	860	489	665	478
Delivery and Unloading $	26	26	26	26	26	26	26	26	52	52	52	52
Studs $	46	46	46	46	46	46	46	46	3	3	3	3
Cartridges $	24	24	24	24	24	24	24	24	2	2	2	2
Discs $	6	6	6	6	6	6	6	6	(Included in cost of cartridges)			
Tie Supplies (Hog rings) $	-	-	-	-	-	-	-	-	3	3	3	3
Sled Installation on Paver $	-	-	-	-	-	-	-	-	40	40	40	40
Total Material Costs $	240	338	245	388	305	508	217	332	960	589	765	578
Labor Costs	24	24	24	24	24	24	24	24	79	79	79	79
Grand Total $	264	362	269	412	329	532	241	356	1039	668	844	657
Total sq. Yds of Pvt. in Section	444	444	444	444	444	444	444	444	1701	1701	1701	1701
Cost/Sq.Yd of Pvt. Surface $	0.57	0.86	0.61	0.93	0.74	1.20	0.54	0.80	0.61	0.39	0.49	0.38

*Only 20 sheets of 6-36-20 Bituminous Road Mesh were laid. The noted cost figures are theoretical values for laying an area equivalent to the 3-12-30 Bituminous Road Mesh and welded wire fabric sections

TABLE 2

Cost Per Sq. Yd. of Various Types of Wire Mesh

Type	Designation	Width of Expanded Metal	Case I Joints only* — Cost prorated per 180 sq.ft. of pavement. Assumed that concrete is 12' wide with 15' joint spacing: Metal Cost	Installation Cost (4 Studs per 12' Sheet)	Cost Per Slab 15' long x 12' wide	Cost/sq.yd. of mesh	Case II Joints plus one Transverse Crack Per Slab* — Cost prorated per 180 sq. ft. of pavement. Assumed that concrete is 12' wide with 15' joints and 1 transverse crack per slab: Metal Cost	Installation Cost (4 Studs Per 12' Sheet)	Cost Per Slab 15' long x 12' wide	Total Cost/sq. yd. of mesh
Expanded Metal	1/2"x#20	2'	3.66	1.52	5.18	0.26	7.32	3.04	10.36	0.52
		4'	7.32	1.52	8.84	0.44	14.64	3.04	17.68	0.88
Expanded Metal	3/4"x#16	2'	4.09	1.52	5.61	0.28	8.18	3.04	11.22	0.56
		4'	8.18	1.52	9.70	0.49	16.36	3.04	19.40	0.98
Expanded Metal	3/4"x#13	2'	5.79	1.52	7.31	0.36	11.58	3.04	14.62	0.72
		4'	11.58	1.52	13.10	0.65	23.16	3.04	26.20	1.30
Expanded Metal	1-1/2"x#16	2'	3.29	1.52	4.81	0.24	6.58	3.04	9.62	0.48
		4'	6.58	1.52	8.10	0.40	13.16	3.04	16.20	0.80
Bituminous Road Mesh	3-12-30 (3"x8" diamonds)		10.23	1.97	12.20	0.61	10.23	1.97	12.20	0.61
Bituminous Road Mesh	6-36-20 (6"x12" diamonds)		5.77	1.97	7.74	0.39	5.77	1.97	7.74	0.39
Welded Wire Fabric	3x6-10/10		7.91	1.97	9.88	0.49	7.91	1.97	9.88	0.49
Welded Wire Fabric	6x6-10/10		5.69	1.97	7.66	0.38	5.69	1.97	7.66	0.38

*Coverage applies to expanded metal only

wire mesh sections. The second survey in May, 1955, after 11 months of traffic, did not show any material change and no crack over six feet long. The latest survey, made in December, 1955, revealed slightly more transverse cracking in the control sections, two cracks extending over the entire width of 20 feet of the old pavement. No transverse cracks of any kind were visible in the wire mesh sections. Therefore, as of this date no conclusions can be drawn except that so far there is no difference in the relative abilities of the various types of wire mesh to prevent or retard reflection cracking.

At this later survey, however, considerable longitudinal edge cracking was noticed in both the travel lane and passing lane. This cracking extended along the joint between the old concrete pavement and the newly laid widening strip of cement-treated base. As none of the longitudinal edge along the travel lane was covered with wire mesh this cracking is irrelevant as far as the wire mesh is concerned. However, in the passing lane which is underlain only with eight feet of old portland cement concrete due to a shifting of center line, the eight-foot-long expanded metal sheets placed over the joints were laid to the edge of the old pavement only. The bituminous wire mesh and welded wire fabric, however, extended the full width of the new pavement and covered four feet of the new cement-treated base. It was noted that no longitudinal cracking occurred over the joining edge which was covered with the bituminous road mesh or welded wire fabric. The total length of the project is 8,320 feet. Of this distance, 6,540 feet or 78.6 percent consisted of the nonreinforced edge and 1,780 feet or 21.4 percent is covered with metal. Approximately 1,200 feet comprising 18.3 percent of the nonreinforced edge section has developed longitudinal cracking. It appears that up to this time the bituminous road mesh and welded wire fabric has definitely prevented longitudinal cracking.

Cost Analysis

It is difficult to present an accurate cost analysis where a number of relatively short test sections are involved. The installation of the various types of wire mesh was not part of the original contract and was performed under "extra work" and, therefore, no bid prices are available. However, an attempt has been made to present a cost comparison based on our observations during construction and cost figures supplied by the resident engineer. Labor costs, transportation and unloading costs and the price paid for construction and installation of the sleds all tend to reflect somewhat

Table 3

Cost Per Mile of Various Types of Wire Mesh For Specific Condition of Existing Concrete Pavement

Type	Designation	Width of Expanded Metal	Original Concrete Condition (12' Lane with 15' Joint Spacing): Jts. Only No Cracks Cost/Mile for 24' Pvt. Width	Jts. + 1 Transverse Crack Per Slab. Cost/Mile For 24' Pvt. Width
Expanded Metal	1/2" x #20	2'	$ 3,660	$ 7,320
		4'	6,190	12,392
Expanded Metal	3/4" x #16	2'	3,942	7,884
		4'	6,900	13,800
Expanded Metal	3/4" x #13	2'	5,068	10,136
		4'	9,152	18,304
Expanded Metal	1-1/2" x #16	2'	3,380	6,760
		4'	5,632	11,264
Bituminous Road Mesh	3-12-30 (3"x8" Diamonds)	-	8,588	8,588
Bituminous Road Mesh	6-36-20 (6"x12" Diamonds)	-	5,490	5,490
Welded Wire Fabric	3"x6"-10/10	-	6,900	6,900
Welded Wire Fabric	6"x6"-10/10	-	5,350	5,350

Cost/Mile of 1" of added thickness of P.M.S. for 24' Pavement = $ 3,878

Cost/Mile of 1½" of added thickness of P.M.S. for 24' Pavement = 5,817

Cost/Mile of 2" of added thickness of P.M.S. for 24' Pavement = 7,756

(Based on average cost price of $6.30 per ton in place) higher prices due to the short test sections. The final analysis is based on the cost of mesh per square yard of pavement. This method was selected as the only way that a true cost comparison could be made between the small diamond sheets which covered the individual joints and cracks only, and the wire mesh which covered the entire pavement.

Three tables showing analyses for different conditions are presented. *Table 1* shows the actual cost of the metal reinforcing on this job calculated on the basis of square yards of pavement covered. The 6- by 6-inch welded wire fabric appears the least expensive with the large diamond bituminous road mesh only slightly higher in cost. As the handling and installation of these two types of metals are similar, the final cost depends primarily upon the original price of the metal. The cost of the expanded metal per square yard of the pavement is noticeably higher and is greatly influenced by the number of random cracks and the cost of fastening.

A direct cost comparison between the small diamond expanded metal sheets and the mesh which covers the entire pavement is difficult to make. On a pavement exhibiting little random cracking and where only the expansion and contraction joints would be covered, the cost of the expanded metal would be greatly reduced. A relative comparison may be obtained by assuming various conditions of the concrete pavement as shown in *Table 2*. In Case I the joints only are to be covered whereas Case II assumes the coverage of at least one random crack per 15-foot slab. The cost figures are based on the actual installation costs as shown in *Table 1*. The first assumed condition indicates that the two-foot-wide expanded metal sheets are less expensive than mesh which covers the entire slab. In the second assumed condition where one additional crack per slab is to be covered, the cost of the expanded metal is exactly doubled and exceeds the cost of the bituminous road mesh and welded wire fabric. The cost of the four-foot-wide sheets, of course, is considerably higher. As badly cracked concrete pavements very often have more than one random crack per slab it would appear from this analysis that the cost of covering these cracks with expanded metal sheets of either two-foot or four-foot widths would be prohibitive. On the other hand, the cost of the other two types of wire mesh which cover the entire pavement remains the same regardless of the number of random cracks.

In *Table 3* a cost comparison, for the same specific conditions of the pavement as shown in *Table 2*, has been calculated in terms of cost per mile for a 24-foot width of pavement. For further comparison the cost of adding an increasing thickness of plant-mixed surfacing is included at the bottom of the table. The cost of plant-mixed surfacing is based on average bid prices current in California. Roughly, the cost of either the large diamond bituminous road mesh or the 6- by 6-inch welded wire fabric is equal to the cost of 1½-inch thickness of plant-mixed surfacing.

As stated, the cost comparisons presented are approximate only. There is little doubt that large-scale installations of any of the wire mesh types described, together with experience gained by contractors, should show an appreciable reduction in cost.

SUMMARY AND CONCLUSIONS

The various types of wire mesh used and described in this report can be laid and paved over by conventional construction equipment without undue difficulty. The plain expanded metal placed over joints and cracks only, required no modification of equipment. The bituminous road mesh and welded wire fabric required some type of hold-down device in order to press the wire flat against the old pavement and prevent the tracks of the paving machine from catching in the mesh. On pavements that are badly cracked or extensively patched it would appear that the use of wire mesh which covers the entire pavement would be more feasible and economical than the use of individual sheets placed locally over the joints and cracks only. Care should be taken in transporting and handling these sheets. The flatter the sheets, the less difficulty will be encountered with springiness and resulting cracking of the mix after placing. Any twisted or kinked sheets should be discarded. When paving on curves the paving machine operator should carefully control the traction of the paver so as to avoid shifting of the wire mesh.

The cost analysis indicates that the welded wire fabric is the least expensive of the various types of metal used. The large diamond bituminous road mesh can be considered competitive with the welded wire fabric and the two-foot-wide sheets of the expanded metal when placed over expansion or contraction joints only. The cost of the continuous wire reinforcement is equal to about 1½ inches thickness of bituminous surfacing.

A few transverse cracks have appeared in the control sections but none in the wire-reinforced sections. At this date there is insufficient evidence to form an opinion regarding the effectiveness of the various types of wire mesh used in preventing or retarding reflection cracking. There is, however, definite evidence that the wire reinforcement has prevented the formation of longitudinal cracks.

Although these experimental sections should eventually provide some very definite data regarding the beneficial effects, if any, of the various types of wire reinforcement to prevent or retard reflection cracking, it would appear that in any future installations thought should be given to incorporating one or two other variations such as: Vary the thickness of surfacing from perhaps two inches to four inches in the reinforced sections, and in certain control sections increase the thickness of the bituminous mix so that the price per square yard of the nonreinforced portion is equivalent to that of the wire reinforced section. There is evidence that an increase in thickness of bituminous surfacing may not entirely prevent reflection cracking but the magnitude or severity of such cracking may be greatly delayed and reduced. This is demonstrated to some extent by the pavement represented by *Figure 1* where a one-inch blanket began to show reflection cracking after 30 days when compared to the District X job where the four inches of bituminous surfacing in the control sections has

... *Continued on page 71*

HOUSE MOVING

Continued from page 40 . . .

possible to find the cut lines after the operation is completed.

The various municipal and county agencies require that a building being relocated on a lot to be renovated and redecorated so as to make the building consistent with the majority of the houses in the neighborhood. A house moved in must be as good or better than any house within a 1,000-foot radius of the new site. This requirement applies both to the exterior and interior of the improvement. The electrical wiring and plumbing systems are inspected and are required to meet current standards. The renovating of these improvements to meet such requirements add years of safe and useful life to the older houses that are moved.

Moving Problems

The movement of the houses within a metropolitan area is not without its problems. The housing crises has been replaced with the world's greatest traffic headache. To facilitate movement of houses without the snarling of traffic, all house moving must be done between the hours of midnight and 6 a.m. Traffic during these hours is relatively light, however, there is a small percentage of drivers during these hours who may become confused upon sighting a house rolling down the street. There have been accidents at the rate of one per week in which drivers have collided with houses being moved. One such driver had lodged his car underneath a house in the process of movement. When the policeman questioned him as to what had caused the accident, his reply was, "I have driven this same street for the last 10 years and I never saw that house before."

Problem of Overpasses

Another problem is the construction of overpasses in the freeway program. The normal overhead clearance of such overpasses is about 15 feet. However, the usual minimum height of a one-story house in transit is approximately 22 feet. With each grade separation, good routes are becoming more and more difficult to find for movement of improvements from the central Los Angeles area. Overhead wires also present a problem within the metropolitan area. It is necessary for various utility company employees to be available to raise wires in order to allow houses to pass. In some instances the cost of moving wires is greater than the cost of moving the house.

There is no house moving authority established in the State of California to enforce safety regulations on the house mover. Therefore, to advance the moving industry, the reputable house movers have joined together in an association known as the House Moving Contractors Association and they police their own industry. Any improvement more than 36 feet in width must have a permit of feasible movability issued by a committee of three representatives of the association in addition to the necessary transportation permit issued for use of city streets, county roads or state highways. The association, through its efforts, has done much to make the house moving industry safe and prosperous.

Today, house moving in the Los Angeles area amounts to about $7,000,000 annually. Add to this the resale price of the houses, together with labor costs of carpenters, plumbers and workers necessary to renovate the homes, the relocation of improvements in the Los Angeles area will amount to a sum in excess of $15,000,000 annually. This is BIG BUSINESS.

Sales Section

In 1946, as the postwar highway program was being accelerated and freeway construction was again started in earnest, it became apparent that there was need for a section within the Division of Highways to handle the sale of improvements and the clearance of right of way, together with the renting of houses that had been purchased but were not immediately needed for construction. No one at that time could foretell that the clearance program would reach the immensity of its present operation.

It normally takes from one year to eighteen months to buy sufficient right of way to award a construction contract. Rather than remove the houses immediately, after purchase, it has been the policy of the Division of Highways to allow the improvements to remain in place until such time as the property is needed for construction. Instead of allowing the houses to remain vacant, the rental section has been successful at renting them at the current rental rates. The Los Angeles office has approximately 1,750 such houses now being rented. This house pool is in a constant state of flux because of the acquisition and sales program. Approximately 40 to 60 prop-

LEFT—A 16-unit apartment house in the process of being reassembled at its new location. RIGHT—Sixteen-unit apartment house fully reassembled at the new location. These units were so expertly finished it is now impossible to find the cuts that were necessary to move the building. This building was originally located in Sherman Oaks and was relocated in El Segundo.


LEFT—Frame residence prior to relocation. RIGHT—Same residence after relocation. This residence was completely renovated and is now an attractive stucco house.

erties are added weekly by purchase and subtracted weekly by sales from this group.

Timing in Sales

Timing in house sales is of the essence. If the improvement is sold long before the property would be needed for construction, the State is deprived of rents that it would have collected. Furthermore, if less than 90 days is allowed to the purchaser for clearance, the house brings a lower return on the market. Notwithstanding these facts, the right of way must be cleared and be available to the contractor upon the awarding of the construction contract. Timing is related to the price that an improvement will bring on the market in another way. If too many houses are sold in a short period of time, the market becomes flooded and the sale prices are lower. By the same token, if sales are too slow to stimulate interest in the area, the market tends to become stale and stagnant and the sale price of the improvement is lower.

All salable improvements are sold at public auction on the premises. The buyer is required to "put up" a $1,000 faithful performance bond for the removal of improvements in a manner acceptable to the State by the removal date specified at time of sale. It is the further responsibility of the purchaser to determine whether or not the buildings are m o v a b l e as well as whether or not they will be permitted to move into a certain locale or neighborhood. In addition, the buyer must obtain moving permits from each political subdivision through which the improvement is to pass.

Last year the House Sales Section in the Los Angeles district sold 2,250 units for a total return to the State of $2,073,000. In addition to this it collected $888,000 in rents. This money is added to the Gas Tax Fund for freeway construction. This is BIG BUSINESS.

Vandalism

One problem that grew with the accelerated program was vandalism. This problem is twofold. First, the vacant h o u s e s awaiting sale are plagued by youthful vandals. This problem first started with the unquenchable desire of youth to heave a rock through a plate glass window. The second phase of this problem is the professional vandal. Several individuals saw an opportunity to pick up side money by scavengering state-owned houses.

Vandalism in these two forms became so extensive that it could no longer be ignored regardless of the fact that most houses were redecorated inside and out during the relocation process. The various municipalities were sympathetic with the State's problem of vandalism but did not feel justified in hiring additional police to guard state property. The various areas in which these properties are located were so widespread that a system of night watchmen or foot patrolmen was impracticable. To cope with this ever-growing menace the House Sales Section was authorized to hire three state policemen as motorized units to rove the various areas. These patrolmen vary their hours and routes so that no one will be able to predict their time and place or know when to expect them. The results of this program have been heartening. In the first six months of 1955, 69 convictions of theft were obtained through the courts, and professional vandalism has almost been completely eliminated.

Parents Held Responsible

The abolishment of youthful vandalism has not been quite so successful because of the difficulty of prosecuting minors. However, on September 2, 1955, legislation became effective governing the prosecution of juvenile offenders. Under this new law, the parent is held responsible for the acts of vandalism by the child. Upon apprehension, the parents of each child are required to reimburse the State for the damage done. Although the parents do not publicize the apprehension and the effect thereof, you may be sure that the child's playmates and friends receive full details of this together with details of other punishments administered by the parent. So effective has been this law that the waning of youthful vandalism is already apparent.

Results

Los Angeles like most other cities had not experienced growth by large subdivisions and housing projects, with a house on every lot, until the early 1940's. As a result, there were a number of vacant lots in the older sections of the city. To build a new house in such a section would result in an over-improvement. With the program of relocation of improvements for freeway construction, most of these lots have now been utilized for the relocation of houses that are consistent with other homes in those neighbor-

USED HOUSE LOTS—Many lots in the Los Angeles area display as many as 25 to 30 homes that are for sale to be moved onto lots of prospective buyers

hoods at a price that is economically feasible.

The Los Angeles area has never known the tenement housing that has plagued most large cities. This does not mean that this city does not have any slums or substandard housing areas. For the most part, the slum areas consist of one-story slums crowded closely together. The freeways passing through these older sections of the city have done much to eliminate many of these one-story slums. These substandard houses are frequently on the fringe of industrial areas.

For years these industrial areas have creeped like an amoeba, constantly overflowing its boundaries, as a result of individual requests for zone variances and zone changes. This problem has continued to exist despite the tireless efforts of the various planning commissions to draw a permanent boundary to separate residential and industrial zones. The freeway frequently forms a good dividing strip or buffer zone making a permanent boundary to separate these two zones. The remaining old homes on the industrial side of the freeway are immediately gobbled up for industrial development. The owners of residential improvements on the other side of the freeway have a new sense of security and are no longer reluctant to spend money on needed repairs and rehabilitation of the properties.

Once again Yankee ingenuity is due commendation. Not only has this far-sighted program netted a substantial monetary return to state coffers for highway construction; but through the wholehearted cooperation of private enterprise and the public works program the public has received a double dividend. A house that is good before it is moved is good after it is moved. An older house is rejuvenated and modernized in the relocation process to add years of useful life. Many dwellings on the verge of discharge from service without honor have been recalled by relocation to do another "hitch" of honorable service as a home in one of the fastest growing population centers in the world. This is GOOD BUSINESS.

A public auction of an apartment house in North Hollywood conducted by state personnel

REFLECTION CRACKS

Continued from page 68 . . .

shown practically no reflection cracking so far. Traffic is similar in both cases. Another variation might be to place, prior to resurfacing, a cushion course of granular material varying perhaps in thickness from four inches to six inches over the old pavement and compare the cost and effectiveness with the wire-reinforced sections. One other alternative might be to add rubber in various proportions to the bituminous mixture as a possible method of reducing reflection cracking.

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The work described herein was performed under the general direction of Mr. F. N. Hveem, Materials and Research Engineer, California Division of Highways. Excellent cooperation was extended by the Resident Engineer, Mr. L. E. Daniel of District X.

The writer wishes to especially acknowledge the efforts of Mr. John Skog who took care of most of the detailed work and assisted the Resident Engineer during the placing of the test sections.

Assignments

Transfers Affect Three Districts

THREE District Engineer assignments for the California Division of Highways, effective March 1st, were announced by State Highway Engineer G. T. McCoy:

A. M. Nash, District Engineer of District III, with headquarters at Marysville, was transferred to District V, with headquarters at San Luis Obispo.

A. M. NASH

J. W. Trask, District Engineer of District II, Redding, was transferred to District III, Marysville.

H. S. Miles, Assistant District Engineer in District IV, San Francisco, was promoted to District Engineer of District II, Redding.

When Nash assumed responsibility for District V, Acting District Engineer, L. L. Funk, returned to his previous assignment as Assistant District Engineer—Planning. District V includes the counties of Santa Barbara, San Luis Obispo, Monterey and San Benito.

J. W. TRASK

Nash had been District Engineer at Marysville, a district which includes 11 Sacramento Valley and mountain counties, since 1952. His earier service included two periods as District Engineer of District I, Eureka, and one three-year assignment as Engineer of Design for the Division of Highways, at headquarters office in Sacramento.

He has been an employee of the Division of Highways since 1920, following aviation service in World War I. A native of Elk City, Kansas, Nash studied at the University of Washington. He has served on important national committees of highway officials concerned with highway design and administration.

Trask had been on the staff of District II, which includes seven north central and northeastern counties, since 1943. He became district engineer in 1950. A native of Lincoln, Kansas, he has been with the Division of Highways since coming to California in 1928, serving first with the Bridge Department and later on various assignments, including that of resident engineer on the Newcastle Tunnel on US 40 in 1931.

Trask is a graduate of Utah State College and served in World War I with the Army Corps of Engineers.

Miles, the new District Engineer of District II, joined the Division of Highways in 1931 upon graduation from the University of California, and

H. S. MILES

has been engaged in various engineering and administrative assignments in the San Francisco Bay area district ever since. He was District Maintenance Engineer of District IV from 1947 to 1950, and since 1950 has been Assistant District Enigneer—Administration.

Miles was born in Elmira, New York, but came to California as a child and attended public schools in San Francisco. He has long been active in civic affairs in his home community of Millbrae, San Mateo County. Miles is married and has a 10-year-old daughter.

GOODWIN J. KNIGHT
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