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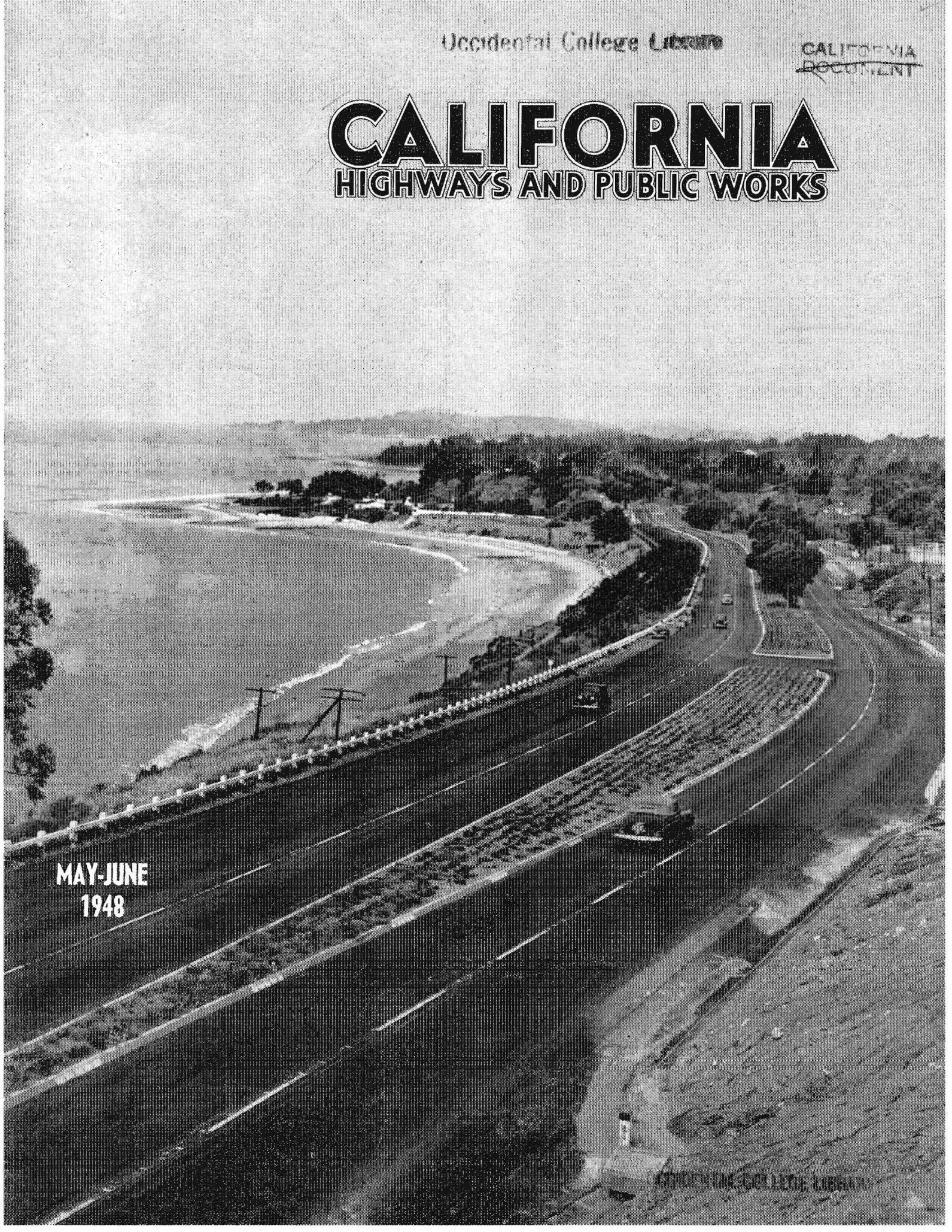
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HIGHWAYS AND PUBLIC WORKS

MAY-JUNE
1948

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California Highways and Public Works

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

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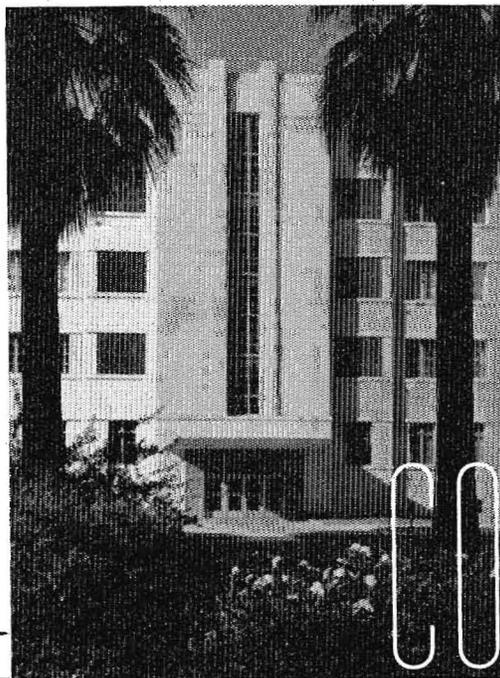
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Outer Highways

A Study in Successful Planning for Major Retail Business Development

By FRANK F. MARSHALL and DEXTER MacBRIDE, Right of Way Agents, District VII

WHEN energetic Franciscan Fathers from San Gabriel planned a new city in Southern California in 1781, they indicated a pattern which is remarkably evident in the \$15,000,000 development now being completed along the outer highway of Crenshaw Boulevard, six miles southwest from the old Plaza Mission and center of downtown Los Angeles.

The problem of the fathers inhered in city planning: integrate the central building mass with (future) traffic flow.

Within practical limits they planned well. They gave a north-south direction to a main street; adjacent thereto was marked off a central plaza area. Opposite the plaza was to be the mission. The pattern was clear—controlled traffic; central gathering area; building structure.

Pattern Now Complex

The pattern has now become wonderfully complex and can be observed and studied by referring to *Aerial Photograph "B."* Study of this photograph will show the area, generally, to be west of Crenshaw, south from Exposition Boulevard to Stocker Road. Dominant feature is traffic flow, facilitated and regulated by means of the paralleling outer highway (sometimes denominated "service road," or "marginal access roadway"). Implicit in this study is an acceptance of the fact of metropolitan decentralization—involving major industry, retail merchandising and residential population.

Along the outer highway lies the building mass; behind this mass is placed the terminal parking facility.

It is our purpose to sketch briefly the planning and growth of this new Crenshaw area; to present pertinent building and management data; and to categorize those factors which tend to make this highly developed retail business area commercially successful and, in the sense of community planning, significant.

Prior to 1937 the area was "open country." See *Aerial Photo "A."* North

IN CONNECTION with the construction of freeways through metropolitan areas, many property owners become concerned over the effect on the fair market value of their remaining property which, previous to freeway construction, had access to the through lanes of traffic but, upon completion of the freeway improvement, will front upon an outer highway.

The Right of Way Department, which renders a public service the affected property owner is entitled to expect, is carrying on an extensive study to determine the actual effect of this type of freeway development upon the remaining portion of a property owner's holding from which the freeway right of way is taken. This study is not only being made in California but throughout several of the Atlantic Coast states, including New York, Connecticut, New Jersey, Michigan, Ohio and Illinois, in some of which states this type of freeway development has been completed and in use by the traveling public for a period as long as 12 to 15 years.

From time to time as these studies are carried on, the reports will be published so that the general public will have the benefit of information developed.—Editor

of Santa Barbara Avenue the land was used for airports; south of the intersection lay the Sunset Fields Golf Course. The aerial photo, taken July 10, 1930, illustrates the extent of the relatively undeveloped territory. It is interesting to observe that even then the territory appeared to be, island-like, in a sea of houses.

North of Santa Barbara, in the airport area, development may be observed in four sequential stages.

In the initial stage of development, a subdivision, Tract 11100, was recorded by the McCarty Company

of Los Angeles on January 26, 1937, and embraced the land adjacent to and west of Crenshaw between Exposition Boulevard and Rodeo Place. The area embraced 120.83 acres, costing \$1,564.18 per acre. An outer highway was not constructed. Ralph's Grocery Company pioneered the spot, purchasing the entire block between Exposition Boulevard and Rodeo Road for the sum of \$27,000. They erected a "super market," utilizing the remainder of the block for parking.

Second Stage

In the second stage, the pioneer retail investor was followed in 1940 by other major chain merchandising interests and soon almost the entire block between Rodeo Road and Rodeo Place was built up. The land was leased on a basis of \$8 to \$10 per front foot minimum guarantee. Land selling prices began at \$60 per front foot and have recently attained sums up to \$700 per front foot.

It would be well to interpolate at this point the fact that, commencing at Rodeo Place, the outer highway has been planned and constructed southward to Stocker Road. It was constructed in its entirety by private capital. Unlike the "pioneer" tract of Ralph's Grocery and the block between Rodeo Road and Rodeo Place referred to above, the remainder of the area possesses an outer highway—an initial evidence of community engineering applied to traffic flow and (future) structure mass.

Third Stage

In its third developmental stage, the G. D. Robertson Company purchased land (August 16, 1940) immediately west of Crenshaw between Coliseum Street and 39th Place for approximately \$2,700 an acre. A subdivision was effected. Lots first sold for \$75 per front foot with R-4 zoning. After rezoning to C-2 and C-3, and full realization of development trends was had, purchasers paid up to \$400 per front foot. At present this land is not for

sale; but has a potential market value of approximately \$600 per front foot. If this land were improved with high class store buildings similar to those constructed in this neighborhood, rentals ranging from \$15 to \$17.50 per front foot could be expected.

As fourth and final step in the growth of the area adjacent to Crenshaw on the west and north of the Santa Barbara intersection, there remained a parcel containing approximately nine and one-half acres. The Robertson Company purchased this for \$91,500. Six acres of the tract was then leased to The May Co. for a 99-year period. Here again in the subdividing process provision for the outer highway was a major feature in development.

Our attention now swings south of the Santa Barbara Avenue intersection.

On March 1, 1948, a subdivision map was filed on Tract No. 13258, covering property comprising 31.96 acres. The outer highway became an integral portion of the planning. The area was leased to the Broadway Department Stores; said lease was based upon a land value of \$600,000 or \$18,750 per acre. The entire Broadway Department Store leasehold is covered by a title insurance policy in the amount of \$3,000,000.

This brings our account of the planning and growth of the Crenshaw Boulevard property to its fulfillment. For here, efficiently located on an outer highway, paralleling a major traffic artery, there is placed a building mass of the highest type retail business. Adjacent to the building mass is the complementary gathering area or ter-

minal parking facility. The development, then, has grown south from Exposition Boulevard to Stocker Road along the westerly side of Crenshaw Boulevard.

It will now prove helpful to turn our attention to pertinent building and management data.

Building and Management Data

The two areas which afford the most interesting building data are those immediately north and south of the Santa Barbara-Crenshaw Avenue intersection.

North, in the area bounded by Crenshaw, Santa Barbara, Marlton Avenue and 39th Street, lies the May Company development with approximately 400-foot frontage on the outer highway. The additional area along the outer

Photo A—Showing area in vicinity of Santa Barbara Avenue and Crenshaw Boulevard. The property under discussion in this article lies west of Crenshaw Boulevard in the center of photograph.—Spence Photos

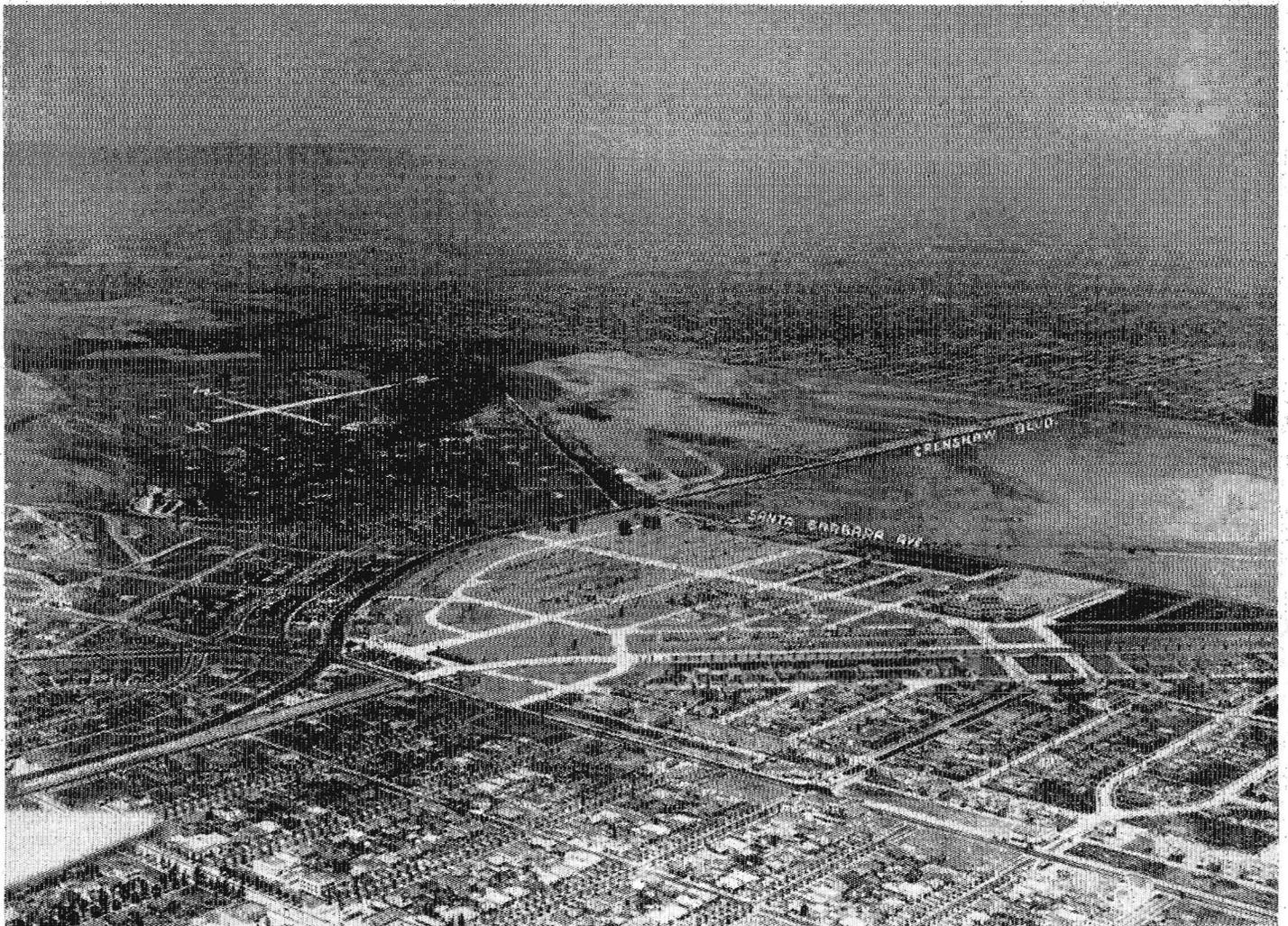




Photo B—Showing recent development on west side of Crenshaw Boulevard from Stocker Avenue to Exposition Boulevard, looking northerly. Hollywood and Beverly Hills in background.—Photo by Nickerson

highway will be leased on the basis of \$20 per front foot minimum, plus a percentage of gross sales. Contiguous parking facilities have not been provided for any of the tenants in this block other than that of the May Company store itself.

The May Company structure is four-storied and concrete, containing a floor space of 265,000 square feet. It has been completed at a total cost of

\$4,750,000, of which approximately \$1,250,000 was expended for fixtures.

South of the intersection lies the Broadway-Crenshaw development, which completely absorbs the irregularly shaped parcel of 31.96 acres lying within the confines of Crenshaw, Santa Barbara, Marlton Avenue, Santa Rosalia and Stocker Street.

The Broadway Department Store lease runs for a period of 50 years with

option to renew for an additional 25-year period. The Broadway building mass has absorbed an estimated \$4,800,000 in construction costs, and the fixture expenditure is placed at \$1,120,000.

Integrated with the central structure to provide maximum customer service are four other major building masses. Facing the outer highway and immediately adjacent to the Broadway Store is a series of structures which was built

at an estimated cost of \$2,495,000, and which will provide space for eight major chain tenants. Set somewhat apart from this entire unit is Von's Super Market; estimated cost \$565,000, plus fixtures.

On the southwest corner of the parcel, the General Petroleum Company is erecting a super station at a cost of \$200,000, with facilities to service every automotive need. The last unit will be a building for the use of the Pacific Telephone and Telegraph Company to be erected at an estimated cost of \$1,000,000. Each of the building masses is being erected to utilize and service a fast-growing business and residential area. In the especial instance of the

P. T. & T. Co., the subscriber demand (present and potential) requires such a centrally located exchange to lessen the service load on exchanges located on the periphery of the area.

Generically relevant to a study of this area are the following factors: the ground slope of the parcel was estimated to be over 4 percent in grade; underlying strata contain a large area of peat formation; ground water level was estimated to be 80 feet below grade.

Of major interest is the service tunnel, a \$400,000 project. It serves all the tenants facing Crenshaw and Santa Barbara, is nearly one-half mile long and has a 20-foot clear width with

sufficient height to easily accommodate trucks regularly permitted on California state highways. It lies between the parking area and the building masses. Basement loading docks in each of the buildings are directly appurtenant to the tunnel; and all merchandise receiving and delivery of trash is handled by means of this underground delivery service. Using the two open ends as a source of supply, ventilation is facilitated by an exhaust system located in the approximate center of the tunnel.

Planning: Major Factor in Success

Consideration of the third aspect of this study now becomes pertinent: factors which tend to make this highly

Photo C—Aerial view looking westerly showing development at intersection of Santa Barbara Avenue and Crenshaw Boulevard.—Photo by Nickerson



developed retail business area commercially successful and, in the sense of community planning, significant. It is easy to become lost in a multitude of "success factors." Modernity of design, double frontage, efficiency of delivery and waste processing, esthetic treatment of landscaping—each is important.

But centrality of location, with attendant consumer power, parking facilities, efficient ingress and egress to arterial traffic flow by means of an outer highway: these three are dominant factors. They are foundations upon which capital can safely erect the highest type of retail business development with consequent minimum obsolescence.

A Central Location

In the year 1946, and after a definite pattern and trend had been established in this area for a high-class development, an economic survey was made by Coldwell, Banker Company, local realtors. The following facts were revealed:

1. This area has the highest percentage of owner occupancy in Los Angeles County.
2. Over 567,000 residents live within a 20-minute driving radius of Santa Barbara Avenue and Crenshaw Boulevard, and this area is easily accessible to residents of many beach cities as well as the Wilshire, Beverly Hills, and Hollywood districts.
3. This area has a potential buying power of over \$411,879,000.

Corroborative of this survey is the Prudential Life Insurance Company's plan to erect 1,300 to 1,400 units to house approximately 5,000 persons. This development, occupying 129 acres west of major Crenshaw development, will contain 10 to 12 units per acre with separate garages and off-street parking.

Parking Facilities

Too great emphasis cannot be had upon the importance of parking facilities. After the flow of traffic has been modulated by means of an outer highway, a well planned terminus must be available, especially in so great a retail

business center as the subject development.

Although at present the parcel north of and contiguous to the May Company site does not have such parking facilities, the May Company itself provides a maximum terminus for approximately 750 cars. In addition, parking facility for a 2,000-car maximum was made available in the Broadway Store development.

An interesting commentary on the high value placed on the outer highway and parking facility factors is afforded by even a cursory glance at two areas across the street from one another. One possesses the facility factors, the other does not. The Broadway Department Store interests have erected buildings for leasing to leading merchants of their choice. These merchants pay \$40 minimum per front foot with parking facilities, for which is charged an additional one-fourth of one percent annual gross income.

Directly across the street, building space lies idle at an asking rental of \$25 per front foot. This area is without an outer highway for traffic terminus.

The Outer Highway

The outer highway has followed a simple, effective pattern along Crenshaw Boulevard, in direct relation to maximal safety measures for automotive and pedestrian traffic. (The width of the outer highway varies from 28 feet to 38 feet.) It is separated from the arterial flow on Crenshaw Boulevard by an "island," or dividing strip, approximately 13 feet wide and 6 inches high. Building lines are set back 108 feet from the center line of Crenshaw Boulevard.

In such retail business development as this, an essential predication for value is site, adaptability and use. In the planned diversion of automotive traffic into a quiet safe zone paralleling the major thoroughfare, maximal use is achieved.

Metropolitan Planning and the Outer Highway

There is no more incisive and comprehensive summary of the importance and value of outer highway development than inheres in a statement pre-

pared especially for this study by Mr. Milton Breivogel, Principal City Planner for the City of Los Angeles, who states:

"I believe that a service roadway (outer highway) parallel to a major boulevard will reduce the interference to the free movement of through traffic to a minimum for the following reasons:

1. Property fronting the highway will have no direct access to the main roadway. This will eliminate the stopping of vehicles at the curb and the turning into and out of driveways to the property.
2. Street intersections with the major boulevard are reduced to a minimum. Practically all local streets can be terminated at the service roadway.
3. Street intersections can be controlled by openings in the divider strip. This will permit the proper spacing of intersections and signal control on the main roadway.

"Since it will not be possible to use all boulevard frontage for commercial or industrial purposes and much of it will, of necessity, be developed for residential use, a service roadway (outer highway) will make such residential development more practical and the use of such frontage more desirable for the following reasons:

1. The residential structure will be set back a greater distance from the main roadway, thus removing it from the noise and confusion of the fast moving traffic.
2. The dividing strip, when developed with an adequate screen planting, will form an insulation against the noise, fumes, etc., of the traffic on the main roadway.
3. Developments on property fronting the service roadway are more readily financed than those fronting directly on a main roadway. Such lots become eligible for F.H.A. mortgage insurance.
4. The provision of a service roadway assures greater pedestrian safety, particularly for the children.
5. Such roadways stabilize the value of lots by decreasing speculation based upon change of use when traffic volume on the main artery increases.

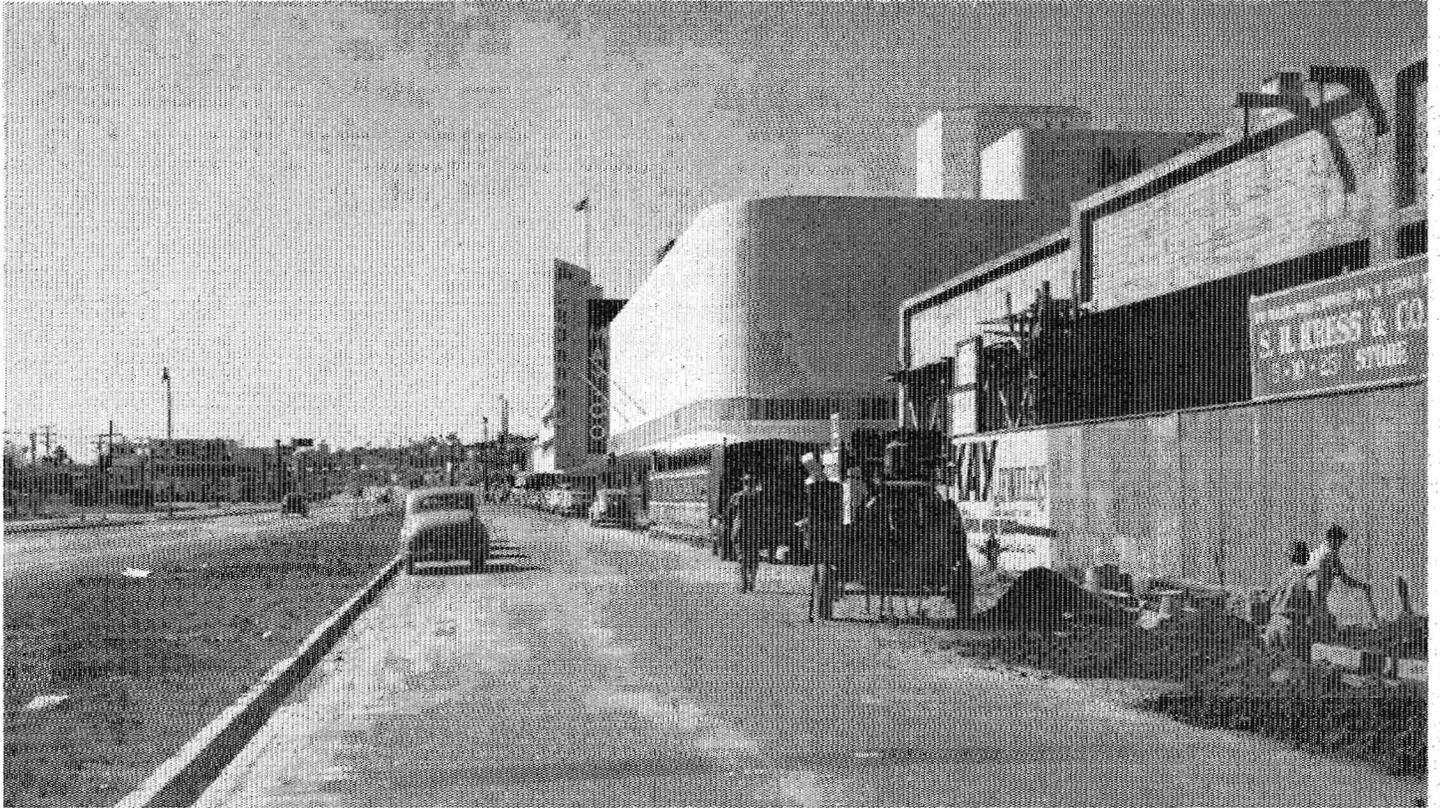


Photo D—UPPER—Looking southerly on Crenshaw Boulevard and showing outer highway development. LOWER—Looking northwesterly along Crenshaw Boulevard and showing development of May Company and Broadway Department Store and portion of property under sublease from the Broadway Department Store.

6. A service roadway (outer highway) will eliminate the necessity of an alley in the rear of the lots. In all cases where

lots front directly on the major boulevard, alleys are required in the rear of such lots.

"The use of a service roadway (outer highway) parallel to the major boulevard where the fronting property is zoned for



Photo E—Typical outer highway installation adjacent to multiple-lane limited freeway improvement on U. S. 99 at Malaga, a short distance south of Fresno

commercial use, while still in the experimental stage, can be of great benefit to the public and the property owner:

1. The interference to the free movement of through traffic is materially reduced, since there will be no servicing of the commercial buildings from the main roadway and no stopping and starting at the curb of the customers.
2. The service roadway (outer highway)

can accommodate the shopper, who can move slowly and safely without interference from the high speed through traffic on the major street.

"There are some benefits to the general public which will result from the use of service roadways:

1. There will be a minimum interference with the general public's use of the traffic artery by reducing contact points

and, consequently, reducing the possibility of accidents.

2. By increasing the desirability of lots fronting the service roadway, more development will occur which will result in a greater tax revenue which can be sustained at a higher level over a longer period of time due to the reduced rate of obsolescence of property."

BILLION DOLLAR STATE AND FEDERAL HIGHWAY PROGRAM PLANNED FOR 1948

HIGHWAY programs of the 48 state highway departments and the District of Columbia call for the building of 46,821 miles of state and federal highways during 1948 at an estimated cost of \$1,072,283,810, a recent survey by the American Road Builders' Association shows. The survey, covering state and federal highway construction and maintenance for 1947 and 1948 shows that 3,414 miles of concrete roads, 25,631 miles of bituminous mixes and treated types, and 17,776 miles of other

types make up the 46,821 miles to be built.

It is estimated that state highway departments will let contracts for some 27,859 miles of highways during 1948, with 48 states and the District of Columbia reporting a total of 18,962 miles of work carried over from 1947 contracts. Work carried over includes 1,290 miles of concrete pavement, 10,920 miles of bituminous mixes and treated types, and 6,752 miles of other types.

Traffic Congestion Threatens Healthy Community Growth

MOUNTING traffic congestion is threatening healthy community development. This conclusion is drawn from a comprehensive study made by the Urban Transportation Committee, United States Chamber of Commerce.

In its report, the committee urges business and civic groups to aid in the adoption of measures recommended for downtown traffic improvement.

The study, entitled "Urban Transportation," was conducted under the chairmanship of Laurence F. Lee, of Jacksonville, Florida.

Traffic Safeguards

Improvements on Arroyo Seco Parkway Are Recommended

RECOMMENDATIONS by the Planning Department of the State Division of Highways for bettering the remarkably fine traffic accident record established on the Arroyo Seco Parkway between Los Angeles and Pasadena have been announced by Director of Public Works C. H. Purcell and include:

1. Installations of additional sections of steel barrier rail along certain portions of the freeway and the placing at other points of low fencing in the division strip supplemented by planting, which would have definite value in the screening out of glare from approaching headlights as well as providing a visible barrier against crossing;

2. Closing of the present Fair Oaks off-ramp where the greater number of wrong-way movement accidents have originated and construction in its place of another connection at a new location, which will preclude the possibility of wrong way use;

3. Increased visibility of curbs to lessen the danger of motorists driving against or over them;

4. Utilization of a number of locations where provision can be made for the parking of disabled cars beyond the inside curb and clear of the traveled lane;

5. Establishment of appropriate speed zones on curved sections of the parkway;

6. Maintenance of a high level of uniform control by traffic officers.

Study by Vickrey

The recommendations are the result of an extensive traffic investigation conducted by J. W. Vickrey, Assistant State Highway Engineer of the Division of Highways, to examine into the advisability of installing a positive barrier between the two roadways of the parkway, which is a six-lane divided highway, consisting of three 11-foot lanes in each direction, separated in general by a narrow, low-curbed division strip and bordered on the outside by a 12-inch gutter and 10-inch curb.

The study covers the seven-year period 1941-1947 but was confined to the section of the parkway lying within the City of Los Angeles be-

tween Avenue 22 and the easterly city limits for the reason that accident records in that section are thorough and complete, each report containing a description and sketch of the accident sufficient to indicate whether or not the division strip was involved.

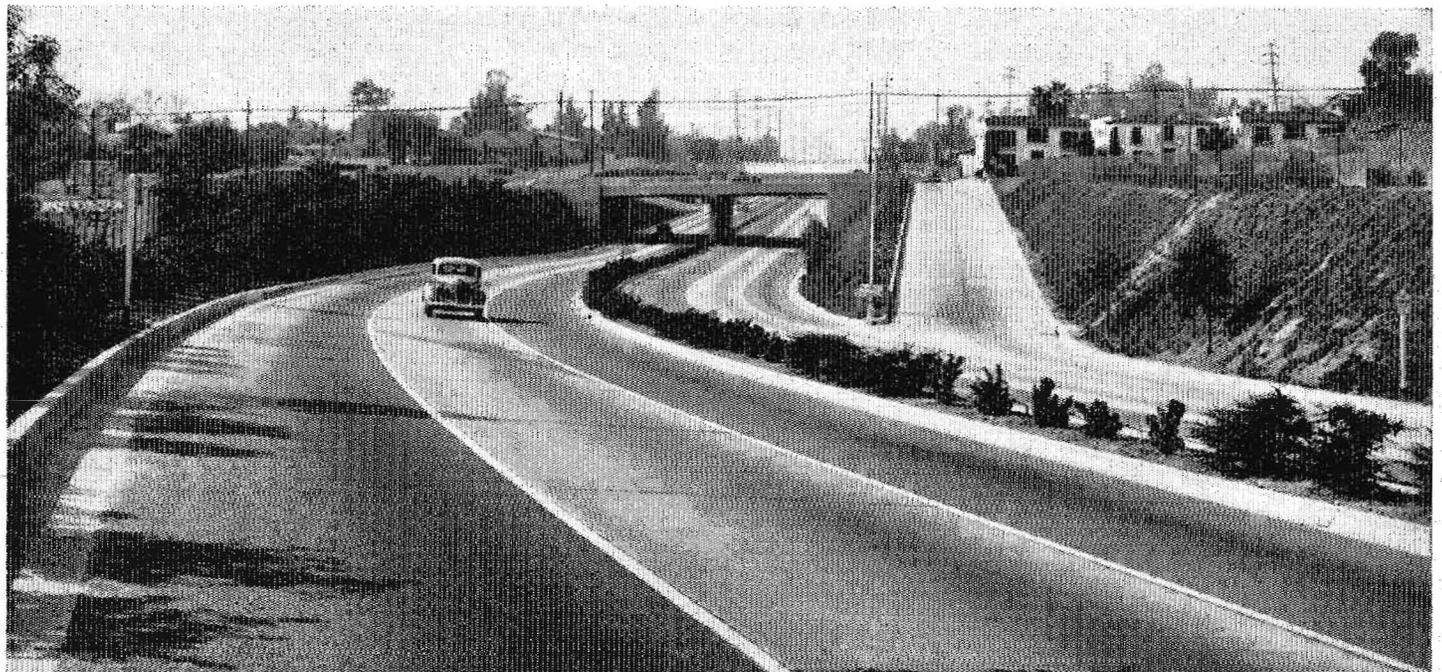
The section studied is believed adequate for the purpose of the investigation because it comprises 4.4 miles of the 6.2 mile parkway, is more heavily traveled than the northerly section, and includes the worst alignment.

Parkway Has Fine Record

"This special study," Vickrey's report says, "very positively confirms that this parkway has a remarkably fine record both in the number and the severity of accidents in relation to the large volume of traffic carried. Compared with other metropolitan traffic arteries which must serve an equal volume of traffic without the advantage of the high design standard of the

... Continued on page 21

Present Fair Oaks off-ramp on Arroyo Seco Parkway where greater number of wrong-way movement accidents have originated. This structure is to be replaced by a new one, which will preclude the possibility of wrong-way use



Montecito Parkway

Modernization of U. S. 101
Adjacent To Santa Barbara

By J. M. CHAFFEE, District Office Engineer



Completed section of Montecito Parkway with outer highway along the southerly side

INITIAL freeway on the Coast Highway, U. S. 101, is extended by completion of construction between Sheffield Drive and San Ysidro Road on the Montecito Parkway adjacent to the City of Santa Barbara. This is one of the first projects of a program contemplating development of this route into a freeway from Los Angeles to San Francisco.

This section of highway now carries from ten to fourteen thousand vehicles daily. It is noted for the picturesque and abundant growth of trees and shrubbery bordering the highway. Ribbon development along this section by extension of the Montecito business district would have resulted in traffic congestion. Foreseeing the increased volume of traffic that this portion of U. S. 101 would have to carry, and desirous

of preserving the natural growth of trees and shrubbery, the Santa Barbara Planning Commission and the Division of Highways joined in a study to find a solution of the problems presented by the proposed modernization of this section of highway.

This study resulted in the planning of the Montecito Parkway, consisting of a four-lane divided highway with outer highways to serve local traffic and eliminate conflict between main line traffic and entering or cross traffic at frequent intervals. Access to the inner highway is provided only at main cross roads. The first unit of this freeway was constructed from San Ysidro Road to Olive Mill Road under a cooperative agreement between the State and County in 1937.

Construction of this second unit of the freeway was scheduled for 1942. Plans had been completed and the funds provided to finance its construction but due to exigency of the war effort, the project was indefinitely deferred. During the war when the state-federal postwar program was formulated it was included as one of the first projects to be undertaken under this program.

Construction being through an area noted for its beauty and abundant growth of trees and shrubbery, particular care was exercised to preserve all the trees and shrubs possible. Only those trees and shrubs falling within the limits of the traffic lanes and shoulders or which were in such close proximity to the traffic lanes as to constitute



This is another attractive stretch of the Montecito Parkway adjacent to Santa Barbara

a potential hazard to traffic were removed.

Coco palm trees, which flourish in the mild climate of this area, that had to be removed were transplanted to the outer parkway areas, as well as an exceptionally fine specimen of Phoenix Reclinata palm tree.

Four Lanes of Traffic

The completed 1.3 miles of roadway provides a set of two lanes for traffic in each direction separated by a 26-foot curbed central division strip. Existing low bearing ratio soils with fairly high expansions and 5,000 pound equivalent wheel loadings which this section will be subjected to, required a total 24-inch thickness of base and pavement. This consisted of a 12-inch subbase of cement stabilized imported borrow, 9 inches of cement treated base and 3 inches of asphalt concrete.

An exception to this construction was made where existing pavement fell within the traffic lanes. At these locations the existing pavement was resurfaced with a minimum 2-inch thickness of asphalt concrete. The cement treated base consisted of a soft sandstone mineral aggregate mixed with 5 to 7 percent of Portland cement and water. The materials were proportioned and

mixed at a central mixing plant and spread and compacted on the roadbed by the procedure which has become standardized through the extensive construction of this type of base throughout the State.

Cement stabilized imported borrow subbase, as constructed on this project, however, has not been widely used and should not be confused with cement treated base.

Laboratory tests performed on samples of material from the deposit of soft sandstone selected by the contractor for production of imported borrow indicated that it would not meet specification bearing ratio requirements for subbase construction. Further tests indicated that the material would meet these requirements when blended with 30 percent of commercial 1½-inch crusher run base, or after being treated with one-half percent to 2 percent of Portland cement.

Cement Stabilization

The contractor elected to use the cement stabilization method to increase the bearing ratio of the material so that it could be used as imported borrow because of its economy. Except for the material placed on one-half of the roadbed over a short experimental section

in which one-half percent of Portland cement was used, 1 percent of Portland cement was mixed with the imported borrow.

The imported borrow, as excavated from the pit, was spread on the roadbed in six cubic foot windrows by use of two spreader boxes. Rocks in excess of two and one-half inches in size and lumps of material were broken up by flattening out the windrows and rolling the material with a 12-ton three-wheeled roller. Any oversize rocks remaining after this operation were broken up by hand, using sledge hammers.

The flattened out windrows were then reshaped and the cement distributed along the tops of the windrows by hand at the rate required to obtain the designated percentage based on dry weight of the material.

Moisture Determinations

Frequent moisture determinations were made on the material on the basis of which water was added to the mixture to bring the moisture up to the optimum, or between eleven percent and twelve percent of the dry weight. The windrowed materials were mixed by one pass with a road mixing machine which metered and introduced the

required additional water at the time of mixing. A very even distribution of water and cement was obtained.

After mixing, the materials were spread in approximately 4-inch layers with a motor grader and compacted by rolling with a 12-ton three-wheeled roller.

Samples of imported borrow untreated, mixed with one-half percent cement and mixed with 1 percent cement were obtained from the roadbed and tested by the Materials and Research Department of the Division of Highways in Sacramento.

Subbase Construction

The specifications required that material used in subbase construction have a bearing ratio of not less than 60 percent at one-tenth inch penetration on a compacted and soaked specimen, as determined by the California Bearing Ratio method.

The following average test results show that stabilization of the imported borrow with the small percentages of Portland cement was very effective in

increasing its bearing ratio and also decreased its expansion:

Material	Bearing ratio	Expansion per sq. in.	Cementing value, lbs. per sq. in.
Unstabilized	42%	1.0%	352
Mixed with 0.5% cement	78%	0.3%	274
Mixed with 1.0% cement	112%	0.3%	245

It was observed that the stabilized imported borrow did not develop the contraction cracks which usually occur in cement treated bases containing higher percentages of Portland cement; however, some cracking did occur in the cement treated base placed over the imported borrow subbase. Since the mineral aggregate for the cement treated base was obtained from the same soft sandstone deposit as the imported borrow, it can only be concluded that the amount of cracking in this type of base is directly related to the percentage of Portland cement used.

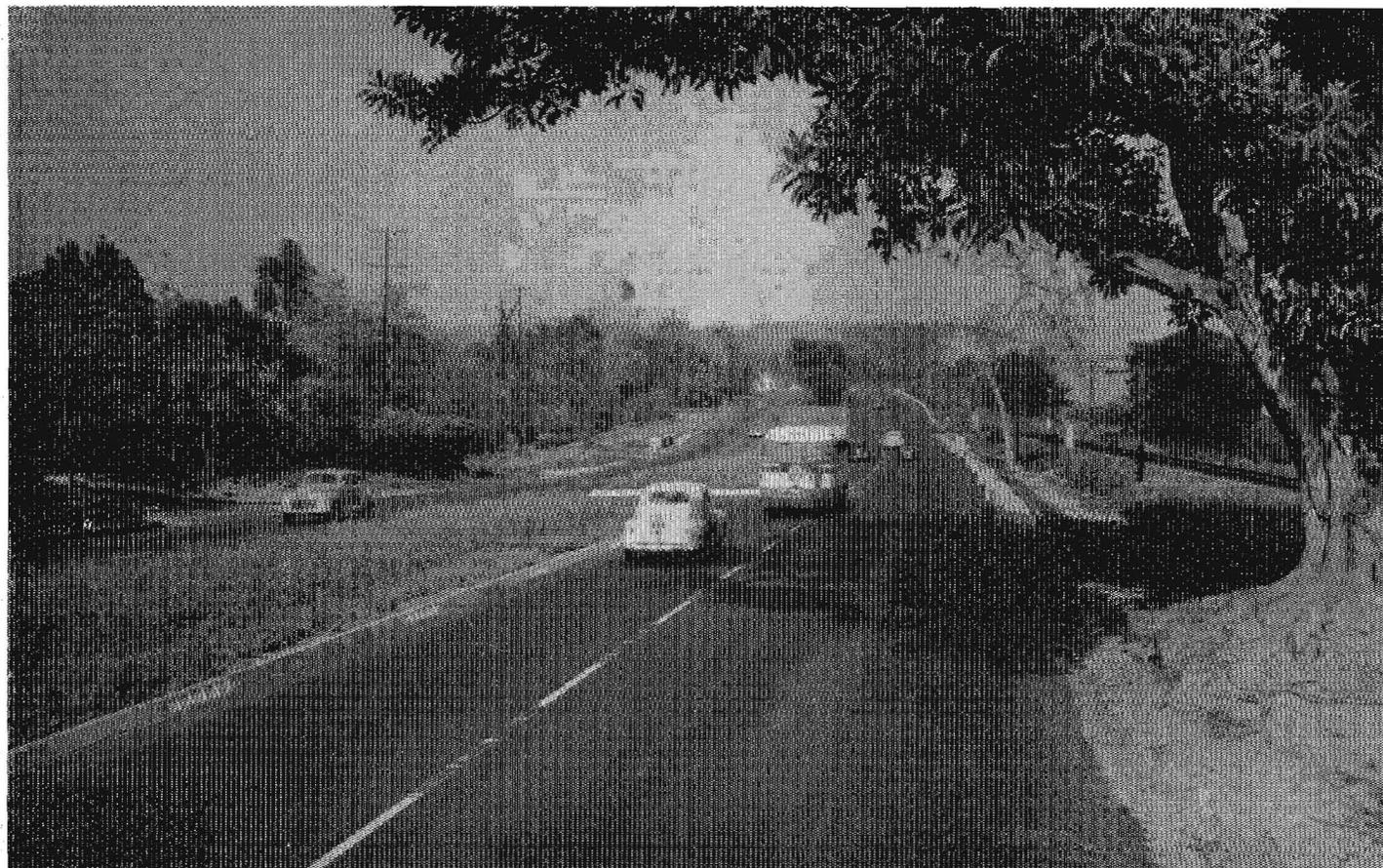
The large volume of traffic carried by this section of highway and necessary encroachment of construction

upon the existing pavement presented an acute construction problem. There being no practical detour, it was necessary that public traffic be permitted to pass through construction operations at all times with as little inconvenience and delay as possible. Reduction of the number of lanes available to traffic from three to two and required speed restriction through the construction limits aggravated the congestion so that it was not practicable to carry on construction on Saturdays when traffic increased materially due to week-end travel.

In order to provide an adequate two-lane passageway at all times it was necessary to plan and perform various construction operations in short sections and at separated locations. The highly developed and exclusive residential nature of the area and existing alignment had prevented planning to position the construction so as to permit completion of at least one set of lanes before disturbing the existing pavement. With proper planning, tim-

... Continued on page 40

Looking east from La Vuelta Drive. The tree in the foreground is a large rubber tree



Overhead Structure

*Salsipuedes Project In
Santa Barbara Started*

By ROY E. FETTER, Associate Bridge Engineer

THE SALISPUEDES overhead structures now being constructed in Santa Barbara will form a link in the new four-lane divided freeway, which will carry the main highway traffic around the main portion of Santa Barbara. The new freeway is approximately $2\frac{1}{4}$ miles long and skirts the southern edge of the City of Santa Barbara carrying U. S. Highway 101 and State Route 2. The new alignment will relieve considerable congestion on the streets of the city and will greatly facilitate the passage of highway traffic through this area.

The separation over Salsipuedes and Quarantina Streets and an industrial spur of the Southern Pacific Railroad consists of twin parallel structures. The separation is located in the industrial section of the city and will carry the highway traffic over these two heavily traveled streets as well as the busy spur railroad tracks.

The twin structures are each 1300 feet long, rising on a long vertical curve from approach fills on each end, high enough to give adequate clearance over the railroad track and the two streets. The two structures, one carrying traffic

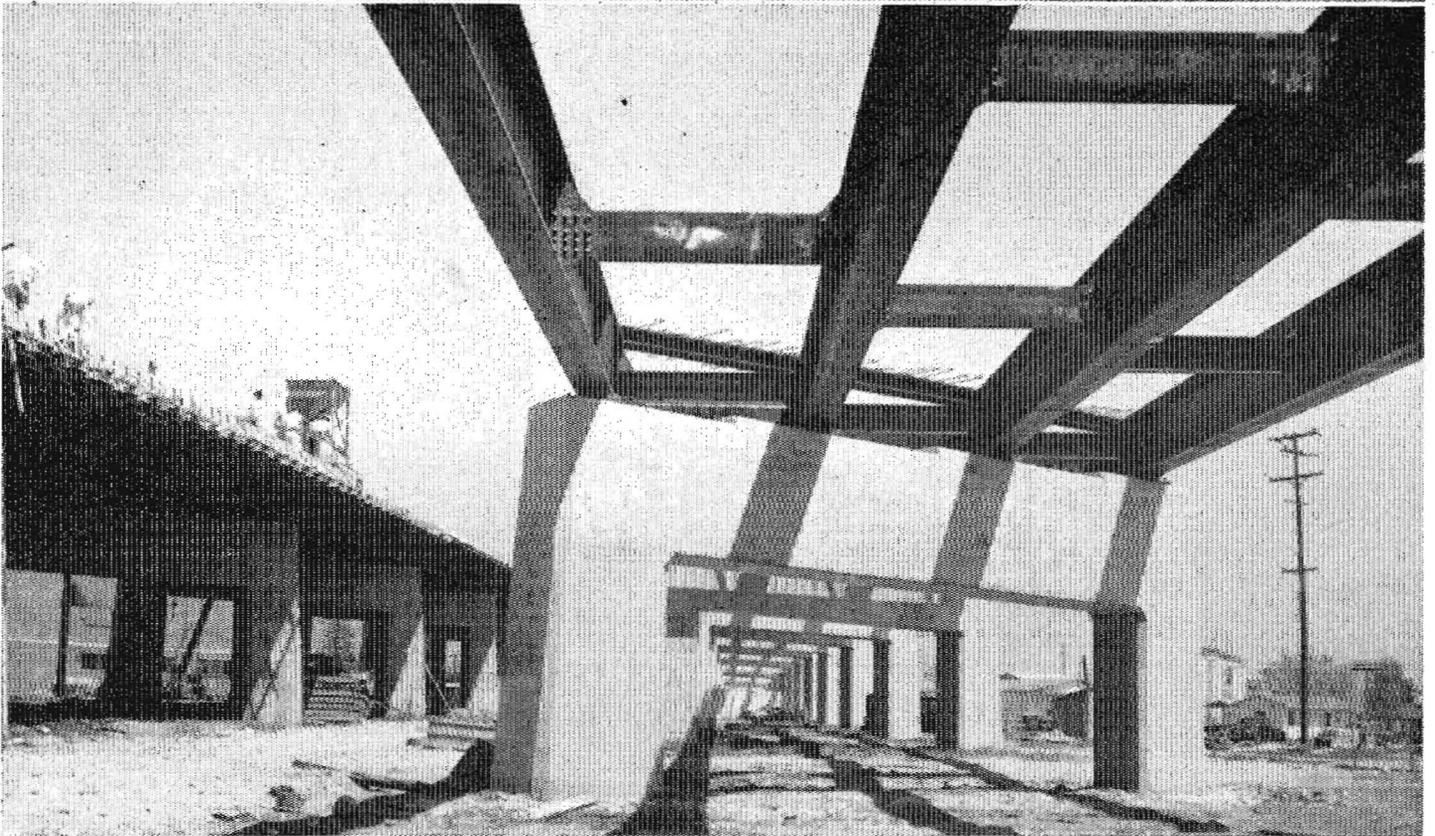
each way, have a 26-foot clear space between them, with a space of 36 feet between the inner curbs which matches the width of the dividing strip on the remainder of the freeway. Each structure has a 26-foot roadway with sidewalks provided on the inside.

Before the structures could be built through this congested district it was necessary to move a brickyard, an oil storage plant, and the yard of a roofing company as well as other facilities. It was also necessary to rearrange the railroad spur tracks in this area so as to

... Continued on page 44

Looking northwesterly toward Santa Barbara along the northbound lane as it leaves the structures. The concrete deck has been poured and the sidewalk is being placed





UPPER—Looking southeasterly between the two Salsipuedes structures. The steel work is all in place and the deck and sidewalk have been completed on the foreground portion of the north structure. LOWER—Looking southeasterly under the structures and through the bents of the south structure

Freeway Procedure

*Rights of Tenants
Safeguarded by State*

By ROBERT D. POLLOCK, Right of Way Agent

IT IS RARE that an extensive new system of highways is thrust directly through the heavy stand of a city's buildings, which are removed in large numbers to allow space for road construction.

Such a program of construction in Los Angeles has created one of the greatest operations in right of way clearance ever attempted in the country.

The California Division of Highways has launched a 10-year project which anticipates the completion of 100 miles of freeways within the Los Angeles Metropolitan Area, and will involve the tremendous job of moving approximately 10,000 buildings and 25,000

people. This undertaking is comparable to the complete removal of a small city about the size of Beverly Hills.

For the past nine years the Division of Highways has been making preparations for this gigantic plan. After the most feasible routes had been charted by the engineers, right of way agents began the intricate task of appraising and acquiring title to all land and improvements located within these areas. Now the buildings must be sold and removed in order to clear the land for construction purposes.

Two major elements predominate in the clearance work; the physical removal of all structures from the right

of way, and the relocation of tenants in a manner to cause them the least amount of inconvenience. The welfare of the people occupying the freeway areas is a constant concern to the Division of Highways and tenant considerations are the main influence in forming decisions from the time of the initial survey of an area until the last building is off the land.

Because of the personal concerns of occupants, removal of buildings has required development of special techniques wherein tenant consideration is the central element. In order to give maximum protection to the tenants in the procedure of disposal, buildings are placed into two

Two-story 20-unit frame and stucco apartment house moved from its former location within the Hollywood Freeway right of way. This building has now been relocated, modernized, and is housing 20 families at the corner of Rosewood and New Hampshire Avenues in Los Angeles





This five-room frame dwelling has just left the old location at 1456 Bellview Avenue, within the limits of the Hollywood Freeway right of way, and will soon be completely rehabilitated, modernized, and again in occupancy by a family. This procedure minimizes the affect of freeway construction on the housing shortage in the metropolitan areas

general classes, vacant and tenant-occupied. In the case of the latter class, the buyer must provide tenants with continued housing for a period of six months, and he must not move the house over eight miles from its original location.

In addition, the buyer is required to provide a place for storage of furniture and personal property during the time of moving. Vacant buildings are further classified as those which will be demolished at the expense of the Division of Highways, and those which can be sold to the highest bidder at public auction.

Elements of Cost

The principle of judgment used to place buildings into these various categories is that of cost of removal in relation to value. In other words, will the value of the building be sufficient to cover the costs of removal and leave a margin for profit?

Elements of cost to the buyer are moving and relocation charges, and the expense of care of tenants for the required six months period. This tenant expense amounts to about fifty dollars for each person occupying the premises. Buildings rendered vacant by the Division of Highways are those in which the cost either equals or exceeds

the value. If costs exceed value after the tenant burden has been eliminated, the Division of Highways must bear the expense of demolition. These buildings are usually brick or concrete commercial structures.

Houses Sold With Tenants

Vacant buildings can be sold to a buyer because removal of the tenant burden makes value exceed cost. Houses can be sold tenant-occupied, because the value of the buildings can bear the burden of all costs and yet return a profit to the buyer. In the average district, 85 percent of the houses are sold with tenants.

The primary application of the principle of cost in relation to value of a building arises when an area designated to be cleared is surveyed for the first time. Within such an area every building is inspected and an estimate made of its value. On the basis of this value estimate, the houses are tagged to be demolished, sold vacant or tenant-occupied. As soon as this preliminary estimate is completed, all of the leases and rental agreements held with the Division of Highways are cancelled, and those buildings eligible for demolition

are let on a demolition contract. The tenants occupying houses tagged to be sold as vacant must be provided with other houses in which to live. This process of providing for the tenants requires extra time and thought, therefore, houses to be sold as vacant are left entirely alone for the time being, and are considered at a later date.

Sale Procedure

Meanwhile, a survey is made of the houses ear-marked for sale with tenants. This survey is a recording of the pertinent items of information pertaining to the buildings and the land upon which they are situated. A mimeographed form is used which allows space for the name of the grantor to the State, parcel number of the land, type and structure of the buildings, names of the tenant-occupants and estimated selling price, together with the minimum bid acceptable at the public auction, which is the method of sale employed by the Division of Highways.

After all buildings tagged for sale with tenants in the original survey are auctioned, the houses remaining in the area which were excluded from the

first group sold are given a very close inspection for possible additional sales of tenant-occupied houses in order that the tenants may derive the maximum benefits of continued housing. This close inspection will reveal that one-fourth of the remaining houses can also be sold tenant-occupied. As a result of these two inspections and their consequent sales, there usually remains about 15 percent of the houses which originally occupied the district.

Moving Problems

This residuum of 15 percent is the group of houses most difficult to remove from the right of way, because of their low value and relatively high cost of moving in terms of the tenant burden. These houses are either of excessive age, of a structure which makes their removal difficult or impossible, or are occupied by a relatively large number of tenants. Some buildings have all three characteristics.

A typical house in this group is a deteriorated two-story structure about fifty years old which has been divided into several apartments. The usual number of occupants in such a house is ten. Vacant, it is worth about \$600; however, the cost element of the tenant burden at about \$50 per person amounts to approximately the full value of the house, which prohibits its sale with tenants.

In the case of many smaller houses, the tenant burden is too great although occupied by only one or two people. The only possibility for sale of these places is to render them partially or completely vacant.

Values Involved

There are two methods by which the value can be raised on these residual items to a sufficient margin over cost to make them marketable as tenant-occupied. One procedure is to create

a partial or complete vacancy by providing for the occupants a more valuable state-owned house which can be sold as tenant-occupied at a later date. In every case the house into which the tenants move is of better quality and a more desirable place to live, because in contrast to the house from which they moved, it has the necessary value to allow its sale with the tenant benefits of continued housing. This procedure has the double advantage of making vacant a low value house for the Division of Highways, and providing better housing for a greater length of time for the tenants.

Those multiple dwellings which are not quite marketable when fully occupied need be only partially vacated to create the necessary preponderance of value. Houses necessitating complete vacancy are those of very low value and cannot support any extra burden of

costs. This process of partially vacating a dwelling can be illustrated by again using the example of the typical house, whose value was \$600, but carried a tenant burden of approximately equal amount. If six of the ten occupants were moved, the building could be sold tenant-occupied with the remaining four people, who would represent a cost of about \$200, and would allow nearly \$400 margin of value over tenant-cost to buyer.

Tenant-occupied Sales

The other method of accomplishing tenant-occupied sales, with their consequent benefits to the occupants, is to sell a number of these residual items of conjunction with an item of high value to make the sale more attractive. For example, a nursery having several glass greenhouses and incidental equipment can be sold in conjunction with seven



Aerial photograph looking easterly from completed section on Santa Ana Freeway at Soto Street to a point easterly of Eastern Avenue, showing completed freeway grade separation structures and right of way cleared ready for roadway construction. Approximately 90 percent of residential buildings in this area were moved to available vacant lots, rehabilitated, and are back in use housing families. Not a single tenant was evicted from a residential unit on the entire Santa Ana Freeway right of way clearance project from the Aliso Street viaduct at the northwesterly terminus of the completed section through the areas shown in this photograph.

or eight high-cost houses occupied by 35 people, or a vacant and an occupied high-cost house can be sold together to insure a sale that benefits the tenants. It is a matter of practice to never sell a house of good quality vacant without first having it occupied by tenants from low value houses in order to insure the greatest benefit to the people, which is accomplished through a maximum number of tenant-occupied sales.

Through a refinement in practice of the methods previously outlined of judiciously allocating value in such a manner as to insure tenant-occupied sales, eviction notices at the present are practically an unused procedure. Strange as it may seem, this tremendous clearance job at the present is not causing the removal from his home of a single person.

Everyone living in the freeway area is being provided for.

Continued Housing

It is interesting to note that the people living in the areas to be cleared are being provided for not only through the benefits of continued housing, but through financial assistance in finding their own homes. A large percentage of the people living in houses sold as tenant-occupied choose to sell their rights of continued housing, to which they are entitled under the terms of sale, and use the cash proceeds to assist them in relocating themselves. Many people would be unable to secure permanent housing without the financial benefits occurring from such a sale.

Buildings of all types, with the exception of those let on a demolition contract, are sold at public auction after publication of a two weeks' notice. This notice consists of posting a sales list in three public buildings and on the house to be sold, together with advertisements in the daily papers on two weekends previous to the sale. Some radio publicity has also been made available as a public service by station KFI in Los Angeles.

Rights of Tenants

Previous to the auction, the tenants are notified regarding their rights of continued housing and other benefits under the terms of sale, and are requested to be present at the time of auction in order to allow inspection of

the house. The auction is held on the site and after a brief period allowed to the prospective bidders for the inspection of the premises, the auctioneer presents a brief summary of the terms of sale, names the minimum bid acceptable to the state, and opens the sale.

Sometimes the occupant wishes to purchase the house, and if he so desires, he is allowed to say a few words to the assembled bidders before the auction starts. The tenant's plea is for a minimum of competition against him in his efforts to become the successful bidder. If the sentiments of a majority of the group are in favor of the occupant the atmosphere is likely to become heavily charged with emotion, and a competitive bidder may be audibly censored by the group of cries of, "Let the tenant have it!" Now and then, sparks fly when two rivals bid against each other for no other purpose than to make their competitor pay a maximum price. In most cases, however, the auction proceeds smoothly and with no special incident.

Bidding Procedure

At the conclusion of the sale, the successful bidder is required to pay 25 percent of the purchased price in cash immediately, with the balance due in 10 days. A faithful performance bond must be posted with the Division of Highways in order to guarantee the removal of the structure from the land and the fulfillment of the other terms of sale. The Division of Highways allows the buyer 90 days from the date of sale for the removal of a tenant-occupied house, and 60 days for one which is vacant.

The Division of Highways has a continued interest in the building until all the terms of sale have been fulfilled. Right of way agents must keep informed of the current progress in each case, and occasionally push the transaction until the final consummation of the sale is attained; that is, until housing has been provided for the tenants and the building has been removed. The buyer is sometimes delinquent in paying his balance due, or in posting his faithful performance bond as required, in which case he must be contacted and induced to meet the requirements.

The tenant-occupants may be uncooperative and refuse to move into the housing provided by the buyer, or the buyer may wish to provide inadequate housing; so the Division of Highways must act as arbiter in these disputes. When a buyer delays the removal of the buildings until his allotted time has almost expired, a right of way agent must give him some impetus toward moving the houses on time in order that the clearance schedule can be met. If necessary, the Division of Highways can repossess any building for non-compliance with the terms of sale and without recourse by the buyer.

The construction of this freeway system contributes very little to the present housing shortage. With the exception of a small number of buildings demolished, the houses are relocated in better condition than before, and are immediately reoccupied to capacity. The only change in circumstances is that the houses are now located outside the zone of construction.

Buildings are sold by the Division of Highways at the rate of \$1,000,000 worth per year. This volume of sales forms the basis for a big business in Los Angeles, in view of the fact that the original \$1,000,000 is pyramided by the buyers' resale turnover, there are wages and salaries paid in the expense of moving operations, the accumulated bonding charges, and the total outlay of relocation costs.

Since clearance and construction will be a slow and gradual accomplishment over a 10-year period, no sudden or alarming displacement should affect the lives of the people or the regular routine of the city. And the end result will bring a marked decrease in traffic problems, facilitating a reduction in travel time in and around Los Angeles, and assure the motorist rapid and easy driving to and from the heart of the city. Any relatively small personal sacrifices or inconveniences experienced by people during the time of clearance and construction will be repaid many times when this giant system of freeways stands in monumental completion.

Consultants

Division of San Francisco Bay
Toll Crossings Hires Experts

THE DIVISION of San Francisco Bay Toll Crossings of the Department of Public Works has retained four nationally prominent engineering authorities as consultants. The division, under Chief Engineer Ralph A. Tudor, is making a detailed study of sites and approaches for, and costs and anticipated traffic of, the proposed two additional bay crossings—a southern crossing and a parallel bridge. The consultants are:

George L. Freeman of the New York firm of Moran-Proctor-Freeman & Mueser, Consulting Engineers.

Ralph Smillie, Consulting Engineer, New York, and Chief Engineer of the Triborough Bridge and Tunnel Authority of New York.

O. J. Porter, of O. J. Porter & Co., Sacramento, California, and New York City, Consulting Engineers.

Herbert R. Pirkner, Consulting Engineer, San Francisco.

George L. Freeman

Mr. Freeman is an outstanding authority on foundations, soil studies, sub-aqueous engineering and marine structures. He assisted with the design and construction of foundations of

four of the bridges across San Francisco and Suisun Bays, the San Mateo Bridge, San Francisco-Oakland Bay Bridge, Golden Gate Bridge and the railroad bridge across Suisun Bay. He aided Mr. Moran of his firm and C. H. Purcell, Chief Engineer of the San Francisco Bay Bridge, in devising the eminently successful method of construction of the piers of the Bay Bridge, which remain unchallenged as the deepest bridge piers ever constructed in the world. The design and construction of foundations of many of the important bridges in the United States and Canada are credited to Mr. Freeman. Among them are: Cooper River Bridge, Charleston, South Carolina; Carleton Memorial Bridge, Kennebec River, Bath, Maine; San Mateo Bridge, San Francisco Bay, California; Highway Bridge across Missouri River, Herman, Missouri; cut-off wall under Wyman Dam, Maine; Huey P. Long Bridge across Mississippi River at New Orleans, Louisiana; Suisun Bay Bridge, California; Vicksburg Bridge across Mississippi River; Southern Pier of Golden Gate Bridge; Bronx-White-stone Bridge, New York; San Francisco-Oakland Bay Bridge.

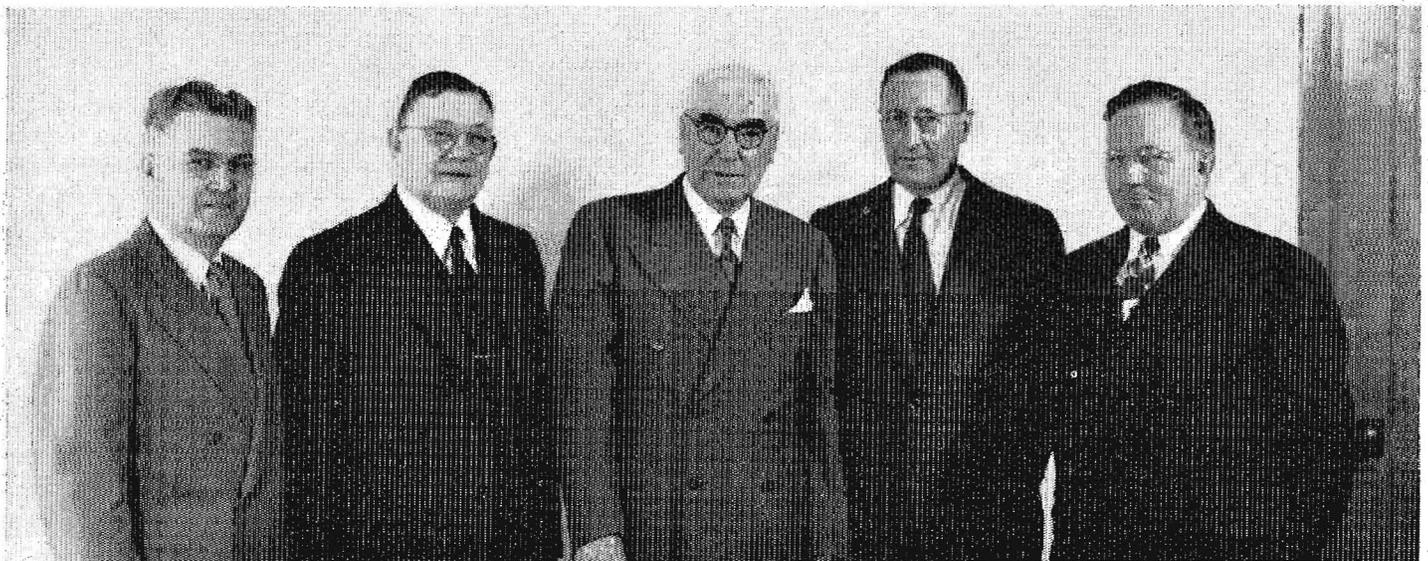
He has been consultant for: Twin tube vehicular tunnel under Delaware River at Philadelphia, Pennsylvania; underpinning and reconstruction of Austin, Texas, Dam across the lower Colorado River; foundations for Caughnawaga Bridge across St. Lawrence River at the head of the Lachine Rapids above Montreal, Canada; foundations for suspension bridge across Delaware River at Wilmington, Delaware.

A graduate civil engineer of University of Maine, Mr. Freeman is a member of Phi Kappa Phi Honorary Society and of numerous engineering societies and associations. He is the author of many engineering papers dealing with the subjects of foundations, soil mechanics and soil surveys.

Ralph Smillie

Mr. Smillie is one of the world's outstanding experts on underwater tunnels. He is now Chief Engineer of the subaqueous vehicular tunnel between lower Manhattan and the Borough of Brooklyn in the vicinity of Governor's Island, New York. He has had extensive experience with the shield-driven type of tunnel and also with the pre-

Top flight engineers who will design and build second San Francisco Bay highway toll crossing. Left to right—Ralph A. Tudor, Chief Engineer; George L. Freeman, New York; C. H. Purcell, Director of Public Works; Ralph Smillie, New York; and O. J. Porter, Sacramento and New York City



cast concrete section type of construction used in the Posey Tube under the Estuary between Oakland and Alameda. This method is likely to be required in the tubes of the Southern Crossing of San Francisco Bay and under the Estuary.

He is chief engineer on the Brooklyn-Battery Tunnel now being built at New York. He was consultant for the Pennsylvania Turnpike; Bankhead Tunnel under the Mobile River at Mobile, Alabama; Boston Vehicular Tunnel under Bay of Boston; Houston Tunnel under Houston Ship Channel, Houston, Texas; Vehicular Tunnel under Galveston Bay, Galveston, Texas; New Orleans Tunnel; Chesapeake Bay Tunnel; Twin Tube Vehicular Tunnel under Delaware River near Philadelphia; Buffalo Tunnel, Buffalo, New York; Newark Rapid Transit System Subways, Newark, New Jersey.

O. J. Porter

Mr. Porter is an authority on borings, soil testing and stabilization problems. He is noted for his development of the method of testing soils for airports which was used extensively during the war. He has been engaged in the construction of highways in California and employed as a consultant by the U. S. Army and Navy, by the Port of New York Authority and by the States of Connecticut and New Jersey.

During the construction of the San Francisco-Oakland Bay Bridge, he was employed on the foundation treatment of approaches. He conducted engineering and research projects for design of airfield pavements and foundations that would stand up under the load of extra heavy airplanes and on the design of Army airfields on the continent and in all foreign theatres of operation during the war for the U. S. Army Engineers. He was consultant to the U. S. Navy Bureau of Yards and Docks on problems of foundations and construction of waterfronts, ammunition depots, harbors and beachhead landings from 1942-1947.

Mr. Porter is the designer and inventor of numerous engineering tools and methods used in sampling and stabilizing soils. The Porter Soil Sampler and his unique Vertical Sand Drain for relieving sub-surface water pressure have

Robert L. Thomas Completes Thirty Years of Unselfish State Service

ROBERT L. (BOB) THOMAS, Assistant Engineer of Surveys and Plans, Headquarters, retired March 31, 1948, following 30 years of service with the Division of Highways.

His retirement was the occasion for a farewell party that is still being discussed by the 90-odd friends and fel-



Robert L. (Bob) Thomas

low workers of Bob who came from all parts of the State to attend. The names of those who were unable to be present were presented to Bob attached to a scroll which illustrated in cartoon the story of his career from birth to retirement. In order that his identity would not be lost, Bob was shown al-

brought him worldwide renown. His latest invention is a mammoth heavy duty roller mounted on 60-ply, eight-foot diameter tires for super-compaction of roads, airfields and similar construction. He is a member of many engineering societies and is the author of numerous papers on engineering and construction developments published in the United States and foreign countries.

Herbert R. Pirkner

Mr. Pirkner, design specialist on vehicular tunnels, has contributed sub-

To the Employees of the Department
of Public Works, Division
of Highways

I can only attempt to express my appreciation and thanks for the splendid memorial and presentation accorded me on the occasion of my retirement from state service.

With best wishes for your continued success, I salute you. Hasta Luego, or until a later time.

Sincerely,

R. L. THOMAS

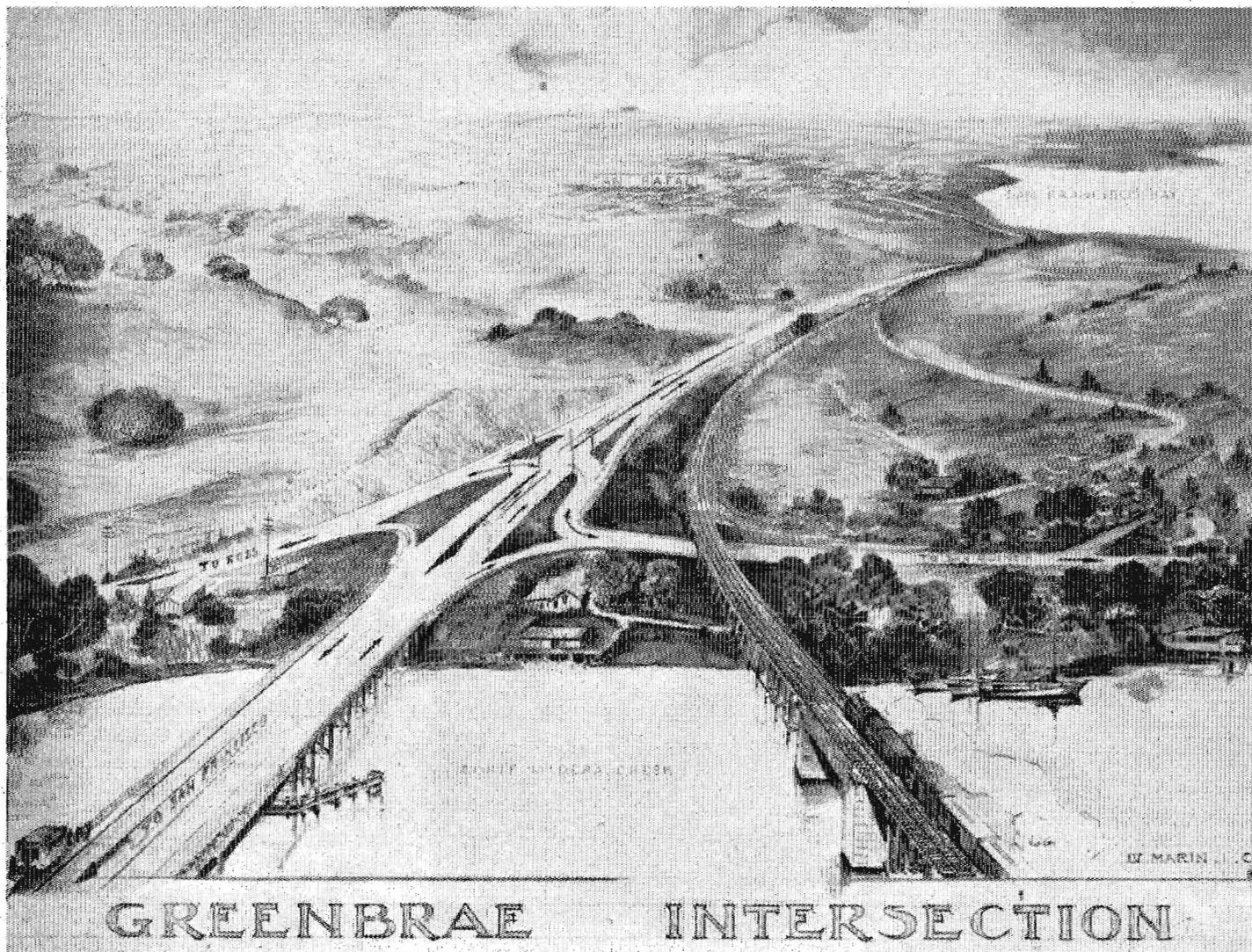
ways with his hat on—even in his bassinet.

Seldom has a man left his associates with whom he has worked intimately for 30 years with more good will, respect, and friendship than Bob Thomas. Completely self-educated, Bob's knowledge of mathematics was extensive and his experience in all phases of highway engineering was respected by everyone. He endeared himself to many by his ever-willing and unselfish attitude toward those less experienced than he.

Some of Bob's better known achievements were his location of the Weldon Canyon Road, Ridge Route Alternate, and the Angeles Crest Highway in District VII where he was employed as Location Engineer and Engineer of Special Investigation from 1927 to 1933.

We're going to miss you, Bob, and we're going to miss your hearty laugh and reminiscent wit. When you've completed your tour of the country, come back and see us. —A. M. N.

stantially to the design of several of the important vehicular tunnels built in the United States during the past 25 years. He has recently been Chief Design Engineer on highway tunnels in Texas and at Mobile, Alabama, which were built by using the open trench type of construction. This method is being studied for the tubes under San Francisco Bay as part of the causeway-trestle-tube design for the Southern Crossing and also for the tube under the Oakland Estuary, included in the Southern Crossing project.



Greenbrae Intersection Project Will Cut Accidents

PLANS for improvements designed to reduce accidents and facilitate cross and turning movements at the Greenbrae intersection of U. S. 101, the Redwood Highway, with Sir Francis Drake Boulevard two miles south of San Rafael, Marin County, are in the final stages, and it is expected that actual construction will be undertaken within a short time. Col. John H. Skeggs, Assistant State Highway Engineer, San Francisco, will supervise the project.

The present plan depicted in this sketch by Van der Goes of the Bridge Department, Division of Highways, is designed to facilitate the safe movement of crossing and turning traffic

which, owing to the steadily increasing numbers of vehicles using the roads and the rapid growth of residential areas bordering Sir Francis Drake Boulevard, has created undesirable intersection conditions.

The presently planned work, estimated to cost in the neighborhood of \$80,000, is a temporary measure, dictated by budget limitations, designed to alleviate the situation until such time as a full grade separation project can be financed.

It includes moving the present crossing some 250 feet north, constructing turning and storage lanes, and installing three-phase traffic actuated stop-and-go signals.

Western Highway Institute Sets Its Annual Meeting For Seattle June 25-26

SELECTION of Seattle as headquarters for the 1948 membership meeting of the Western Highway Institute June 25 and 26, has been announced by R. H. Cutler, chairman of the WHI board of directors.

The Institute, which was organized in 1947 by the interstate motor carrier group in the 11 western states, has been active on a regional basis upon behalf of reciprocity, uniform sizes and weights, taxation, and similar problems.

Colorado Parkway

Studies Being
Made for Los Angeles Unit

(Projection on pages 22 and 23)

THE DIVISION OF HIGHWAYS is making studies of various proposals and alternatives in planning a portion of the Colorado Parkway in the vicinity of Arroyo Seco. The drawings by Van der Goes of the Bridge Department,

Division of Highways, on pages 22 and 23, do not include the latest agreement with the City of Pasadena to preserve the major portion of Carmelita Park. Later designs will show the Parkway with a slightly changed alignment from

the bridge to Holly Street. These studies are giving consideration to present and future channel requirements, cross roads, pedestrian needs, and aesthetics. The details shown portray only one of the types now being considered.

Structure No. 53-166—Arroyo Seco—A concrete arch is proposed to cross the Arroyo Seco. The arch supporting the centerline portion has a span of approximately 385 feet with side arches, with a span of 275 feet. The deck, consisting of six lanes, will have three lanes in each direction separated by a division strip. The study shows sunken sidewalks with a protective wrought iron guard on both sides of the structure. This will give a clear vision to the motorist as well as protection to the pedestrian. Ramps to and from the bridge are of the box girder type supported on single piers.

Structure No. 53-482—Linda Vista Undercrossing—This structure is treated as a continuation of the main bridge over the Arroyo Seco and designed as a rigid frame.

Structure No. 53-762—Grand Avenue Overcrossing—This study proposes a reinforced concrete box girder with standard steel railings and will have a sidewalk on one side only.

Structure No. 53-763—Orange Grove Overcrossing—This study proposes a reinforced concrete box girder type structure with sidewalks on both sides and standard steel railing.

Structure No. 53-759—Patrician Way—The same type of structure as proposed at Orange Grove Overcrossing.

Structure No. 53-761—San Rafael Overcrossing—This structure also is similar in all respects to the structure proposed at Orange Grove.

Structure No. 53-760—Melrose Avenue Undercrossing—This study proposes a reinforced concrete rigid frame with standard steel railings.

Traffic Safeguards for Arroyo Seco Parkway Planned

Continued from page 8 . . .

Parkway, the accident record of the Arroyo Seco Parkway is outstanding.

"In fact, the seven-year fatality record of 2.4 per hundred million vehicle miles compares most favorably with any highway or freeway in the nation. In the seven years to December 1, 1947, there have been six fatalities, none of which, incidentally, has been due to a car crossing the center division and hitting another going in the opposite direction. The first fatal accident of that type occurred early in 1948. It is precisely because of the rarity of such accidents that when one does occur it occasions the most widespread comment.

"Probably the most surprising disclosure in this investigation is the low number of approach-type accidents that a positive barrier would have eliminated—six in seven years.

Volume of Traffic

"Following is a tabulation of the volume of traffic and accidents by type for each of the seven years covered in this investigation.

Year	Average daily traffic	Number of Accidents			
		Fatal	Nonfatal	Property damage only	Total
1941	21,684	1	24	18	43
1942	17,917	0	14	7	21
1943	16,301	0	10	9	19
1944	17,657	1	12	16	29
1945	21,282	2	24	17	43
1946	32,817	2	28	21	51
1947	31,597	0	52	42	94
7-year totals	—	6	164	130	300

"Notable in the preceding table is the large increase in accidents in 1947 and 1946, almost double despite a slight decrease in traffic. The reason for this marked increase is not immediately apparent since it is not confined to any particular types and is being given further study.

"Following is the parkway's seven-year record in terms of accidents per million vehicle miles:

ACCIDENTS PER MILLION VEHICLE MILES

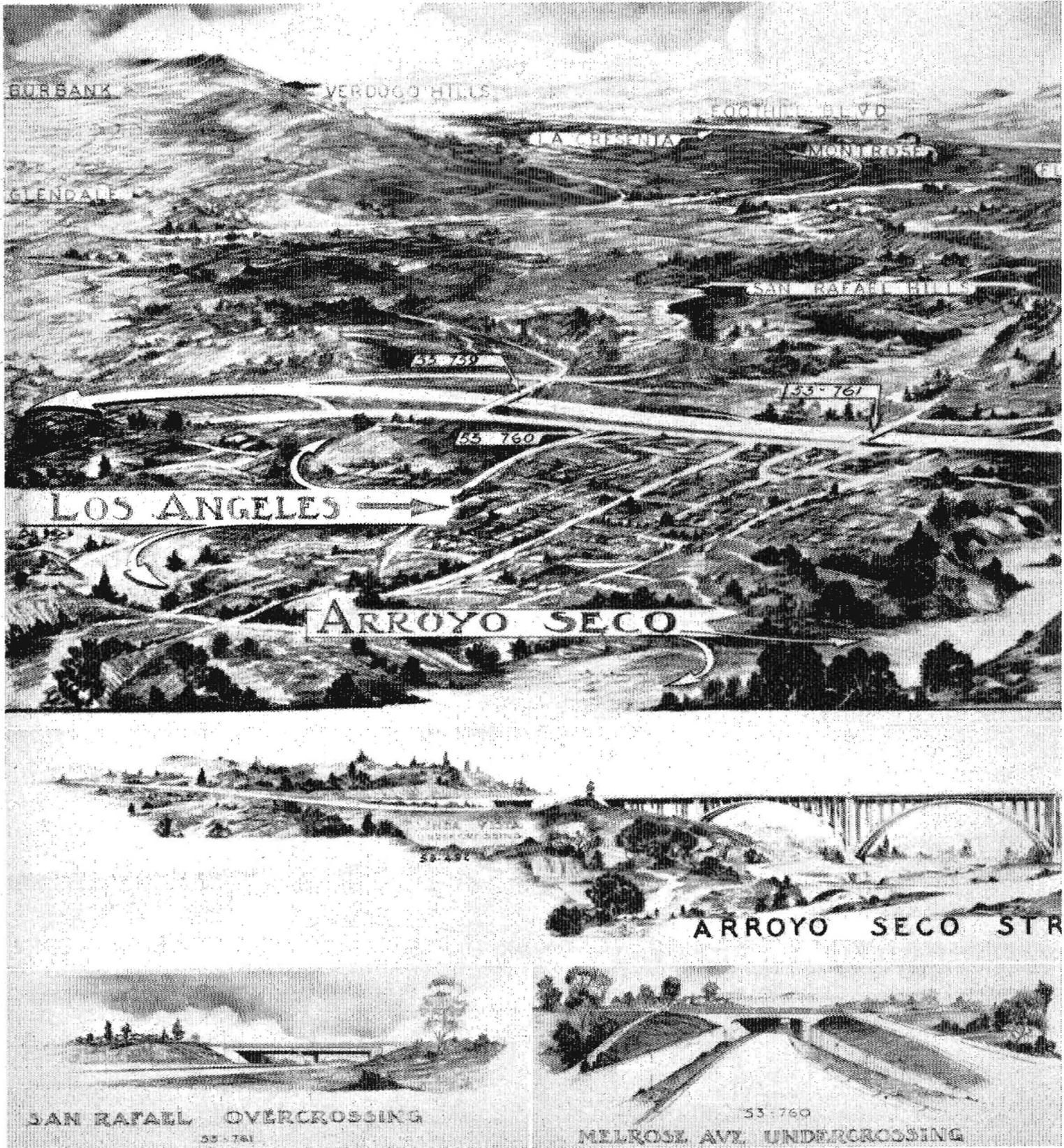
Year	Fatal	Nonfatal	Property damage	Total
			only	
1941	0.029	0.694	0.521	1.244
1942	0.000	0.490	0.245	0.735
1943	0.000	0.385	0.346	0.731
1944	0.036	0.426	0.568	1.030
1945	0.059	0.707	0.501	1.268
1946	0.038	0.535	0.401	0.975
1947	0.000	1.032	0.834	1.866
7-year average	0.024	0.646	0.512	1.182

"By way of comparison, rural state highway averages from 1941 through 1946 (1947 figures are not yet available) were as follows:

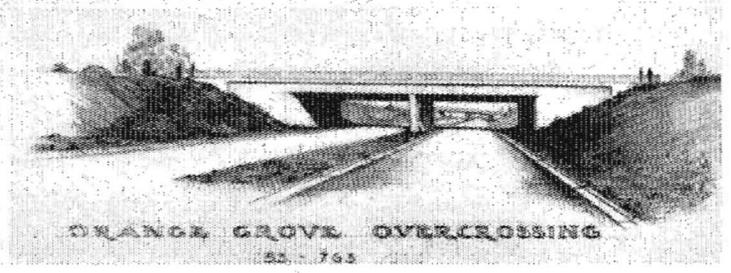
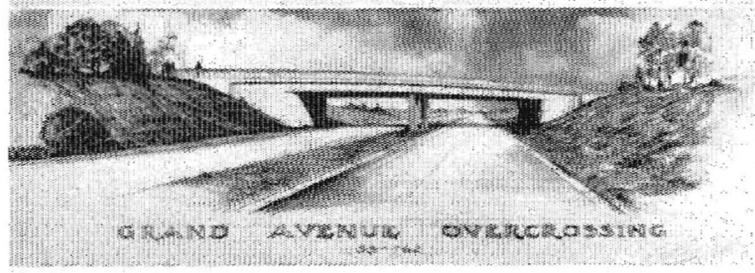
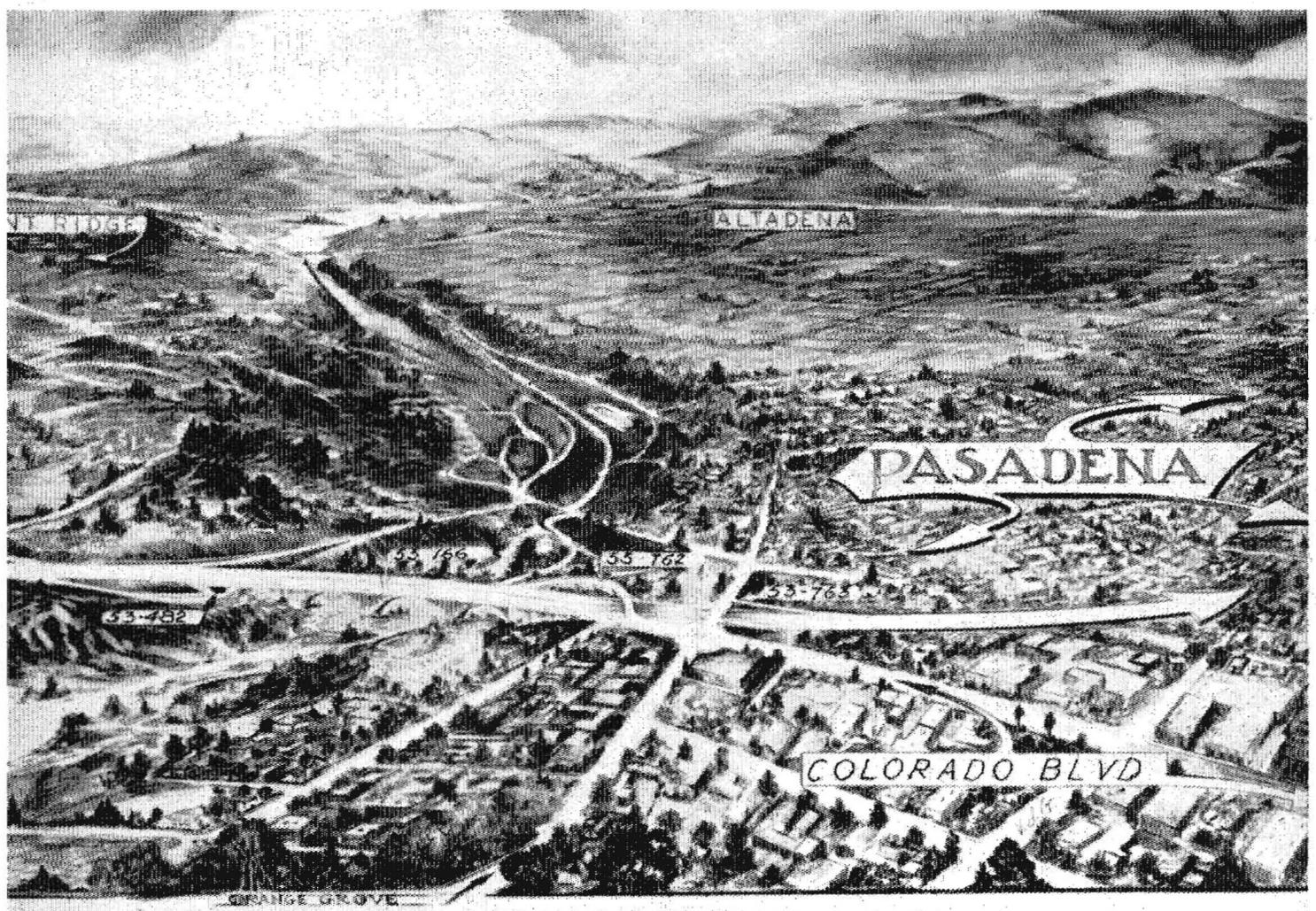
ACCIDENTS PER MILLION VEHICLE MILES

All Accidents	Fatal	Nonfatal	Property damage	Total
			only	
0.12	0.93	0.71	1.76	

Panoramic Projection of the Location of Pro



posed Colorado Parkway in Los Angeles



Concrete

*Its Durability When Exposed
To Sea Water and Alkali Soils*

By THOMAS E. STANTON, Materials and Research Engineer *

*This paper was presented at the 1948 Convention of the American Concrete Institute held in Denver, Colorado,
February 24, 1948*

AUTHORITIES are unanimous in the opinion that imperviousness is a prerequisite to resistance against the destructive forces of nature, including the salts in sea waters and alkali soils.

Some contend that the entire problem (assuming the use of sound ingredients) is allied with porosity. Others, although upholding the theory of the superior virtues of impermeability, are equally convinced that the most impervious concrete will be disintegrated in time if exposed to sea water.

The writer agrees in the main with the first group but for reasons hereinafter recited favors certain protective or insurance measures against the possibility of failure through inferior workmanship or the use of unsuitable materials.

Two of the most interesting discussions on the subject will be found in the publications of the American Society of Civil Engineers; one the international discussion provoked by the paper by William G. Atwood and A. A. Johnson on "The Disintegration of Cement in Sea Water" published with discussions in A. S. C. E. Transactions, Vol. 67, p. 204 (1924) and second the paper by Homer Hadley titled "Concrete in Sea Water; a Revised Viewpoint Needed" and attendant discussion, published in A. S. C. E. Transactions, Vol. 107, p. 345 (1942).

Impermeability

Although many differing viewpoints were expressed by the participants in the above discussions, there was unanimous agreement that a prime requisite is impermeability, and that this desired condition can only be attained by proper mix design and construction procedure.

There have been many other published contributions to the subject, particularly in the proceedings of the

* Member, American Concrete Institute.

Summary

THIS DISCUSSION is a continuation of a discussion on the same subject published in the American Concrete Institute Journal for March-April, 1938.†

Data which was not available at that time, but which has since come to light contributes materially to our understanding of the causes of concrete deterioration when exposed to sea water and alkali soils and appropriate corrective or protective measures.

The principal new developments are:

1. The discovery that one cause of excessive expansion and cracking of concrete is an adverse reaction between certain minerals in the aggregate and the alkali constituents of portland cement, thereby provided an avenue for the ingress and deposit of aggressive salts in excessive amounts. The cure in this case is to use either a nonreactive aggregate or a low alkali or suitable portland-puzzolan cement.
2. Positive evidence that the resistance of concrete to sulphate attack is materially improved through the use of a suitable air entraining agent. Accelerated tests indicate the ASTM approved air-entraining agents Vinsol Resin and Darex are suitable and effective.

† Resistance of Cements to Attack by Sea Water and by Alkali Soils, by Thos. E. Stanton and Lester C. Meder.

American Concrete Institute. All stress impermeability.

Numerous laboratory studies conducted by the California Division of Highways, the principal one being the study referred to in the opening paragraph of this paper, have confirmed this conclusion. Further confirmation of an impressive nature will be reported by the P. C. A. Committee on the Long Time Performance of Cement in Concrete when the report is published this year on Project No. 7, Exposure to Alkali Soils.

Sound Ingredients

It is axiomatic that the first prerequisite of a durable concrete is sound ingredients.

In practice, however, while it is standard procedure to apply tests to insure the soundness of the cement, the necessity for soundness tests on the aggregates is not so well recognized or universally applied.

In general, California concrete aggregates are sound in the ordinary definition of the term and there are few evidences of concrete failure due to deficiencies of this nature.

However, there has been at least one case of serious failure which was attributed at the time primarily to sea water attack but which later information indicated rather conclusively could be at least partially attributed to unsound aggregates.

The case in point was the disintegration of the concrete in the piles of the Ford Motor Company Plant at Long Beach, California, which was referred to by Mr. Harry E. Squire, Assistant Chief Engineer, Board of State Harbor Commissioners, San Francisco, in his discussion of Homer Hadley's paper.

Quoting Squire:

"Analyses of disintegrated concrete taken from a recent and somewhat disconcerting failure of good concrete in sea water (that of the concrete piles of the Ford Motor Company Plant at Long Beach, California) indicated not only the usual increase in magnesia content at the expense of the calcium, but in

addition a marked increase in the alumina content. Search for the source of the alumina led to the discovery of variable percentages of soluble alumina and active silica in samples of fine aggregate taken directly from the gravel pit. Submitted to the state mineralogist, the samples were identified as mixtures of quartz particles with varying percentages of feldspar particles, the feldspar being partly kaolinized. The disintegration was confined to that part of the pile below the line of immersion and was spotted in a most irregular manner over the entire wharf structure. The conclusion was inescapable that it was due to chemical reaction caused by the sea water; the variation in the behavior of the piles could readily be attributed to variations in the percentage of deleterious feldspar in the aggregate. A marked characteristic of this disintegration was swelling in volume of the concrete affected. The formation of sulfo-aluminates (alums) with their great capacity for increase in volume by taking up water of crystallization has been suggested as the primary cause of this type of breakdown. No matter what the theory, whether due to replacement of calcium by magnesia, to the formation of sulfo-aluminates, or of complex silicates from the active silica of the sand, the fact remains that exactly the same phenomenon of disintegration was simulated in the laboratory by A. A. M. Russell, Associate M. Am. Soc. C. E., using the suspected sand mixed with local cement and immersion in San Francisco Bay water. The breakdown of the mortar was similar to what occurred in the Long Beach piles exposed to sea water."

Blackman Comments

In the same discussion of Mr. Hadley's paper and presumably referring to the same structure, Mr. J. W. B. Blackman, Construction Engineer, Long Beach, comments:

"The writer was asked to inspect a wharf built some few years ago in Long Beach (California) Harbor. A large number of the concrete piles were in a serious stage of disintegration. The concrete in which disintegration showed was swollen and disrupted, and this condition appeared to be more acute on the upper side of the batter piles. Repairs to the structure cost about \$250,000. In the opinion of some engineers the disintegration was due to feldspar in the small aggregates.

"In the opinion of others the damage was due to other causes. It is interesting to note that a large number of the piles adjacent to those disintegrated showed no apparent decomposition. Is it to be assumed that the cause of the disintegration was due to faulty workmanship? For instance, some of the piles may have been compacted carelessly, there may have been too much water, and the porosity may have been much greater than that of the adjacent piles that were not injured. This raises a question that is difficult to answer."

Hadley's Discussion

In commenting on the remarks of Messrs. Squire and Blackman, Mr. Hadley in his closing discussion states:

"This is the case the writer referred to under the heading 'Unsound Materials.' It is undoubtedly the one Captain Blackman refers to in his discussion. It appears to be shown conclusively that the felspathic aggregate was the cause of the trouble. The concrete used in the piles deserves Mr. Squire's characterization as 'good concrete' in every respect, except that all unwittingly the unsound aggregate was incorporated in it. Thereupon it ceased to be 'good.' As for Mr. Squire's 'chemical reactions caused by the sea water', the writer would gladly subscribe to them while directing attention to Mr. Russell's demonstration, previously cited, of the 'chemical reactions caused by the sea water' upon those aggregates all alone and without any cement present while the reactions were in progress. Since the aggregate alone is most unstable in the presence of sea water, it seems scarcely necessary to speculate upon the effects of the addition of cement. It is not an uninteresting fact that while this trouble was occurring at Long Beach the Ford Plants at Richmond, California (on San Francisco Bay), and at Seattle, Washington (in the strongly saline waters at the mouth of the Duwamish River), built at the same time as the Long Beach Plant, were—and still are—free from any trouble in their concrete piles."

It would, therefore, appear that there is considerable evidence of at least one prominent failure of concrete exposed to sea water which can be in part rather definitely traced to lack of durability of at least a portion of the aggregate.

Long Beach Trouble

A complete and accurate analysis of the cause of the Long Beach trouble is complicated by the fact that the aggregate was secured from a source now known to be contaminated with opaline chert of the nature which has caused so much trouble in California through a chemical reaction between the cement and aggregate. These opaline chert particles are not necessarily unsound in the presence of sulphates as evidenced by tests conducted by this department and reported in ASCE Transactions Vol. 107 (1942) p. 81, Table 4 on Rock No. 28039, a highly reactive opaline chert which lost only 2.8 percent in the sulphate soundness test and only 20 percent at 500 revolutions in the LA Rattler Test.

It is understood that the aggregate in the Long Beach structure originated in the Palos Verdes Hills area just north of Long Beach. Strongly reactive opaline chert aggregates have been found in this area and there are numerous concrete structures in the vicinity in which similar aggregates were used which have developed extensive crack-

ing through what is now recognized as a cement-aggregate reaction, even though well inland and hence not subject to attack by the sulphates in sea water or from any other source.

Unsound Aggregates

Therefore, while there appears to be indisputable evidence of unsound aggregates having been used in the Long Beach structure, there is no data to show just how much, if any, of the swelling and disintegration described by Messrs. Squire and Blackman can be ascribed initially, if at all, to attacks by the sulphates in the sea water on unsound aggregates and how much to an initial cracking through the expansive reaction between the cement and aggregate and subsequent disintegration through sea water attack on both the unsound aggregates and the cement.

This brings us to possibly the most important consideration next to, if not more important than impermeability; namely, the role of a reactive aggregate.

REACTIVE AGGREGATE-CEMENT COMBINATIONS

If an aggressive salt laden moisture can readily penetrate the interior of a concrete mass and the percentage of the salts is built up to large amounts through alternate wetting and drying, the concrete may disintegrate through the action of the sulphates on the vulnerable components of the cement and aggregates. That this actually does occur when cracks are opened up through a reaction between the cement and aggregate has been conclusively demonstrated along the seacoast in California, particularly in the case of the sea walls at Santa Barbara and in Ventura County (Figs. 1 and 2).

The extensive cracks which developed in these structures were caused by an expansive reaction between the reactive minerals in local aggregates and high alkali cements.

Portions of the sea walls in both locations are in protected areas not subject to wave action and other portions to frequent daily wettings by sea water.

The cracking due to the reactive action is of the same nature in the unexposed as in the exposed portions of the sea walls. However, little disintegration typical of sulphate attack has taken place in the protected portions

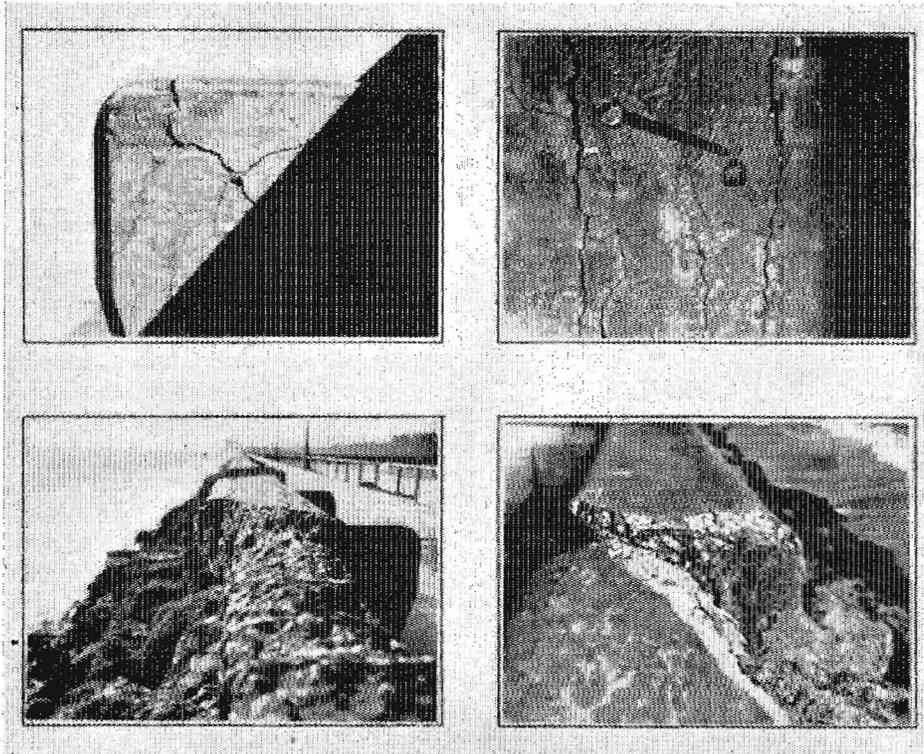


Figure 1. Cracks in sea wall at Santa Barbara

and comparatively little in the vertical or readily drained portions even though exposed to wave action. However, whenever the sea water overflows the horizontal or slightly inclined surfaces of the copings and seats and remains long enough to penetrate and thoroughly saturate the underlying concrete, serious disintegration has taken place.

It is pertinent to speculate how much, if any, of the lack of durability of concrete exposed to sea water reported by other observers may have been facilitated by cracks caused by an unsuspected cement-aggregate reaction.

CEMENT COMPOSITION

Based largely on work done by the technicians of the Portland Cement Association Fellowship at the National Bureau of Standards, Washington, D. C., supplemented by prior and subsequent studies by independent investigators, it has been determined that resistance to sulphate attack can be improved by rigid control of the manufacture and composition of the cement and that the most vulnerable constituent of the cement is what is termed the tri-calcium aluminate component.

Numerous tests conducted by the Materials and Research Department of the California Division of Highways substantiate this conclusion.

Types II and V of the ASTM Cement Standards are designed to meet these conditions, the C_3A in Type II (Moderate Sulphate Resistant) cement being limited to a maximum 8 percent and in Type V (Sulphate Resistant)

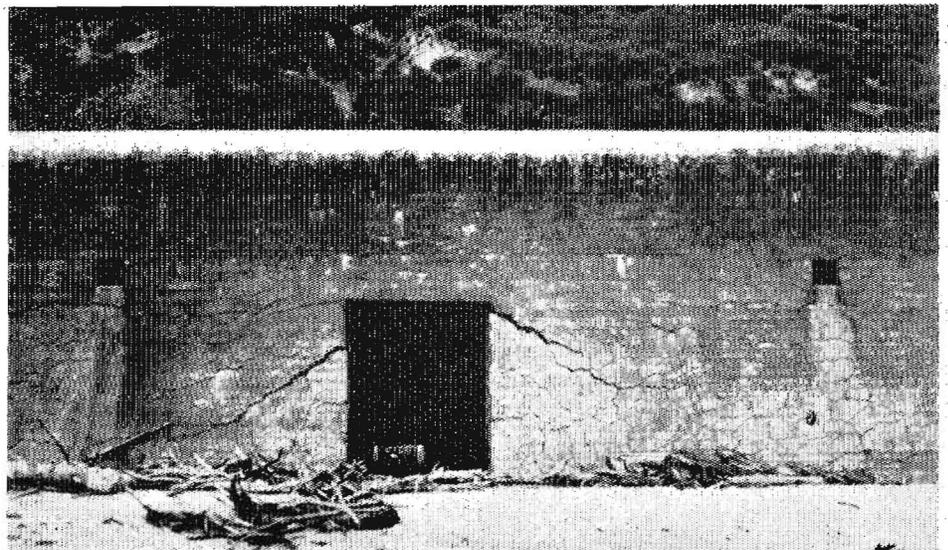
Cement to a maximum of 5 percent. Type IV has similar characteristics to Type V.

Virtues of Imperviousness

There is ample evidence that concentration of sulphates such as encountered in alkali soil areas and in sea water exposures through alternate wetting and evaporation may cause serious disintegration in a short period in the presence of cements containing substantially greater than 8 percent C_3A , say 10.00 percent and up, particularly where the concrete is permeable. In this connection the tests in normal sea water reported in the Engineering News-Record article, a portion of which was quoted by Hadley in the closing discussion of his ASCE paper, wherein a porous 1:3 mix mortar specimen of standard Ottawa sand and a 17.2 percent C_3A cement was exposed to normal sea water and almost completely disintegrated in four years, whereas a companion specimen of the same cement and mix proportions but using a well graded concrete sand was still intact (Fig. 4) afford a striking demonstration of the virtues of imperviousness.

Based on this demonstration of the definite deterioration of a pervious high C_3A cement mortar in the presence of normal sea water, supplemented by further demonstrations of the durability of the same Ottawa sand mortar in combination with low C_3A cements (Figs. 3, 4, and 5) the author

Figure 2. Showing face of sea wall along the coast in Ventura County, California. Wall badly cracked through cement-aggregate reaction but little subsequent disintegration of concrete through sea water attack



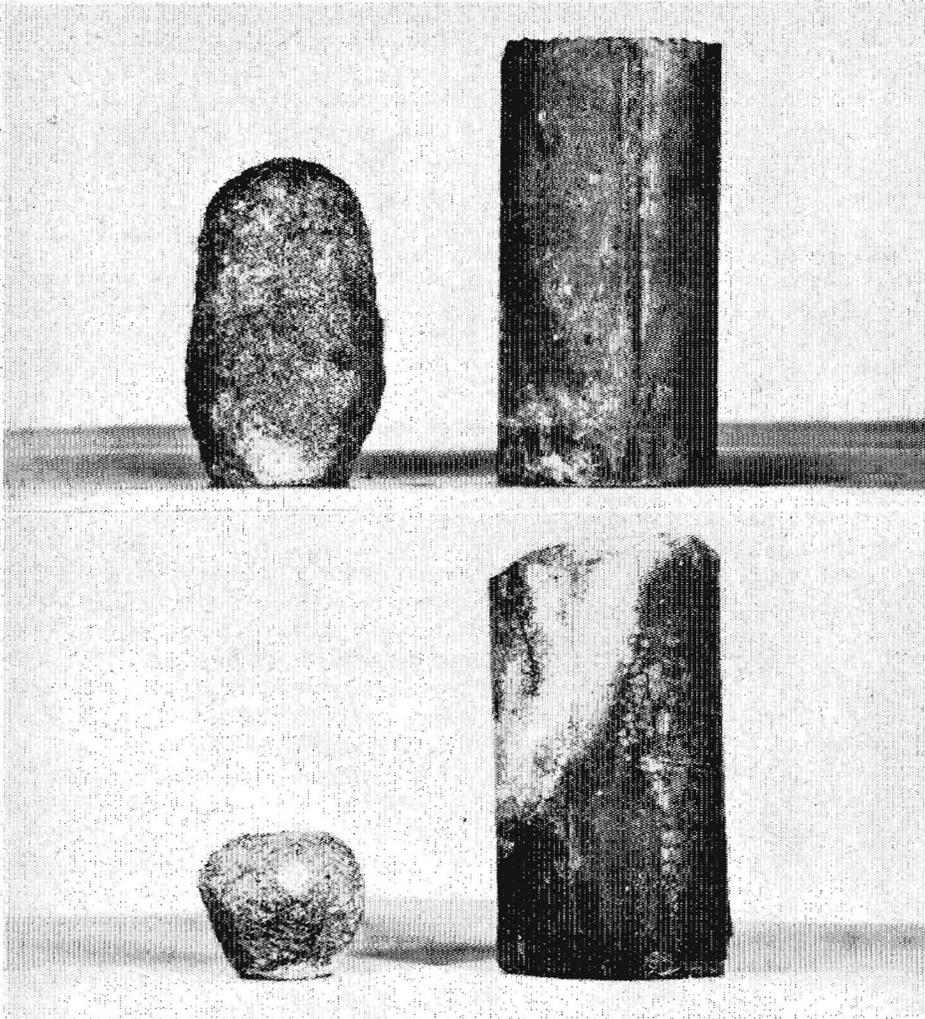


Figure 3. Showing effect of cement composition on durability of mortar specimens cured in sea water. The relative durability of different cement using STD. Ottawa sand 1:3 mix. UPPER—Condition of specimens after 34 months in sea water. LOWER—Same specimens after 48 months

has always felt that any moderate added cost of a Type II cement is cheap insurance where exposure to sea water is anticipated.

AIR ENTRAINMENT

As noted in the summary one of the new additions to our knowledge of the prerequisites of durability of concrete exposed to sulphate attack has been definite proof of the value of a suitable air entraining agent in reducing the absorptive properties of concrete and thereby improving its resistance in the same manner as an increase in impermeousness by any other means, such as mix design.

While the most convincing evidence of this fact will be found in the report on P. C. A. Project No. 7, the results of that study have been checked by some supplemental tests by the writer

which included a comparatively high C_3A (12 percent) and a moderate C_3A (7.0 percent) cement concrete of 4.0 and 5.5 sack mixes with and without an air entraining agent and exposed to an alkali soil over a period of years (Fig. 6).

The high C_3A cement concrete on the 4.0 sack cement mix disintegrated very rapidly when stored in the alkali soil even with the air entraining agent (Vinsol Resin). The corresponding 5.5 sack high C_3A cement mix likewise failed at an early date but the benefit of the AEA was definite.

Specimens of a Type II cement of the same brand were definitely more resistant and the beneficial effect of the AEA was quite evident even in the 4.0 sack mix. The results of similar tests are shown in (Figs. 7 and 8). From these tests it would appear that in the

case of low factor high C_3A cement concretes exposed to high concentrations of sodium sulphate the benefit of an AEA, though marked, is insufficient to materially retard disintegration. With the richer mixes the benefit of the AEA is more apparent and with a Type II cement the durability of even a lean (4.0 sack) mix is materially improved.

Tests conducted on the AEA concrete show considerably greater resistance to moisture absorption, thereby accounting for the improvement in durability.

PORTLAND-PUZZOLAN CEMENTS

At least one California brand of portland-puzzolan cement has shown considerable resistance to sulphate attack as well as to the cement-aggregate reaction regardless of the C_3A or alkali content of the cement clinker.

I refer to cement DL (Fig. 9). The standard Type I cement of this brand (DS) contained 14.2 percent C_3A . This standard Type I cement has shown little resistance to sulphate attack in any tests conducted by this department. It is the brand, though with a lower C_3A content (12 percent), used in the tests illustrated by Fig. 1.

When the clinker is modified by the subsequent addition of calcined Monterey Shale this cement becomes highly resistant not only to sulphate attack* but likewise to excessive expansion through a cement-aggregate reaction even though the standard cement clinker contains 0.78 percent total alkali as Na_2O .†

Numerous tests subsequent to those described in the published reports referred to have all confirmed the original tests. There appears to be no doubt but that a suitable puzzolanic addition will materially improve the resistance of any standard cement to sulphate attack, and in addition, will effectively correct or dissipate any tendency to excessive expansion through a cement-aggregate reaction.

If some of the adverse characteristics of most, if not all puzzolanic ce-

* "Resistance of Cement to Attack by Sea Water and by Alkali Soils," Stanton and Meder, Journal of the American Concrete Institute, March-April, 1938, pp. 453-456.

† Cement HP, Fig. 4, "California Experience with the Expansion of Concrete Through Reaction Between Cement and Aggregate," Stanton et al, Journal of the American Concrete Institute, January, 1942, Fig. 4, p. 216.

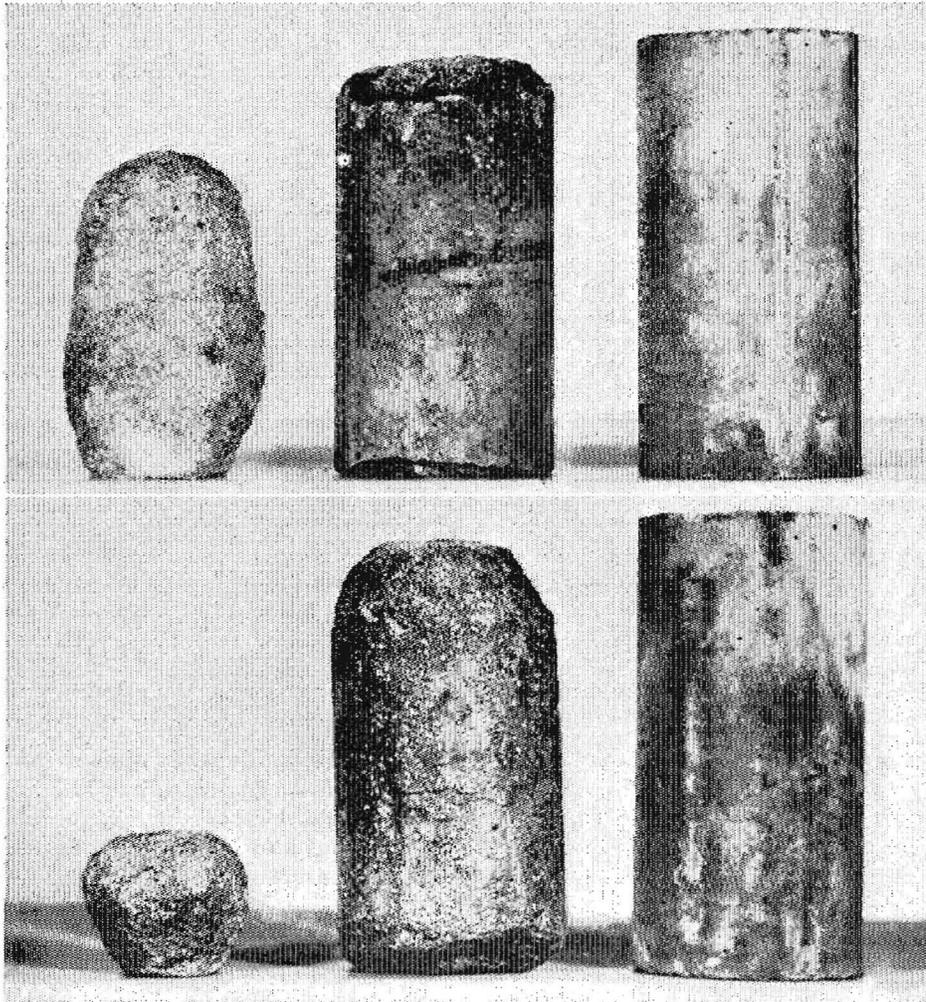


Figure 4. Showing effect of density on durability of mortar specimens cured in sea water. Relative durability of variable density mixes using same cement, high C₃A cement, 17.2% C₃A. UPPER—Condition of specimens after 34 months in sea water. LOWER—Same after 48 months

ments, such as excessive shrinkage, can be overcome or at least minimized there would appear to be a very definite place for cements of this type in construction subject to the adverse weathering conditions described in this report.

54 YEARS EXPOSURE TO SEA WATER

Reference was made by Messrs. Hadley and Squire to the concrete in the piers of the San Francisco Ferry Building which at that time were approaching 50 years age (having been constructed in 1894-'95) and to other concrete piers under the same structure constructed in 1912 and in which a high C₃A cement (17.2 percent) was used.

Mr. Frank G. White, Chief Engineer for the State Board of Harbor Commissioners, recently had some cores cut

from the old concrete to ascertain its condition after 50 years.

The cores were cut during the latter part of 1947 and 2 inch by 4 inch specimens tested for compression.

The results of the compression tests are illustrated in *Table 1* in which the test results are arranged with relation to the core number and the depth below the top of the structure. The table likewise shows the corresponding absorptions.

Although 11 cores were cut and samples (where obtainable) were retained for the entire depth, compression tests were made only on typical specimens from which 2 inch by 4 inch specimens could be cut.

There were no definite evidences of unsound concrete, but considerable evidence of honeycomb and considerable rather hard, white deposit which

analyzed high in magnesium. A similar white deposit but no soft disintegrated mushy mortar was observed in the honeycomb areas and throughout the broken mass of all specimens but particularly of the lower strength specimens.

No Disintegration

On Tuesday, January 6, 1948, a surface inspection was made of the concrete in the 1894 and 1912 concrete piers, 54 and 36 years old respectively, but other than a possible washing out of some mortar in and immediately adjacent to the honeycomb areas of the 1894 structure, no evidence of disintegration was observed. (Figs. 10, 11, 12, and 13.)

Analyses have been made of the bay water which was found to be of substantially the same salinity as the ocean water outside the bay.

The cement in the 54-year-old structure is reported to have been Dyckerhoff cement from Germany.

There was considerable controversy during the construction with regard to the quality of the aggregate and of the concrete with the result that the Deans of Engineering at the Universities of California and Stanford, Professors Frank Soule and Chas. D. Marx, were employed to make an investigation and report. These engineers filed their report under date of April 10, 1895.

Because of long-time performance of the concrete in this structure and the fact that it may be the subject of future study, it has been deemed worthwhile to quote quite freely from some of the findings.

Excerpts from April 10, 1895, report of Professors Frank Soule (Dean of Engineering, University of California) and Chas. D. Marx (Dean of Engineering, Stanford University) on the concrete in the San Francisco Ferry Building piers, constructed in 1894-95.

CEMENT

"We pronounce it to be a fair grade of Portland cement, suited to the work in hand."

SAND

"The sand * * * is a clean finely pulverized material. It is not a sharp coarse beach sand or its equivalent as called for by the specifications."

STONE

"The rock which has been used is not 'blue traprock of the best quality' (as called for in the specifications) but is pronounced by Professors Branner of Stanford University and Lawson of the University of California, to be indurated sandstone, containing some

MORTAR DURABILITY TESTS

STANDARD UNGRADED OTTAWA SAND-CEMENT MORTAR SPECIMENS* STORED 72 MONTHS AT THE LABORATORY, SACRAMENTO, IN NORMAL CONCENTRATION SEA WATER FROM SAN FRANCISCO BAY, 1933 - 1939

MIXING WATER - FRESH

IRREGULAR EDGES RESULTING FROM REMOVAL OF CAPS ORIGINALLY PLACED WITH INTENTION OF TESTING ALL SPECIMENS FOR COMPRESSIVE STRENGTH

1-2 MORTAR	DISINTEGRATION COMPLETE							
	AVE. % LOSS	100	42.0	26.5	20.8	0	0	7.0
1-3 MORTAR	DISINTEGRATION COMPLETE	DISINTEGRATION COMPLETE	DISINTEGRATION COMPLETE	DISINTEGRATION COMPLETE				
	AVE. % LOSS	100	100	100	100	1.4	0	37.0
	CEMENT IDENT.	C.S.	D.S.	A.S.	B.S.	E.S.	B.S.W.	D.L.I.***
	% C ₃ A	17.2	14.2	13.1	12.1	7.2	3.7	14.2

MIXING WATER - NORMAL SEA WATER**

1-2 MORTAR	DISINTEGRATION COMPLETE							
	AVE. % LOSS	100	69.2	64.8	47.6	0	0	20.8
1-3 MORTAR	DISINTEGRATION COMPLETE	DISINTEGRATION COMPLETE	DISINTEGRATION COMPLETE	DISINTEGRATION COMPLETE				
	AVE. % LOSS	100	100	100	100	0	0	40.0
	CEMENT IDENT.	C.S.	D.S.	A.S.	B.S.	E.S.	B.S.W.	D.L.I.***
	% C ₃ A	17.2	14.2	13.1	12.1	7.2	3.7	14.2

* REPRESENTATIVE SAMPLE FROM EACH SET OF SPECIMENS
 ** COMPANION SPECIMENS MIXED WITH SEA WATER, BUT CURED IN FRESH WATER, SHOW NO DISINTEGRATION
 *** PORTLAND-PUZZOLAN, 70% STD. CLINKER & 30% SILICA COMPOUND, C₃A CONTENT OF STD. P.C. CLINKER ONLY

Figure 5

TABLE 1

Compression Tests (p. s. i.) on 2-Inch Diameter Core Specimens From 54-Year-Old Piers at the Ferry Building, San Francisco. Piers Constructed in 1894-95. Cores Cut in October, 1947—Tested in December, 1947. Specimens Tested Secured From Approximate Depths Indicated

Hole	1	2	3	4	5	6	7	8	9	10	11
Pier	23-A	20-C	16-C	13-C	13-A	12-A	8-C	6-A	3-A	4-C	12-A
Depth*	COMPRESSIVE STRENGTH p.s.i. 2" x 4" CORE SPECIMENS										
1											
2					2,971						
3											
4									3,731		
5								2,344	4,095	3,702	
6											

Mean Higher High Tide —6.00

7							2,974				
8			3,589					1,792			
9					5,150	*	2,731				
10					4,563				2,668		
11		2,647									

Mean Lower Low Tide —11.84

12	2,483										
13									2,671	4,939	
14										5,254	
15				6,043							
16											4,494
17											
18											
19				3,104		3,968					
20		1,693						1,650			
21										3,699	

Percent Absorption in 48 Hours.
Specimens listed in order of compression tests shown above.

	2.6	2.4	2.5	1.4	2.3	1.7	2.5	2.3	2.0	1.6	1.7
		2.5		3.0	1.2		1.9	2.3	1.5	1.0	
					1.6			2.4	2.2	1.2	
									2.1	1.6	

*Figures in left-hand column indicate depths below top of Piers.

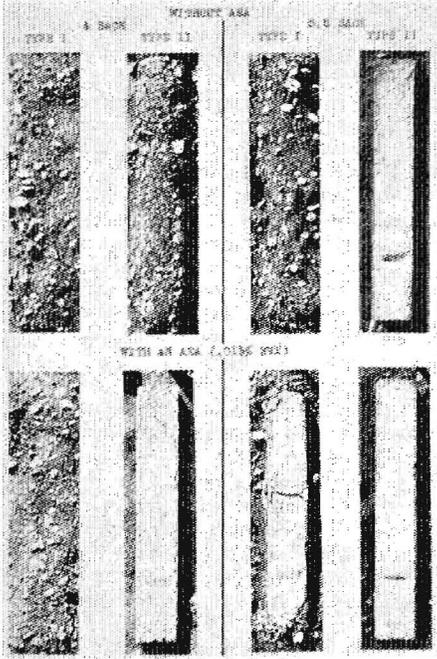


Figure 6. 4.0 and 5.5 sack concrete with and without an air entraining agent after 30 months' exposure to an alkali soil high in Na_2SO_4 . The cements were a California Type I (12% C_3A) and a Type II (7% C_3A) cement of the same brand

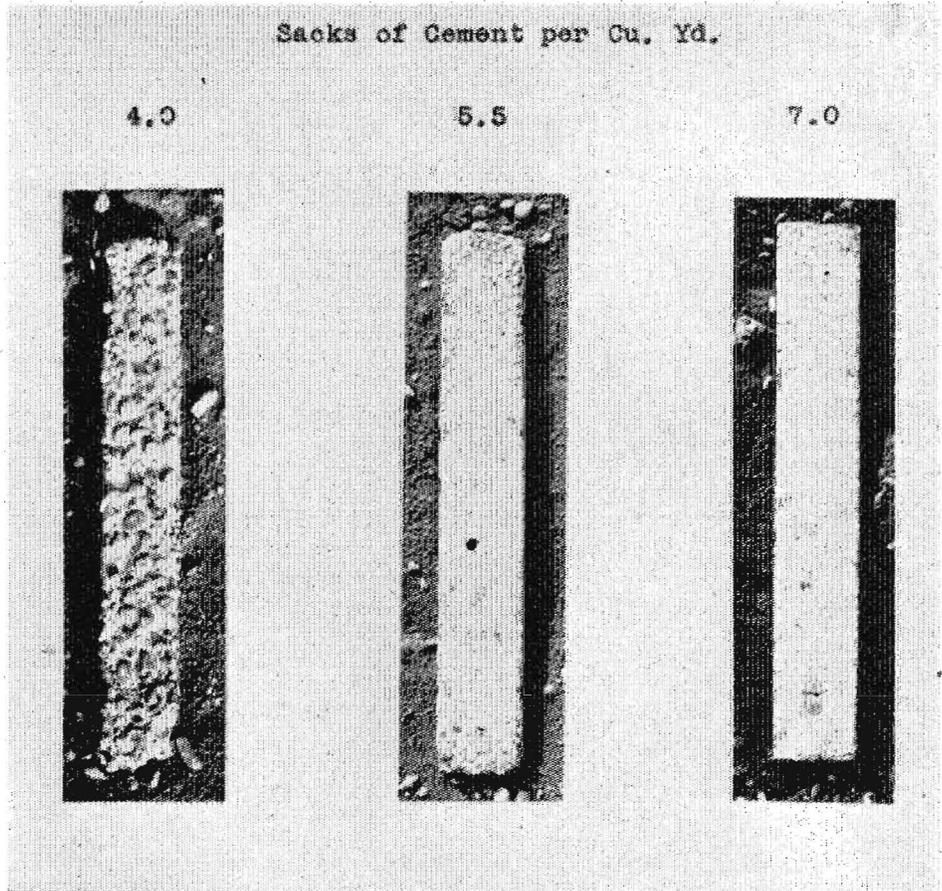


Figure 8. Showing condition of Type IV cement (3.5% C_3A) concrete beam-specimens after five years' exposure to an alkali soil

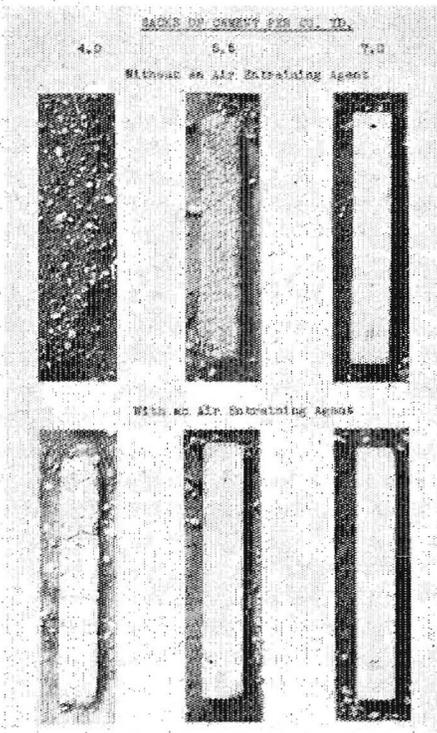


Figure 7. Showing condition of Type II cement (6.5% C_3A) concrete beam-specimens after five years' exposure to an alkali soil

lime and a little iron, and to possess a considerable degree of hardness and durability * * *. It breaks rather easily, along natural cleavage surfaces, into irregular fragments, one or two inches in greatest dimension, and then exhibits a bluish color; after which it is not readily broken into smaller pieces.

"Tests of its resistance to crushing were made by us upon samples selected by ourselves from the 'mixing table' at the ferry; and the results obtained from these small sized specimens proved that the stone is of good quality in this respect and that it belongs to the class of 'excellent sand stone, fit for building purposes.' The use of this stone in other marine constructions as in the S. F. Seawall shows that the action of the sea water upon it is not destructive.

"While this rock is not 'blue traprock of the best quality' we record our opinion that it is good enough to fairly comply with the spirit of the specifications in this regard and that it will give strength and resistance entirely comparable to those of the other components of the concrete."

CONCRETE

"From what precedes it follows that, with the exception of the sand, the materials used in this work are capable of being made into good concrete * * *. The proportions (of the ingredients) as specified of 1 part cement,

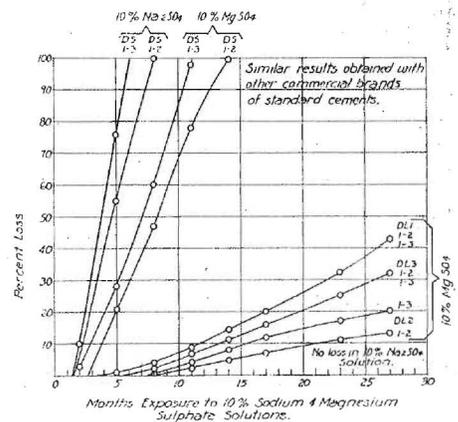


Figure 9. Mortar durability tests—showing effect of magnesium and sodium sulphate solutions on Portland puzzolan type cement (DL) and companion standard Portland cement (DS). All specimens cured 28 days in fresh water before exposure

1½ sand, and 6 stone, undoubtedly give a concrete richer in cement than is necessary to obtain good results.

"The poor quality of the sand in the mixture is offset in part by the fine particles in the broken stone, which acts as so much good sand; and in part by the excess of cement used. To that we must attribute the fact that

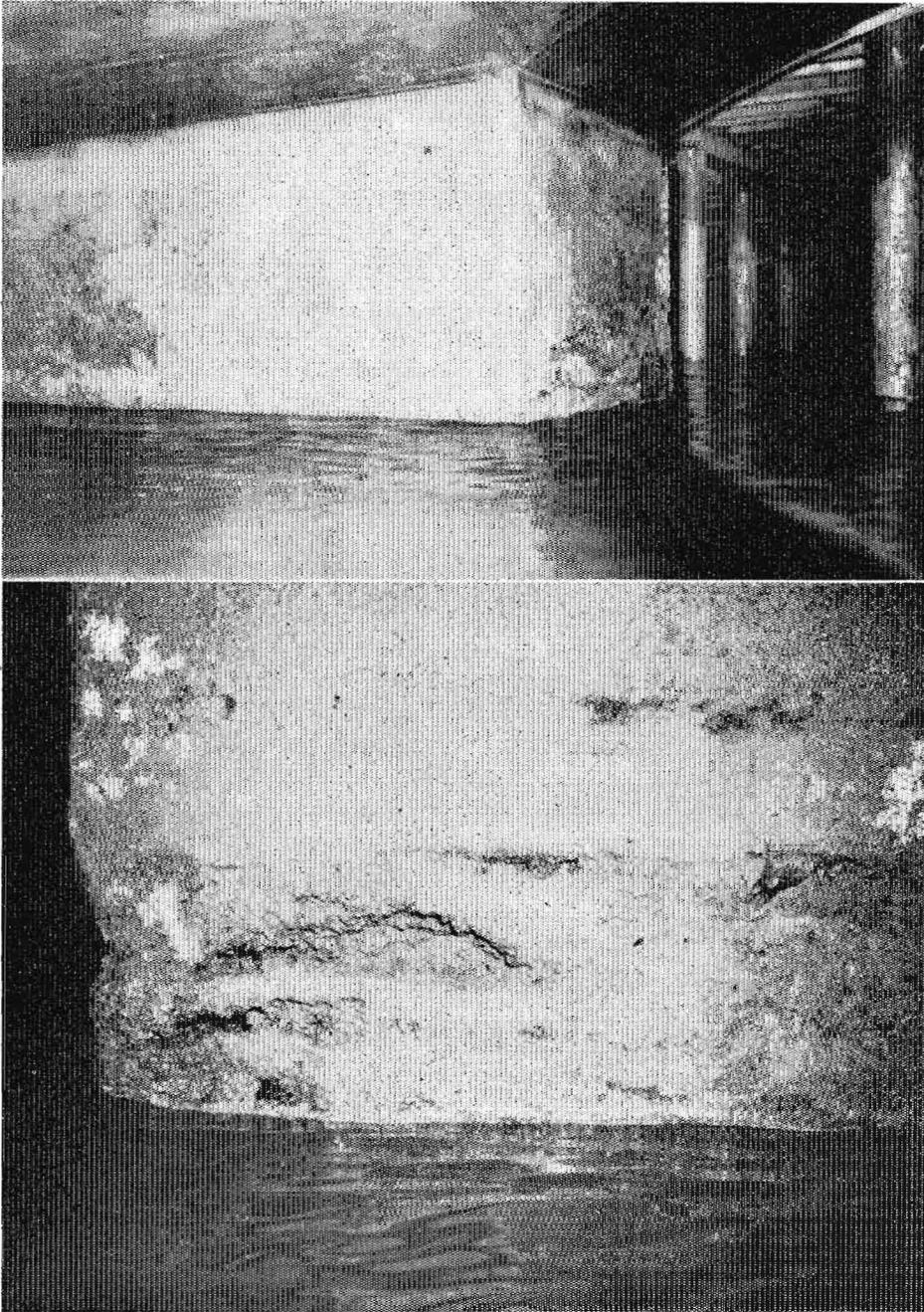


Figure 10. UPPER—Pier at north end of main Ferry Building, San Francisco Harbor, constructed in 1894. LOWER—Close up of right face of pier at near corner showing honeycomb, but little if any concrete disintegration. Notwithstanding some honeycomb as shown, the concrete in this 54-year-old pier is in excellent condition as far as can be judged from a surface inspection and the sound under blows of a hammer. Picture taken at low tide January 6, 1948

the concrete as shown by the actual tests recorded below is as good as it is."

MIXING AND TAMPING THE CONCRETE

"The method of mixing, called for in the specifications, has been materially departed from.

"The specifications require that [the] materials must be thoroughly and completely mixed * * *.

"The mixing to be done as follows, viz: the broken rock must be first spread on a

wooden platform in a layer not exceeding six (6) inches in thickness. On this must be spread over its entire area, first a layer of sand, and then a layer of cement, each in its proper proportion, the bed thus formed must be turned with shovels while dry, and once after being wet, or the same may be mixed by any machinery approved by the Chief Engineer.

"The method of mixing the concrete was changed * * *. The process of mixing [was] by using the 'Gray Mixer', Patent No. 477361.

We feel certain that the substitution of this method was a mistake.

"The ingredients having been mixed dry, the heavier parts fall or roll down the chute first and the light powdered cement delayed a little by the atmospheric resistance and often blown aside by the wind, goes down more slowly and un-uniformly.

"The introduction of water to wet the mixture, by means of a hose in one side of the chute produces varying degrees of moisture; so that some parts of the layer will be flooded, while others at the same instant will be dry. In some portions of the layer, an excess of cement will be found; in others, an excess of broken stone; in some parts dry powder, in others liquid grout.

"Evidence of this condition of the concrete is derived both from an inspection of the exterior of the piers, where many small cavities exist, caused by lack of cementing material, the wash of sea water and the consequent falling out of broken stone; and also from a study of the interior of the pier which we cut into and of the blocks of concrete which we took from some of the arches and piers.

"There is a general lack of uniformity in the concrete, due to imperfect mixing. Little pockets of sand alone and of broken stone alone may often be found."

Negligible Disintegration

From the above quoted description of the concrete construction procedure, it would not have been surprising if considerable disintegration, at least of the exposed surfaces of the concrete piers had taken place during the 54 years which have elapsed.

An inspection on January 6, 1948, by the author in company with Assistant Chief Engineer Harry Squire disclosed extensive honeycomb and absence of mortar to considerable depth in some of the honeycomb areas but negligible disintegration (as indicated by lack of appreciable softening) of the adjacent mortar. The portions of the piers in which no honeycomb exist are in excellent condition and ring well under a hammer blow.

The 2-inch diameter holes, cut from top to bottom through the same piers furnished ample evidence of a honeycomb condition throughout the mass of the pier but little, if any, evidence of disintegration, although the evidence in this respect is not positive as all disintegrated mortar, if there was any, may have been broken up and washed out during the coring operations.

Inspection of small honey-combed core specimens, however, indicates little, if any, mortar softening, although

as previously stated there is considerable white deposit which analyzes largely as magnesium.

The deposit is usually hard but can be readily pulverized to a powder. Experience in this respect appears to follow the observations in the First Report of the Committee of the Institute of C. E. (England) on the Deterioration of Structures in Sea Water, 1920, in which the following appears on page 273:

"About thirty years since (1890) considerable discussion arose in the engineering world with respect to failures which had occurred in the use of ordinary concrete in harbor and dock works, and these failures created, at the time, a certain amount of distrust with respect to the durability of the material. After very careful consideration of the facts associated with the cases in question, and much discussion with regard thereto, it appeared to be generally agreed that the failures referred to were largely, if not entirely due to defects in the concrete itself and that they owed their origin to the porosity of the concrete and the infiltration of sea water from the tideway, into and out of the same when the material was in a 'green' or unset condition.

"A word with regard to this important subject may not be out of place here and it may, therefore, be remarked that in the case of concrete work, if the material is porous and sea water, especially in the tideway, soaks into and subsequently exudes from it, the magnesium salts in the sea water withdraw a portion of the lime of the cement in the form of calcium salts, and leave a deposit of magnesia in place. Generally speaking, the infiltration and exudation of sea water consequent on tidal action, causes the chloride of magnesia in the sea water to be decomposed, the chlorine combining with the lime of cement, for which it possesses a greater affinity than for the magnesia leaving the magnesia free as a hydrate in which form it is deposited in the concrete."

History of Cement

The fact that the honeycombed concrete in the San Francisco Ferry Building piers has withstood the action of sea water as well as it has led to an investigation of the source and composition of the cement.

With regard to source or brand the records are not clear but it appears certain that Dyckerhoff Cement from Germany was used.

The cement was purchased by the Harbor Board from the J. D. Spreckels and Bros. Corporation of San Francisco, but the reports of the Board do not disclose where the Spreckels Company secured the cement.

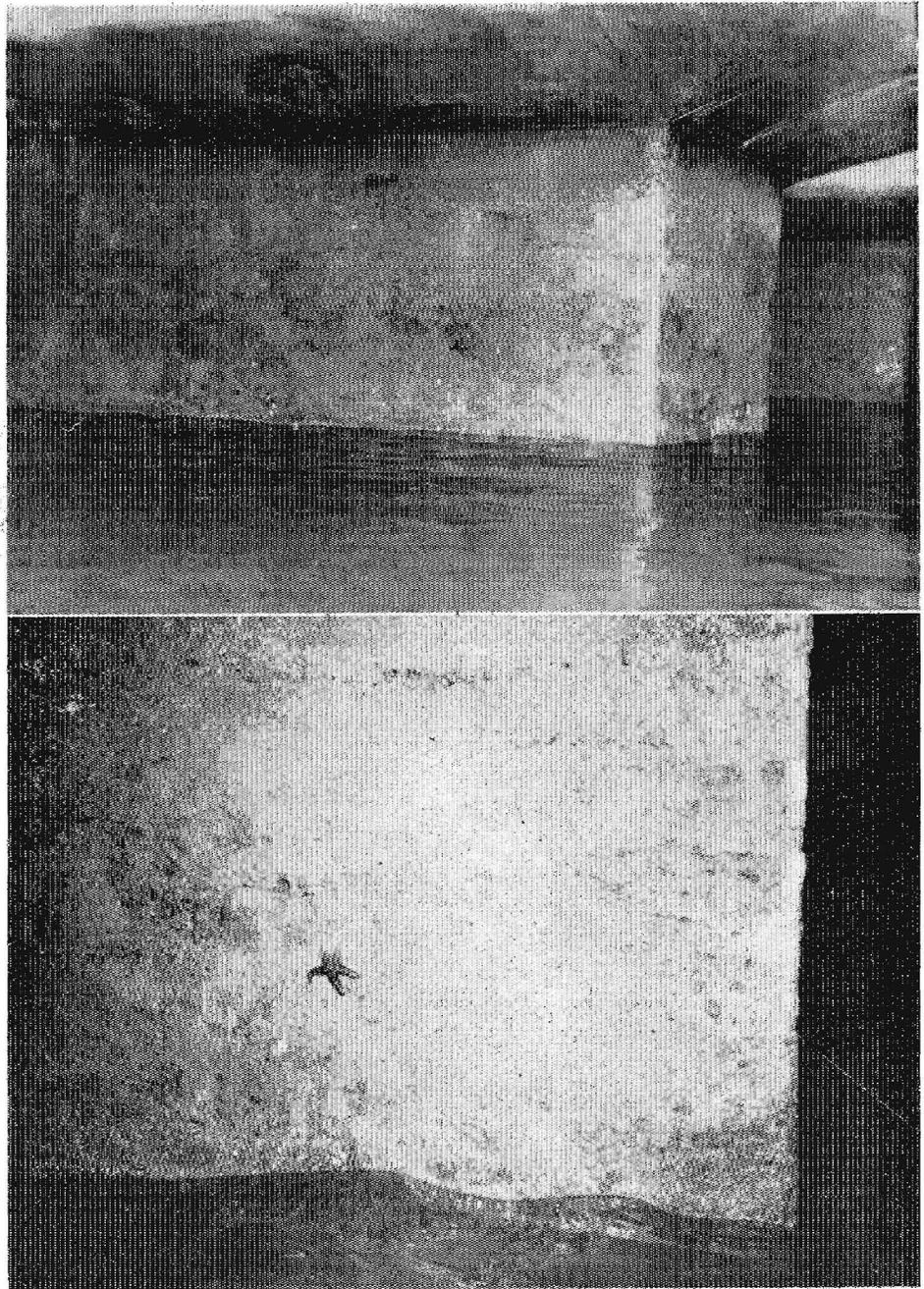


Figure 11. UPPER—Another 54-year-old pier at north end of main Ferry Building, San Francisco Harbor. LOWER—Close up of face of pier. Picture taken at low tide January 6, 1948

A chemical analysis of the cement was made by Thomas Price and Sons of San Francisco which firm under date of April 2, 1895, reported the following analysis:

Calcium Oxide	60.02%
Magnesium Oxide	1.06
Aluminum Oxide	11.31
Silicon Dioxide	20.83
Iron Oxide	1.82
Potassium Oxide	0.73
Sodium Oxide	0.22
Carbon Dioxide and Water	2.26
Sulphur Trioxide	1.37
Loss and Undetermined	0.38

The potential compound composition was approximately as follows:

C ₃ A	27%
C ₂ S	4
C ₁ S	57
C ₁ AF	6
CaSO ₄	2
A/F	6.2

If the compound composition is correctly indicated by the customary method of determination, the effect of a high C₃A on the resistance of the cement to sulphate attack apparently

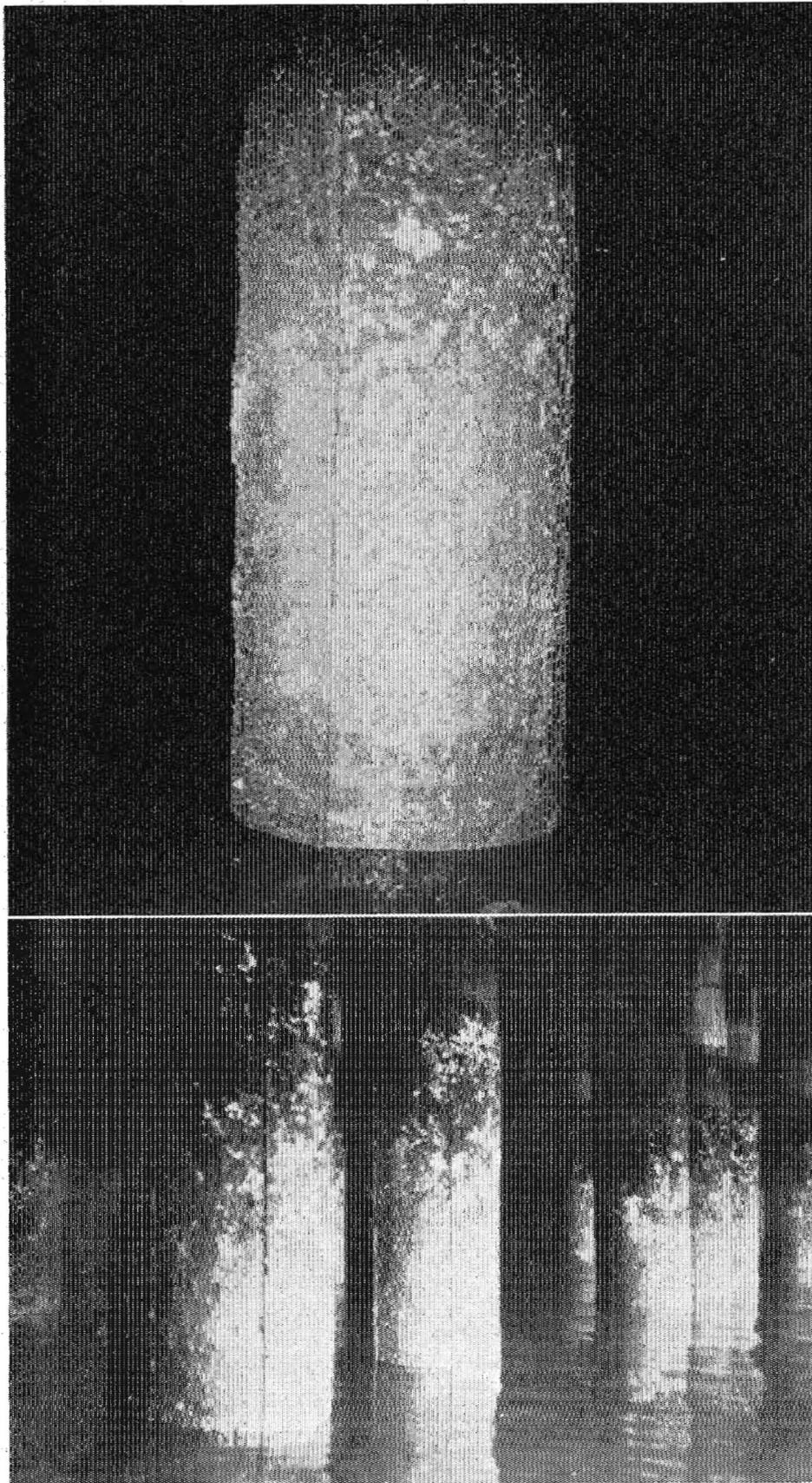


Figure 12. Showing condition of 36-year-old precast reinforced pile jackets. Pier 17, San Francisco Harbor, January 6, 1948. Constructed in 1912. Picture taken at low tide

does not apply to this Dyckerhoff cement. However no cement analyses which have come to the attention of the author of this paper indicate that any Portland cement of similar analysis has ever been manufactured. It is therefore logical to assume that the analysis is in error, due probably to the inexperience of chemists of a half century ago in analysing Portland cements.

Different Brand of Cement

Immediately adjacent and to the north of the original Ferry Building piers a number of cast-in-place concrete cylinders were constructed about 1903. The work was poorly done and there is considerable honeycomb. The disintegration of some of the honeycomb concrete in this construction has been quite extensive (*Fig. 14*).

A hasty search of the records does not disclose the brand of cement but Assistant Chief Engineer Squire reports that it was probably Dyckerhoff.

The workmanship, is reported to have been definitely inferior. While the report on the 1894-'95 project indicates that, in the early part at least, the mixing and depositing procedure was poor, the specifications provided that the concrete should be placed and thoroughly tamped in layers. As a whole, therefore, it was probably comparatively dry and fairly dense with a comparatively high cement content. Criticism regarding the construction procedure on the earlier constructed portion of the work resulted in abandoning the mixer and returning to the hand mix procedure with the result that the later constructed (southerly) piers are in much better condition as far as can be determined from an exterior inspection and the appearance of the 2 inch cores recently cut which showed few honeycombed areas as compared with the extensive honeycomb disclosed by the cores from the earlier work.

1903 Construction

The concrete in the later construction (1903) was poor. It is reported to have been poured quite wet hence was undoubtedly less dense than that in the main piers.

Frank G. White, Chief Engineer for the Harbor Commission and his Chief Assistant Harry E. Squire, report that there were a number of similar con-

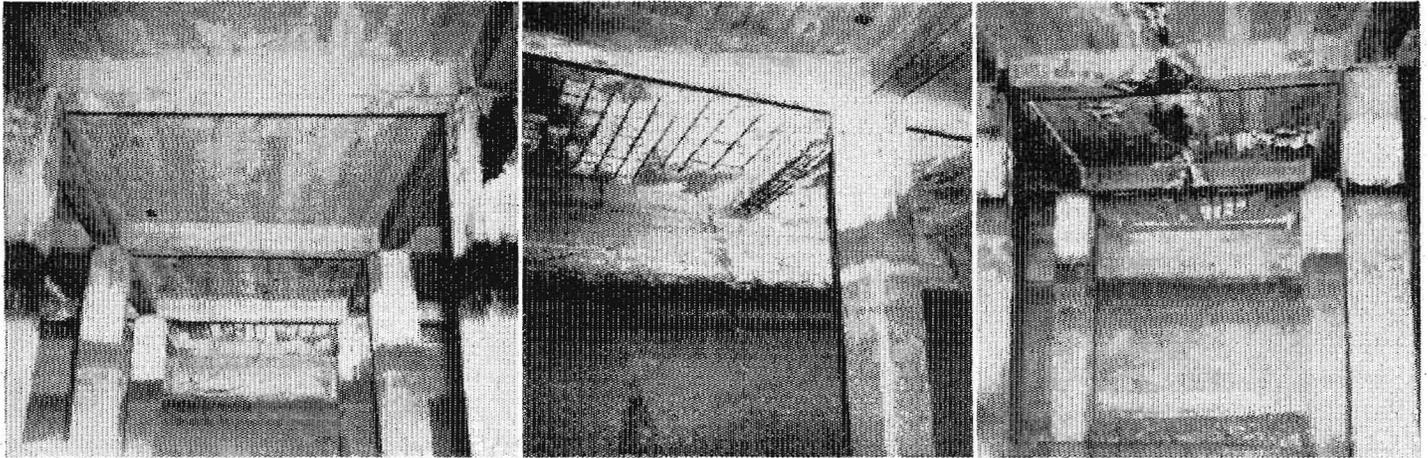


Figure 13. Showing condition of 36-year-old concrete in piles, bulkhead and underside of floor of a portion of Pier 17, San Francisco Harbor, January 6, 1948. Concrete in excellent condition throughout except where affected by rusting of steel reinforcement as shown which resulted from alternate wetting and drying due to splash of water against the concrete bulkhead at the shore end of the pier. Picture taken at low tide. Average tidal range approximately six feet.

crete cylinder projects constructed along the San Francisco Bay waterfront during the first decade of this century on which the workmanship appears to have been even worse than in the Ferry Annex and which failed completely and were replaced, some as early as 10 years after construction; ample evidence of concrete disintegration in sea water when poorly constructed.

Mr. Squire has commented that in his opinion early disintegration (less than 25 years) may be attributed to two kinds of defective concrete:

- (a) Mixes having a deficiency of cement, and
- (b) Placing mixes in excessive water (not merely wet mixes but concrete drowned by leaky forms and by accumulation of water in tight forms).

Pier 17 Construction

(Figs. 12 and 13) show the condition of the concrete in different units of Pier 17, San Francisco Harbor, constructed in 1912 and therefore approximately 36 years old.

Notwithstanding the fact that a high C_3A (17.2 percent) California brand cement was used, similar to that found most vulnerable to sulphate attack in laboratory tests, all units of the structure, piles, bulkheads, floors and girders, are in excellent condition except for failures through rusting of the steel reinforcement in the slab and girders exposed to frequent wetting and drying of sea water from wave action at the shore bulkhead end of

the structure (Fig. 13) and some of the outside exposures.

The workmanship throughout (as evidenced by complete absence of honeycomb in exposed faces) is far superior to the earlier work previously described.

Of further considerable interest is the fact that the piles in this project consist of 3" thick precast reinforced jackets with only approximately 1" cover over the reinforcement. The inspection on January 6, 1948, did not

disclose deterioration through rusting of steel in any of the 1200 piles except in some cases adjacent to the junction of the tops of the pre-cast jackets with the cast in place superstructure.

There was a change of administration shortly before this 1912 project was constructed. The new administration gave the construction engineers a free hand to enforce the specifications to the letter. The result is an excellent demonstration of the durability of a well constructed impervious concrete when exposed to sea water, even in the presence of a high C_3A (17.2 percent) cement.

RECENT SAN FRANCISCO HARBOR CONSTRUCTION

Inspection was likewise made of other harbor concrete structures constructed within the last 15 or 20 years. They were found to be all well built and in excellent condition; evidence of the high competence of Chief Engineer Frank G. White and his principal assistant Harry E. Squire, as well as of the present policy of administrative officials in supporting the application of sound engineering principles and construction procedure, free of political interference.

CONCLUSIONS

From the constructions and the accelerated laboratory tests described in this paper we are justified in reaching the following conclusions regarding procedure, including precautions in the selection of materials and in construction which are easily met, and

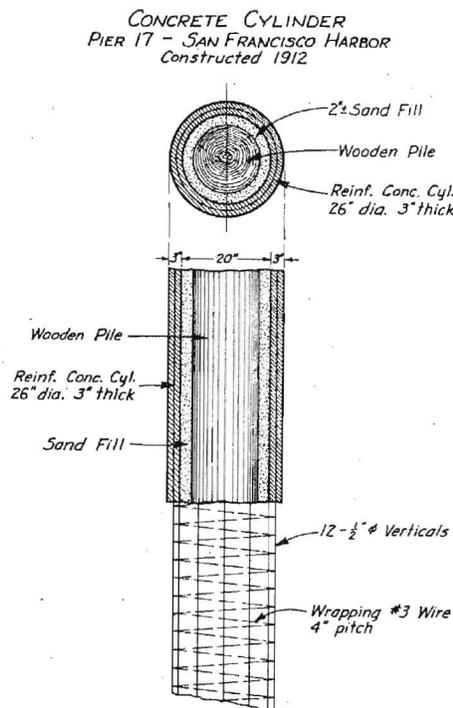


Figure 14

which if followed cannot fail to produce a sound, durable concrete, highly resistant to attack by even the most aggressive alkali soils.

- (1) The cement and aggregate must, of course, be sound.
- (2) Use a nonreactive cement-aggregate combination.
- (3) The mix design should be that which will produce an impervious concrete. Where the concrete can be mixed and placed with a low water cement ratio (not greater than 2-inch to 3-inch slump) it is probable that six sacks of cement per cubic yard will be sufficient. With higher water cement ratios a seven-sack cement concrete is preferable, particularly where exposure conditions are severe.
- (4) The construction should be carried out in such a manner that no segregation occurs and there are no honeycomb areas.
- (5) For further insurance use a Type II cement or a Type IV or V under extreme exposure conditions such as direct contact with alkali soils containing high concentrations of sulphates, particularly sodium sulphate.
- (6) As an aid to impermeability use a suitable air entraining agent.

Items (1), (2), (3) and (4) are the most important; at least insofar as sea water exposure is concerned.

The evidences of the long-time service of concrete structures exposed to sea water which have come to the writer's attention are indisputable with regard to the durability of properly fabricated concrete using any of the five standard types of cement.

However, although poor workmanship and poorly designed pervious concrete mixtures should not be tolerated, accidents will happen and therefore the added protection afforded through the use of a sulphate resistant (Type II) cement and a suitable air entraining agent is so obvious and so easily and economically obtainable that it would seem good

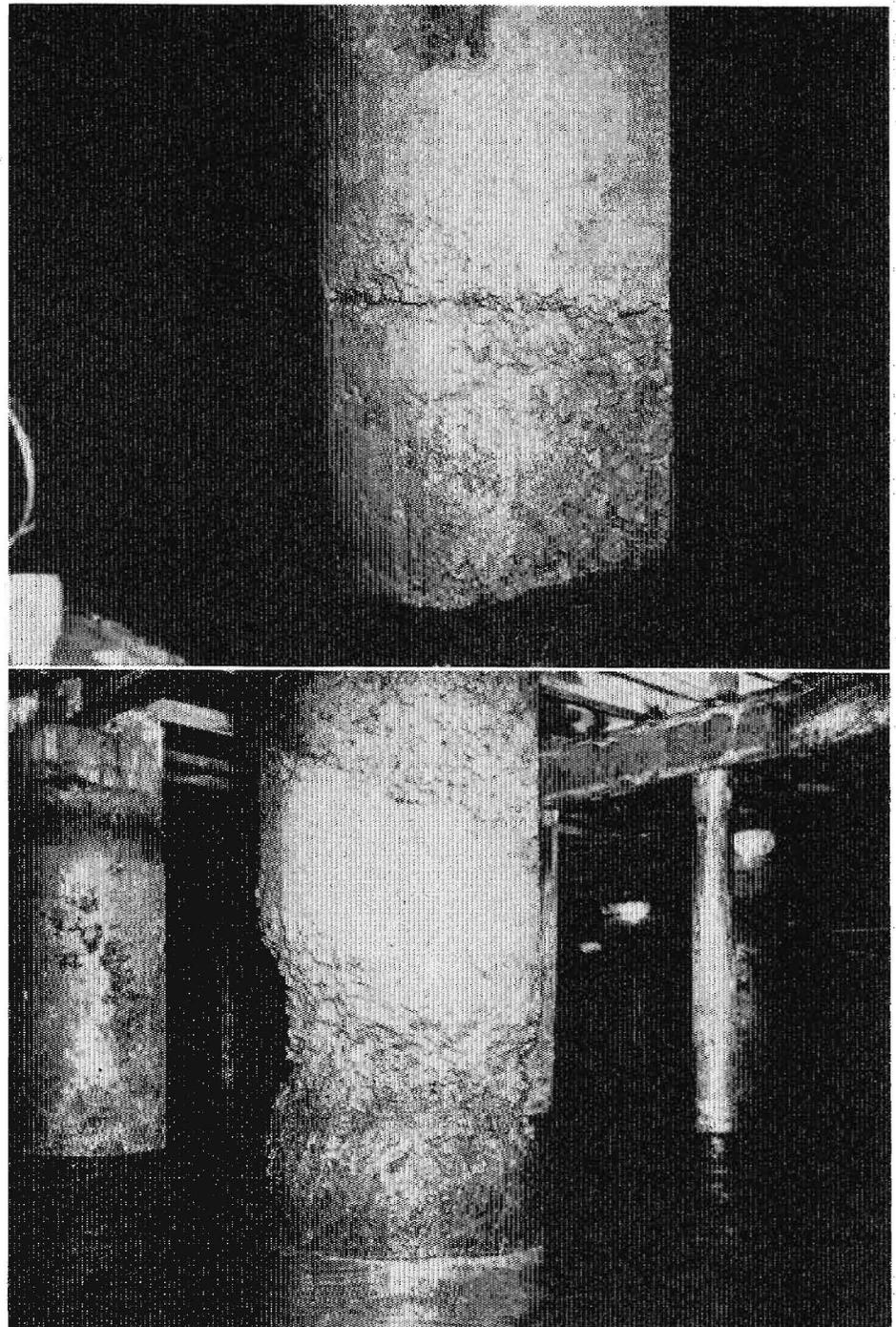


Figure 15. LOWER—Showing condition of 45-year-old concrete cylinders under the North Annex to the Ferry Building, San Francisco. Most, if not all, of the cylinders in this structure have considerable honeycomb. However, the concrete as a whole is in fair condition except in a few cases where considerable disintegration has taken place as shown in upper photo. This disintegration is similar to that observed in specimens exposed to sulphate solutions. The fact, however, that so much of the honeycomb concrete in this structure appears sound except for a slight depth below the surface indicates that the concrete in the portions of the cylinders showing considerable softness and disintegration is below the average through loss or lack of cement or an excess of water during construction. Pictures taken at low tide January 8, 1948

practice to take advantage of their virtues.

The precautions listed above should produce a sound durable concrete, re-

sistant to the more aggressive action of high concentrations of the sulphates in alkali soils as well as to the relatively low sulphate contents of sea water.

Highways

Past History of Road Development and a Vision of What the Future Holds

The following address by Charles M. Upham, Engineer-Director of American Road Builders Association, was given before the Michigan Highway Conference, Grand Rapids, Michigan

DEVELOPMENT in the field of highway construction is one of the wonders of the age. Our vast mileage of good highways and bridges are monuments to the effort, skill and knowledge of engineers, contractors and others who build them. They testify to the progress of the construction industry and profession far more than words of praise.

In discussing present and future highway development, I will go back briefly into the pages of road building history in the United States and touch upon some of the developments which brought about the organized system of construction which has resulted in mass production of highways of greatly improved quality.

The modern era of road building started in 1890. Foreigners coming to this Country in the latter part of the Nineteenth Century always expressed surprise that the United States had the worst roads of any civilized nation.

Pioneer Era

From 1664 to 1890 roads were repaired by compulsory unpaid labor on the statute system developed in Britain in the middle ages, a system that lasted until the advent of the automobile made more skilled road labor necessary. Our eastern system of roads, extensions of cowpaths, lanes and woods roads of pioneer days, had no engineering history. Previous to the French and Indian War, road building as a field for engineering talent did not exist. The war for conquest of the continent and common defense of the colonies roused a feeling of nationality. Certain roads became a military necessity. Axemen felled trees to hew passages for armies. Horses strained to drag ponderous wagons over roots and stumps—through gullies and quagmires.

French traders built portage roads on western frontiers of English colonies. The axe, pick and spade appeared when white men took over the carrying trade from the Indians. Wagons and teams

of horses replaced Indians with canoes, as trails gave way to wagon roads.

Early Contractors

The first boom in road building in America came with the turnpike era. The first of these, the Philadelphia and Lancaster Turnpike was chartered in 1792. It was the first hard road in America constructed on scientific principles. It was 62 miles long, 66 feet wide, covered for a width of some 20 feet with 18 inches of pounded stone, and cost about \$7,000 a mile. Financed by private enterprise, it offered the first real opportunity to contractors. They shortened distances, cut down grades, removed rocks, leveled, gave proper crown to road beds to facilitate drainage, drained by ditches, and erected bridges to replace fords.

Traffic was naturally attracted. From 1803 to 1807, 50 turnpike companies were incorporated in Connecticut alone—67 companies in New York and many in Massachusetts. Early turnpike roads bespeak the efficiency of early highway engineers and contractors.

Contractors and laborers alike hailed with delight the building of the national road by the United States Government under supervision of the War Department. It offered the working class employment worthy of their best labors. The Congress of 1806 authorized employment of a surveyor at \$3 a day with assistants. The first contract was awarded in 1811 and covered a distance of 10 miles. The cost was \$60,-328.25 and with additional allowances for salary of superintendent, mason work and bridges, the cost averaged \$7,500 on the 10 miles.

Efficient Irish Contractor

Efficiency of the contractors working on this road is enthusiastically described by an observer of the day who had watched the work of a contractor named Mordecai Cochran, describing him as, "a great contractor with an immortal Irish brigade a thou-

sand strong. With carts, wheelbarrows, picks, shovels, and blasting tools, they graded the commons, climbed the mountainsides and left behind them a road good enough for an emperor to travel over."

A contract for a bridge on a section of this road near Springfield, Ohio, was let in 1838 at 25 cents a cubic yard for excavation and 25 cents a yard-mile for hauling gravel beyond a one-mile free-haul. The contractor could not sublet any of his work. One clause stated: "The contractor shall not countenance use of ardent spirits by persons in his employ."

No Complex Problems

Contractors of these early days were faced with no complex construction problems as they are today. They built no steel or concrete bridges but used material gathered in the vicinity.

It is interesting to note that at the time the national road was first contemplated in 1802, Thomas Telford, one of the pioneer modern road builders in England, was sent into Scotland to recommend means of developing the country. His recommendation was a system of roads to bring the interior into communication with the coast. Under his direction, roads extending 920 miles and including 1,117 bridges were laid out and built. In 18 years, the system was completed under 120 contracts.

Telford, in describing contractors' responsibilities, rules for road repair and the management of labor said, "All labor by day's wages should be discontinued. Surveyors should make out specifications of work of every kind that is to be done in a given time. This should be left to contractors and the surveyors should take care to see it completed according to specifications before it is paid for. Attention to this rule is most essential, as in many cases, not less than two-thirds of the money usually expended by day labor is wasted."

State Aid Established

The turnpike era was followed by the canal boom of 1810 to 1840 and this gave way to the railroad boom. Little public or private capital was available for repairing public highways, let alone building new ones. The day of the highway was over, people thought. Horsedrawn vehicles could not compete with the locomotive.

But the bicycle with its large influence in establishing state aid for road work came along and then the vehicle that revolutionized transportation, the automobile.

In 1891, the Legislature of New Jersey passed the first state-aid law, assuming a part in the initial cost of construction up to one-third of the whole cost. The era of modern road building had begun.

Roads of 1890

The ideal road of 1890 was water-bound macadam. The rock crusher had been invented in America in 1858, the steam roller in France in 1859. For many years, steam rollers were not in favor because of the high cost and the annoyance of the horsedrawn traffic along the countryside.

In 1894, horsedrawn rollers were recommended as just as good. The whole outfit of a road contractor could be bought for \$2,500 then. Actually up to about 1915, contracting was an era of manual labor and animal power. Highway engineers drew upon the experience of railway builders and adopted methods and equipment suitable for highway work.

Equipment Development

Changes in the design of road-building equipment have taken place so rapidly that their effect has not been given full recognition. Since 1922, and until the Nation's economy was upset by the war, there was a continuous downtrend in the cost of highway construction.

First came the gasoline engine in the early 'twenties to replace horses and mules, causing a pronounced downtrend in unit prices on highway construction from 1922 to 1929. There was little fluctuation in labor rates during the period. The reduction in highway costs was entirely the result of the introduction of gasoline power and the

changes in design made possible by it. The only variable was the efficiency of mechanical equipment.

The downtrend in costs continued with the introduction of the diesel engine, which made possible further changes and, during the following years, changeovers took place which included compressed air and hydraulic controls, the general use of rubber tires where possible, and higher speeds and greater capacity.

Highway Design Improved

During the 18-year period of continuously decreasing highway costs, there was also continuous improvement in highway design. The heavy duty, high speed highway of today is hardly comparable to the highway of 1920. Even had the same highway demand been present at that time, earth moving for the deep cuts and high fills, similar to those now required, would have resulted in costs which would have been prohibitive using the equipment of that period.

Minimum requirements for earth moving are no longer in effect. Modern specifications call for minimum grades and long radius curves. Yet, despite these changes, costs continued downward during the mechanization period between the two wars.

In the years ahead, the importance of continued equipment modernization cannot be overestimated. The country is sorely in need of a huge highway construction program. The greater the reduction in costs, the greater will be the program, and the sooner it will get into full swing. The manufacturers have been successful in the past in reducing highway costs and, with the need more pressing, they can be depended on in the future.

Close cooperation between the manufacturer, the contractor and the engineer will speed up equipment modernization. The engineers are responsible for specifications and standards which the contractors follow in building the highway and for which the manufacturers furnish equipment. It is important at this time that they work together if costs are to come down.

Highway transport is growing tremendously for fundamental reasons. It moves goods from producer to consumer with minimum handling. Dis-

stances traveled steadily increase. Reduced inventories and lower capital outlays have resulted. Truck transportation has revolutionized the Nation's system of distribution.

The vast importance of this growth of highway transport can be suggested by the following facts:

The annual expenditure for highway transportation approximates 18 billion dollars.

Two and a half billions is spent on highway construction and maintenance.

Fifteen and a half billions is spent on motor vehicle operation.

Benefits accruing to the Nation's economy depend on the efficiency of the combination.

Economy in operating cost depends on the extent and condition of the highways.

6,500,000 Trucks

Six and one-half million trucks now operate over highways in the United States. One-third of all these trucks are owned by farmers. They keep flowing a continuous supply of fresh food to the Nation's markets. In fact, more than 25,000 communities have no rail or air facilities. They depend completely on highways for transportation.

Other benefits of major value to national welfare flow from highway transportation. Road transportation, for instance, steadily employs some 5½ million workers. Flexible door-to-door delivery lowers the cost of distribution. Streets and roadways are necessary feeders for both railway and steamship. And there is no substitute for the motor vehicle in fire fighting, city sanitation and mail deliveries; no substitute for adequate highways in mobilization and supply in national defense.

The rapid expansion of highway transportation has created new industries of major proportion . . . rubber, petroleum, motor vehicles, and the many affiliates that furnish materials, accessories and by-products. The construction industry which controls our national economic structure, thus depends upon efficient highways.

Despite high costs, new construction including highways is providing one of the major counter-inflationary forces. New industrial plants are being built for the purpose of increasing production. This expansion provides facilities

for new labor saving processes which will result in more goods at less cost. It is a move toward bringing about the needed balance between goods and demands.

Without adequate highway transportation much of the new investment is wasted. Raw materials cannot be moved economically to the factories, nor can the end product be shipped without incurring high costs. Highway transportation has become an important item in the production line. Increased highway efficiency is a major item in lowering costs and combating inflation.

Mileage

At the present time, there are 614,000 miles of highways eligible for federal aid. This figure includes 232,000 miles primary, 370,000 miles secondary, and 14,000 miles urban. The total is expected to eventually reach 750,000 miles of the most important highways in the Country and will carry 90 percent of the Nation's traffic.

Public Roads Administration has estimated the annual replacement necessary on the existing 614,000 miles at about 40,000 miles annually. This is the mileage which must be built to replace the mileage wearing out from 1947 to 1958. This includes 12,450 miles on the primary federal aid system, 650 miles on the federal aid urban system, and 27,000 miles on the federal aid secondary system.

Since repairs, replacements and new construction has lagged for more than 15 years, it is vitally necessary to step up the highway program to provide the badly needed facilities. Federal aid highway construction reached peak figures in the middle 'thirties. Twenty-one thousand miles were built in 1934 and again in 1937. The average from 1921 to 1941 was 12,500 miles. The average for the war years was 5,500 miles, dropping to a low of 3,000 miles in 1945.

Expanded Program Needed

Prior to the passage of the 1944 Federal Aid Act, however, the expenditure was principally on the original 7 percent system of about 230,000 miles. The annual mileage built was never excessive even during the peak years as proven by the condition of the system today. The mileage has now nearly tripled and is increasing. So a program

estimated at least double that of the prewar years would seem within reason.

State highway construction including federal aid and state work amounted to an annual average of 31,700 miles during the 1923-1941 period. The peak year was 1931 with a total of new construction amounting to 44,600 miles. Mileage under the jurisdiction of the state highway departments increased from 251,000 miles in 1923 to 580,000 miles in 1946.

Despite this increase in mileage and rapid increase in vehicle use, the highway construction program did not increase. Mileage built during the years immediately preceding the war, 1936 to 1942, averaged 33,000 miles annually by the state highway departments. This was about one-half the needed construction. The situation was further aggravated by a drop to 15,000 miles annually for the years 1943-44-45 and 1946.

Increasing Traffic

Traffic volume is increasing rapidly, borne out by the fact that 1947 set an all-time record for vehicle registrations and mileage for the Nation. This is happening after a long lag in highway construction. As a result of these conditions, the Nation is now faced with a situation which threatens to cripple its principal asset, its highway transportation system.

Vehicle mileage amounted to 334,000,000,000 in 1941. In 1946 this total was 340,655,000,000 and in 1947 climbed to 370,000,000,000 car miles.

Vehicle registrations totaled 34,472,000 in 1941, 33,945,000 in 1946, but jumped to 37,164,000 in 1947. Trucks increased from 4,869,000 in 1941 to 6,500,000 in 1947.

In 1941 there were 4,841,000 vehicles produced, and 4,744,000 in 1947. Estimate for 1948 is 5,500,000.

The highway building program ending in 1930 came nearer to providing the highways needed for the period than at any time since. Since that time, deterioration and obsolescence due to lack of new construction and replacements have resulted in congestion, mounting traffic deaths and excessive maintenance costs.

The primary highway system is suffering from old age. Much of it was built in the days of low vehicle speed

and traffic volume. Hence, there are many hazards which should be removed by building new highways according to modern design standards. Lack of width on thousands of miles of the system has become a serious factor, from the standpoint of both safety and maintenance costs. In too many instances two-lane highways are carrying four-lane traffic.

The war caused an uptrend in the use of truck transportation. In 1936, 28,000,000,000 ton-miles were trucked over the Nation's main rural highways. In 1946, this figure had increased to 73,000,000,000 ton-miles and in 1947 to 86,000,000,000 ton-miles. During the war years when the railroads were loaded to capacity, shippers turned to the highways for transportation. Due to the efficiency and economy of this form of transportation, when the emergency ended, shippers kept on using trucks. This trend is sure to continue and increases the need for more heavy duty highways.

Continually shifting personnel is detrimental to good engineering organization. While political changeovers are responsible for this in some states, in most instances the salary scale is so low that graduate engineers are not attracted and if they do take positions, they shift to other industries where the pay is higher at the first opportunity.

Recent figures on engineering personnel in 48 state highway departments list unfilled positions at approximately 10,000. To improve this situation, salary increases are recommended in three-quarters of the states. There is no economy in undermanned and underpaid engineering staffs. Dissatisfaction and inefficiency result. The contractor suffers as the result of inadequate engineering supervision and the public does not get its money's worth.

This salary situation is now becoming a serious obstacle to the carrying out of a highway program which is steadily increasing and which will ultimately become the greatest in history. Its success will depend on the adequacy of its engineering personnel. Unless steps are taken to attract new engineers into this field, and hold the present ones, the program will not only be retarded, but the normal improvement in technical development will be restricted,

with the resultant loss in value of the finished product and loss to those who furnish highway funds—the taxpayer. Highway transport in the United States or any country can only be as efficient as the engineers who are responsible for its design. These engineers will be in charge of the expenditure of millions of dollars, and many times an engineer is in the position of saving thousands of dollars for the department or losing or wasting many times the salaries of all the engineers put together. The employment of high grade engineers results in lower construction costs.

Future Highway Program

The postwar demand for highway construction continues to increase as automobile registrations reach new peaks, along with car mileage gasoline consumption and truck tonnage.

To meet the demand the highway program has steadily increased since the war but has not yet reached a level adequate to provide for either the needed replacement or for new construction. The total highway construction expenditure for 1947 of \$1,200,000,000 was about \$500,000,000 above the 1946 figure and is estimated at \$1,500,000,000 for 1948.

From a recent survey of state highway programs, the highway construction estimated on state and federal work in 45 state highway departments for 1948 was \$1,090,000,000 as compared to \$830,000,000 in 1947. Both of these figures are considerably above those of the prewar years but due to the high costs the volume of work is below that of the peak prewar years. State highway maintenance approximated \$341,000,000 in 1947 and is estimated at \$366,000,000 in 1948.

Mileage to be let to contract in 1948 is estimated at 24,500 miles, and with work carried over from 1947 will total 40,688 miles. Of this total, 3,397 miles will be Portland cement concrete pavement, 22,275 miles will be bituminous mixes and treated types and 15,017 miles will be of other types. This is state and federal aid mileage.

To give you an idea of the highway program needed to bring the system to adequate standards, a recent survey by the American Association of State Highway Officials placed the needs on the 600,000 mile federal aid system at

\$22,000,000,000. If needs of this system were taken into account the total would be much greater. To carry out a \$22,000,000,000 program on a 10-year plan an expenditure of more than \$2,000,000,000 a year would be necessary on the federal aid system alone and this is \$500,000,000 more than has ever been spent in one year on the Nation's entire highway system. The question arises, how fast can the needed highways be built?

Maintenance Costs

Maintenance figures for 1947 for state highways approximated \$355,000,000. The state highway maintenance for 1940 was \$201,000,000, hence there was a 75 percent increase in maintenance costs in 1947 over 1940. Total highway maintenance at all government levels for 1947 was well over a billion dollars, which almost equalled the total construction expenditure. In a study by the American Road Builders' Association, more than one-half the states made the statement that lack of construction has resulted in excessive maintenance costs. In this respect, the lapse in highway construction has been expensive. Maintenance dollars tend to keep the highway in its original condition and do not come under the category of improvement. Unless a constant program of new construction is carried on, maintenance costs tend to rise to exorbitant proportions, the amount of excess cost depending on age and obsolescence. This puts the Country in the uneconomic position of spending extravagant maintenance dollars instead of high powered competitive construction dollars which have such a great and beneficial effect on the national economy.

Montecito Freeway Completed

Continued from page 11 . . .

ing and coordination of the various construction operations the project was completed under restrictions imposed by the heavy volume of traffic without material inconvenience to traffic.

Construction of the outer highways to complete this section of freeway is scheduled within the next few months. These outer highways will be separated from the inner highway by landscaped division strips to prevent access to it except at the main cross roads. A short

Average Gross Weight Of Trucks Dropped In Year 1947

THE AVERAGE gross weight of trucks using state highways as determined from 20 loadometer weighing stations was 6.6 percent less in 1947 than in 1946, according to State Highway Engineer George T. McCoy.

From 1946 to 1947 the increase in the frequency of axle loads over 22,000 pounds was 166.7 percent. The frequency of axle loads over 20,000 pounds was increased 64.2 percent while the frequency of axle loads over 18,000 pounds increased 10.8 percent.

Compared with the 1936-1937 period, the 1947 increases were 685 percent for axle loading of 20,000 pounds or more and 234 percent for loadings of 18,000 pounds or more.

The axle frequencies per 1,000 trucks and combinations in 1947 were: four axle loads of 22,000 pounds or more, 11 axle loads of 20,000 pounds or more, and 42 axle loads of 18,000 pounds or more. The maximum axle weighed was under 30,000 pounds.

The average weight of trucks, loaded or empty, during 1947 and 1946 and the percent change were:

	1947	1946	Percent change
Single unit trucks	10,014	10,328	-3.0
Tractors and semitrailers....	39,356	36,612	+7.5
Trucks with trailers	43,340	45,973	-5.7
All types	18,692	20,002	-6.6

section of the outer highway was constructed as a part of this contract along the southerly side between Hixon Road and Miramar Avenue because it was advantageous to do so in order to eliminate access to the inner highway.

The contract, amounting to \$355,000 was performed by N. M. Ball Sons, Berkeley. The work was done under the general direction of District Engineer L. H. Gibson and District Construction Engineer J. P. Murphy. The Resident Engineer was Mr. J. C. Adams.

Bids and Awards

Contracts Awarded for March and April, 1948

March, 1948—Continued

MADERA COUNTY—An underpass to be constructed under the tracks of the Atchison, Topeka and Santa Fe Railway Company, about 1.5 miles east of Madera and about 0.6 mile to be graded and paved. District VI, Route 126, Section B. Dan Caputo & Ed Keeble, San Jose, \$134,286; Chittenden & Chittenden, Auburn, \$138,992; Fredrickson & Watson Construction Co., Oakland, \$151,737; Charles MacClosky Co., San Francisco, \$152,871; Taylor-Wheeler Commercial, Inc., Fresno, \$157,381. Contract awarded to Trehwhitt Shields & Fisher, Fresno, \$129,160.

SAN BERNARDINO COUNTY—On East Fifth Street between Waterman Avenue and 0.2 mile east of City Creek, about 4.5 miles to be graded, imported borrow to be placed and surfaced with plant-mixed surfacing and a steel bridge to be constructed. District VIII, FAS 711. Match Bros., Colton, \$235,653; Griffith Co., Los Angeles, \$236,274; T. M. Page, Monrovia, \$242,810; Peter Kiewit Sons Co., Arcadia, \$243,587; George Herz & Co., San Bernardino, \$252,014; Wm. Radkovich Co. Inc., Los Angeles, \$265,667; J. E. Haddock Ltd., Pasadena, \$265,735; Clyde W. Wood, Inc., North Hollywood, \$271,692; Norman I. Fadel, North Hollywood, \$290,620. Contract awarded to E. L. Yeager, Riverside, \$222,371.45.

April, 1948

ALAMEDA COUNTY—On East Shore Freeway in the City of Oakland, across Elmhurst Creek, Damon Slough and East Creek Slough, three reinforced concrete slab bridges to be constructed. District IV, Route 69. Stolte Inc. & The Duncanson-Harrelson Co., Oakland, \$251,618; Charles MacClosky Co., San Francisco, \$256,778; Erickson Phillips & Weisberg, Oakland, \$257,172; Ben C. Gerwick, Inc., San Francisco, \$262,096; Fredrickson & Watson Construction Co., Oakland, \$263,754; Guy F. Atkinson Co., South San Francisco, \$265,290; Dan Caputo, San Jose, \$270,717; Healy Tibbitts Construction Co., San Francisco, \$279,537; Johnson Western Co., Alameda, \$285,419. Contract awarded to E. H. Peterson & Son, Richmond, \$248,249.40.

ALAMEDA COUNTY—On East Short Freeway between 38th Avenue and Oak Street in Oakland, about 2.9 miles to be graded and paved with Portland cement concrete on crusher run base. District IV, Route 69. Stolte Inc. & The Duncanson-Harrelson Co., Oakland, \$1,412,218; Guy F. Atkinson Co., South San Francisco, \$1,440,264; Chas. L. Harney, Inc., San Francisco, \$1,485,484. Contract awarded to Fredrickson & Watson Construction Co., Oakland, \$1,373,333.

BUTTE COUNTY—Between Nelson and Butte Creek, between Seventh Avenue in Chico and Pine Creek and in Chico between Hazel Street and Main Street, about 15.6 miles to be surfaced with plant-mixed surfacing and shoulders to be constructed of imported borrow and penetration treatment applied thereto. District III, Routes 3, 47. A. Teichert & Son, Inc., Sacramento, \$168,990; Sheldon Oil Co., Suisun, \$170,096; Rice Bros., Inc., Marysville, \$173,380; Fredrickson & Watson Construction Co., Oakland, \$182,707; Clements & Co., Hayward, \$186,652; A. R. McEwen & E. A. Forde, San Anselmo, \$187,331; Leo F. Piazza, San Jose, \$194,120; Harms Bros., Sacramento, \$196,635; W. C. Railing, Redwood City, \$213,165; Louis Biasotti & Son, Stockton, \$215,325; M. J. Ruddy & Son, Modesto, \$216,616. Contract awarded to McGillivray Construction Co., Sacramento, \$159,337.

GLENN COUNTY—At Campbell Slough and Sacramento River Overflow, about four miles east of Butte City, two bridges to be redecked with reinforced concrete slabs and detours about 0.5 mile to be graded, surfaced with gravel base, and penetration treatment applied. District III, Route 45, Section C. Chittenden & Chittenden, Auburn, \$72,710; Evans Construction Co., Berkeley, \$74,782; Baldwin, Straub Corp., San Rafael, \$75,388; Dan Caputo, San Jose, \$76,170; O'Connor Bros., Red Bluff, \$76,940; H. F.

Lauritzen, Pittsburg, \$79,393; Klay-Bennett Construction Co., Palo Alto, \$80,390; A. L. Miller, Sacramento, \$85,705; Bos Construction Co., Oakland, \$87,893; Wheeler Construction Co., Oakland, \$90,173; Trehwhitt, Shields & Fisher, Fresno, \$102,642. Contract awarded to Charles MacClosky Company, San Francisco, \$72,540.

HUMBOLDT COUNTY—Between 2.8 miles and 7.6 miles north of Orick, about 4.8 miles to be surfaced with plant-mixed surfacing on cement treated base. District I, Route 1, Section K. Sheldon Oil Co., Suisun, \$181,518; W. C. Railing, Redwood City, \$195,387; Clements & Co., Hayward, \$196,820; C. M. Syar, Vallejo, \$217,300. Contract awarded to Mercer, Fraser Co., Eureka, \$169,819.

IMPERIAL COUNTY—Between Junction Route 26 east of the Hebel and Calipatria and between Curlew and Alamorio, about 6.6 miles to be improved with imported base material and roadmixed surfacing. District XI, Route 201, 187, Sections A, B, C, C. Warren Southwest Inc., Los Angeles, \$83,715; Oilfields Trucking Co. & Phoenix Construction Co., Bakersfield, \$99,635. Contract awarded to McArthur & Son, Palmdale, \$78,685.

KERN COUNTY—Between Grapevine and Switzer's and on Taft Highway between mile 6.74 and Route 4, about 29.8 miles to be resurfaced with plant-mixed surfacing and culverts to be installed on Location B. District VI, Routes 4, 140, Sections B, C, B. Peter Kiewit Sons' Co., Arcadia, \$406,511; Griffith Company, Los Angeles, \$416,436; R. M. Price and Rex B. Sawyer, Altadena, \$430,872; J. E. Haddock, Ltd., Pasadena, \$433,650; Oilfields Trucking Co. & Phoenix Construction Co., Bakersfield, \$460,447; Gibbons & Reed Co., Salt Lake City, Utah, \$469,947; A. Teichert & Son, Inc., Sacramento, \$488,465; Brown & Doko, Pismo Beach, \$506,917. Contract awarded to Dico Inc. & Dix Styl Construction Co. Inc., Bakersfield, \$389,245.63.

LASSEN COUNTY—Between Fredonyer Pass and Susan River, about 6.3 miles plant-mixed surfacing and seal coat to be placed over existing pavement on portions of the project and on crusher run base on other portions of the project. District II, Route 29, Section B. Clemens & Company, Hayward, \$93,907; Fredrickson & Watson Construction Co., Oakland, \$110,953. Contract awarded to Sheldon Oil Co., Suisun, \$78,156.25.

LOS ANGELES COUNTY—Between Route 79 and one-half mile south of Santa Clara River about 4.0 miles to be resurfaced with plant-mixed surfacing and imported borrow to be placed on the shoulders and bituminous surface treatment applied thereto. District VII, Route 23, Section I. P. J. Akmadzich, Sunland, \$80,590; Griffith Co., Los Angeles, \$80,760; Clyde W. Wood, Inc., North Hollywood, \$83,828; Smith-Edmondson, Glendale, \$88,670; Clifford C. Bong & Co., Arcadia, \$95,422. Contract awarded to Schroeder & Co., Roscoe, \$79,287.50.

LOS ANGELES COUNTY—Between Saugus and Route 4, about 2.3 miles to be resurfaced with plant-mixed surfacing and imported borrow to be placed on the shoulders and bituminous surface treatment applied thereto. District VII, Route 79, Section B. Clyde W. Wood, Inc., North Hollywood, \$32,295; Baker & Pollock, Ventura, \$34,786; Hensler Corp., Glendale, \$37,812; Griffith Co., Los Angeles, \$39,600. Contract awarded to Smith Edmondson Co., Glendale, \$31,978.50.

LOS ANGELES COUNTY—About one half mile west of Saugus, existing steel bridge across South Fork Santa Clara River to be cleaned and painted. District VII, Route 79, Section B. Re Hue Co., San Fernando, \$1,090; Acme Maintenance & Engineering Co., Bell, \$1,179; J. W. Luten, Maywood, \$1,760; Williams & Kelly, Los Angeles, \$1,797; Action Painting Service, Inc., Maywood, \$1,840; Timmons Painting & Engineering Co., Long Beach, \$2,091; Abbott Painting Co., Los Angeles, \$2,468; Beardsley Painting Co., Los Angeles, \$2,839. Contract awarded to Foster & Kleiser Co., Los Angeles, \$971.20.

LOS ANGELES COUNTY—On Centralia Avenue and Pioneer Boulevard, between Norwalk Boulevard and Orangethorpe Avenue, about 1.9 miles to be resurfaced with plant-mixed surfacing and imported borrow to be placed on shoulders and bituminous surface treatment applied. District VII, Route 170, Section A. Cox Bros. Construction Co., Stanton, \$35,106; O'Brien & Bell Construction Co., Santa Ana, \$35,849; Griffith Co., Los Angeles, \$36,110; Jesse S. Smith & A. A. Edmondson, Glendale, \$36,167; Clifford C. Bong & Co., Arcadia, \$36,349; Warren Southwest Inc., Los Angeles, \$38,651; C. O. Sparks Inc. & Mundo Engineering Co., Los Angeles, \$38,778; W. E. Hall Co., Alhambra, \$39,469. Contract awarded to Sully-Miller Contracting Co., Long Beach, \$34,323.70.

LOS ANGELES COUNTY—Across North Fork San Gabriel River, about 15 miles north of Azusa, a structural steel deck truss bridge to be constructed. District VII, FAS 825. C. B. Tuttle Co., Long Beach, \$383,876; Haddock Co., Pasadena, \$387,067; MacDonald & Kruse and Hensler Construction Corp., Glendale, \$399,372; Bates & Rogers Construction Corp., San Francisco, \$405,078; Peter Kiewit Sons Co., Arcadia, \$416,800; W. J. Disteli, Los Angeles, \$420,162; United Concrete Pipe Corp., and Ralph A. Bell, Baldwin Park, \$423,679; Dimmitt & Taylor and K. B. Nicholas, Monrovia, \$442,378; Guy F. Atkinson, Long Beach, \$448,580; The Contracting Engineers Co., Los Angeles, \$469,450; Byerts & Dunn, Los Angeles, \$469,945; Chas. MacClosky Co., San Francisco, \$533,691. Contract awarded to Norman I. Fadel, North Hollywood, \$377,615.90.

MENDOCINO COUNTY—Between 28 miles south and one mile north of Rattlesnake Summit, about 3.8 miles to be surfaced with plant-mixed surfacing on cement treated base. District I, Route 1, Sections H, I. Sheldon Oil Co., Suisun, \$116,988; Oilfields Trucking Co., Bakersfield, \$129,460; Clements & Co., Hayward, \$138,185. Contract awarded to C. M. Syar, Vallejo, \$110,790.50.

MARIN COUNTY—Repairing a portion of a bridge across Richardson Bay, about five miles north of the Golden Gate Bridge. District IV, Route 1, Section C. E. Bay Cable & Regional Steel Works, Berkeley, \$3,628; Bos Construction Co., Oakland, \$3,760; Evans Construction Co., Berkeley, \$4,491; J. H. Pomeroy & Co., San Francisco, \$9,852. Contract awarded to Joe Gerrick & Co., San Francisco, \$3,262.

MERCED AND STANISLAUS COUNTIES—Between Madera County Line and Salida, furnishing and installing concrete barrier posts and metal plate guard railing at various locations. District X, Route 4, Sections A, C, A, B. Evans Construction Co., Berkeley, \$53,836; J. R. Armstrong, El Cerrito, \$55,728; Harms Bros., Sacramento, \$56,685; Grant L. Miner, Palo Alto, \$57,475; Matthew & Jorgenson, Hughson, \$57,691; Dan Caputo, San Jose, \$58,566; E. G. Perham, Los Angeles, \$62,132; George Pollock Co., Sacramento, \$62,742; Underground Construction Co., Oakland, \$64,005; Thomas Construction Co., Santa Barbara, \$64,594. Contract awarded to Louis Biasotti & Son, Stockton, \$50,068.92.

ORANGE COUNTY—Between Los Patos Avenue and 1.3 miles southerly, about 1.3 miles to be resurfaced with plant-mixed surfacing on imported borrow. District VII, Route 60, Section A. John J. Swigart Co., Torrance, \$65,857; Baker & Pollock, Ventura, \$66,615; Cox Bros. Construction Co., Stanton, \$66,703; Griffith Co., Los Angeles, \$67,284; Jesse S. Smith, Glendale, \$67,670; Sully-Miller Contracting Co., Long Beach, \$67,881. Contract awarded to O'Brien & Bell Construction Co., Santa Ana, \$65,062.20.

ORANGE COUNTY—On Harbor Boulevard at Newport Avenue, Bolsa Avenue, and Garden Grove Boulevard, furnish and install full traffic actuated signal systems and highway lighting. District VII, Routes 43, 183, 179, Sections A, A, A, C, D. Draucker, Inc., Los Angeles, \$33,220. Contract awarded to Tri-Cities Electrical Service, Oceanside, \$29,310.

PLACER COUNTY—Between Nevada Street and one-half mile east of Auburn, about 1.8 miles to be fenced and a parking lane to be constructed. District III, Route 37, Section Aub, A. Chittenden & Chittenden, Auburn, \$14,232; Joe Chevreux, Auburn, \$14,998; Alcorn Fence Co., Los Angeles, \$15,933. Contract awarded to Fredrickson & Watson Construction Co., Oakland, \$12,884.05.

RIVERSIDE COUNTY—Between Edom and 2.9 miles north of Indio, about 7.4 miles to be improved by placing road-mixed surfacing over the existing surfacing. District XI, Route 26, Section E. Dimmitt & Taylor, Monrovia, \$81,335; Matich Bros., Colton, \$86,140; Hensler Construction Corp., Glendale, \$87,983; Arthur A. Johnson, Laguna Beach, \$90,325; Cox Bros. Construction Co., Stanton, \$99,878; Oilfields Trucking Co. & Phoenix Construction Co., Bakersfield, \$108,070; E. L. Yeager, Rixerside, \$128,992. Contract awarded to R. P. Shea Co., Indio, \$80,500.

SAN BENITO & SANTA CRUZ COUNTIES—About 11 miles east of Watsonville at Pajaro River, a structural steel girder bridge to be constructed and about 0.9 mile of approaches to be graded and surfaced with plant-mixed surfacing on crusher run base. District V, Route 67, Sections A, A. Earl W. Heple, San Jose, \$194,699; Granite Construction Co., Watsonville, \$198,415; Charles MacClosky Company, San Francisco, \$201,810; Fredrickson & Watson Construction Co., Oakland, \$206,059. Contract awarded to Dan Caputo and Edward Keeble, San Jose, \$186,604.50.

SAN BERNARDINO COUNTY—Across Tevitt Ditch, about 28 miles east of Amboy, a reinforced concrete slab bridge to be constructed. District VIII, Route 58, Section L. N. M. Saliba Co., Los Angeles, \$18,985; T. A. Kvale, Ojai, \$23,200; E. L. Thorsten, Santa Monica, \$23,319; R. A. Erwin, Colton, \$26,245; H. C. Johnson, Long Beach, \$26,418. Contract awarded to L. V. Mulherron, San Fernando, \$16,968.

SAN BERNARDINO COUNTY—In the city of Upland at intersection of Foothill Boulevard and Euclid Avenue, existing pavement to be widened with plant-mixed surfacing, curbs and traffic islands to be constructed and full traffic actuated signal system and highway lighting to be furnished and installed. District VIII, Routes 9, 192. C. D. Draucker, Inc., Los Angeles, \$20,078; R. E. Ziebarth, Torrance, \$20,811; Paul Gardner, Ontario, \$20,965. Contract awarded to Tri-Cities Electrical Service, Oceanside, \$19,511.

SAN BERNARDINO COUNTY—Between 0.7 mile east of Plunge Creek and Long Point, about 1.8 miles to be graded and surfaced with plant-mixed surfacing. District VIII, Route 207, Section A. Westbrook & Pope, Highland, \$744,032; Ralph A. Bell & A. F. Heinze, Monrovia, \$765,956; Clyde W. Wood, Inc., North Hollywood, \$795,660; Dimmitt & Taylor & T. M. Page, Monrovia, \$798,918. Contract awarded to Claude Fisher Co. Ltd. & L. R. & R. S. Crow, Los Angeles, \$703,144.

SAN DIEGO COUNTY—Across Santa Margarita River, about 4.5 miles north of Oceanside, the existing steel bridge to be cleaned and painted. District XI, Route 2, Section C. Fred T. Judd Co., Berkeley, \$19,982; H. W. Kirch & Co., South Pasadena, \$22,540; Timmons Painting & Engineering Co., Long Beach, \$23,995; Williams & Kelly, Los Angeles, \$27,760; Foster & Kleiser Co., San Francisco, \$32,635; Acme Maintenance Engineering Co., Bell, \$38,990; Action Painting Service, Inc., Maywood, \$39,500; Abbott Painting Co., Los Angeles, \$42,304; West Coast Waterproofing & Painting Co., Los Angeles, \$49,500. Contract awarded to Pacific Bridge Painting Co., San Francisco, \$19,635.

SAN JOAQUIN COUNTY—Furnishing and installing traffic signals in the City of Tracy on 11th Street between East Street and Roosevelt Avenue. District X, Route 5. H. S. Tittle Co., San Francisco, \$12,686; L. H. Leonard Electric Construction Co., San Rafael, \$15,750. Contract awarded to Parker Electric, Tracy, \$12,108.

SAN LUIS OBISPO COUNTY—At the intersection of Marsh and Higuera Streets in San Luis Obispo, furnish and install full traffic actuated signal system and highway lighting. District V, Route 2, Coast Operators, Inc., San Luis Obispo, \$15,900. Contract awarded to L. H. Leonard Electric Construction Co., San Rafael, \$14,755.

SAN LUIS OBISPO COUNTY—Between Deleisigues Creek and Russel Turn, about 2.3 miles to be surfaced with plant-mixed surfacing on crusher run

base. District V, Route 2, Section F. Brown and Duko, Pismo Beach, \$126,802; Baker and Pollock, Ventura, \$131,552. Contract awarded to Madonna Construction Co., San Luis Obispo, \$125,191.

SAN DIEGO COUNTY—At Balboa Avenue and Pacific Highway, traffic signal system and highway lighting. District XI, Route 2. Ets-Hokin & Galvan, San Diego, \$11,578; Tri-Cities Electric Service, Oceanside, \$11,840. Contract awarded to California Electric Works, San Diego, \$10,777.

SANTA BARBARA COUNTY—Between Santa Ynez River and Jonata Park, about 3.6 miles to be graded and surfaced with plant-mixed surfacing on crusher run base. District V, Route 2, Section D. Clyde W. Wood, Inc., North Hollywood, \$546,237; Peter Kiewit Sons' Co., Arcadia, \$553,781; N. M. Ball Sons, Berkeley, \$581,126; Griffith Company, Los Angeles, \$601,889; Granite Construction Co., Watsonville, \$641,298; Brown & Doko, Pismo Beach, \$714,857. Contract awarded to Dimmitt & Taylor and T. M. Page, Monrovia, \$497,287.

SANTA CRUZ COUNTY—Between Rob Roy Junction and Morrissey Avenue in Santa Cruz about 7.7 miles to be graded and surfaced with plant-mixed surfacing on crusher run base. District IV, Route 56, Sections D, E, SCR. Fredrickson & Watson Construction Co., \$1,269,817; Leo F. Piazza & H. E. Parker Inc., San Jose, \$1,273,699; Granite Construction Co., Watsonville, \$1,317,451; Earl W. Heple, San Jose, \$1,348,618; Chas. L. Harney, Inc., San Francisco, \$1,355,300; Dimmitt & Taylor & T. M. Page, Monrovia, \$1,379,918; Guy F. Atkinson Co., South San Francisco, \$1,396,376; Morrison-Knudsen Co., Inc., San Francisco, \$1,396,948; Claude Fisher Co., Ltd. & L. A. & R. S. Crow, Los Angeles, \$1,425,474; Clyde W. Wood, Inc., North Hollywood, \$1,474,061; A. Teichert & Son, Inc., Sacramento, \$1,429,424. Contract awarded to N. M. Ball Sons, Berkeley, \$1,192,329.50.

STANISLAUS COUNTY—Between Newman and San Joaquin County line, about 6.2 miles untreated rock base to be placed over existing pavement and surfaced with plant-mixed surfacing. District X, Route 41, Sections A, B. Frank B. Marks & Sons, Tracy, \$136,795; Louis Biasotti & Son, Stockton, \$141,950; J. R. Armstrong, El Cerrito, \$178,290; Granite Construction Co., Watsonville, \$182,186. Contract awarded to M. J. Ruddy & Son, Modesto, \$136,475.

SUTTER AND BUTTE COUNTIES—Between Lomo and Fagan and in and adjacent to Gridley, about 7.1 miles, to be surfaced with plant-mixed surfacing and imported borrow to be placed on shoulders. District III, Route 3, Section A, LIO, A, Grd. Rice Brothers, Inc., Marysville, \$92,291; Clements & Co., Hayward, \$94,640; Sheldon Oil Co., Suisun, \$99,721. Contract awarded to McGillivray Construction Co., Sacramento, \$89,242.50.

VENTURA COUNTY—At junction of Routes 2 and 60 near El Rio, furnishing and installing full traffic actuated signal system and highway lighting system. District VII, Routes 2 and 60, Sections C, B. L. H. Leonard Electric Construction Co., San Rafael, \$23,441; Underground Construction Co., Oakland, \$39,554. Contract awarded to Tri-Cities Electric Service, Oceanside, \$20,352.

YOLO COUNTY—Between Putah Creek and Zamoza, and between Woodland and Knights Landing, about 24.6 miles, borders to be repaired and a portion of existing pavement to be resurfaced. District III, Routes 7 and 87, Sections AB, Wd, A. Warren & Drayer, Alameda, \$57,074. Contract awarded to Munn & Perkins, Modesto, \$46,353.

ALAMEDA COUNTY—At Redwood Road about one mile east of Hayward, about 0.3 mile, existing pavement to be widened to provide channelization of intersection and traffic signal system to be furnished and installed. District IV, Route 5, Section B. Gallagher & Burk, Inc., Oakland, \$39,754; Independent Construction Co., Ltd., Oakland, \$44,777; Jensen & Pitts, San Rafael, \$45,225; J. Henry Harris, Berkeley, \$53,676. Contract awarded to J. R. Armstrong, El Cerrito, \$36,969.53.

CALAVERAS COUNTY—Between 2.6 miles east of Valley Springs and 4.9 miles east, a net distance of about 4.2 miles, untreated rock base and plant-mixed surfacing to be placed over the existing roadbed. District X, Route 24, Section B. C. M. Syar, Vallejo, \$99,999; Frank B. Marks & Sons, Tracy, \$109,265; Claude C. Wood Co., Lodi, \$111,645; Harms Bros., Sacramento, \$117,380. Contract

awarded to A. Teichert & Son, Inc., Sacramento, \$98,577.50.

FRESNO COUNTY—Between Belmont Circle and Clinton Avenue, about 1.8 miles of existing pavement to be widened by grading and paving with plant-mixed surfacing over cement treated base. District VI, Route 4, Section Fre, C. Geo. E. France, Inc., Visalia, \$252,227; R. M. Price Co. & Rex B. Sawyer, Altadena, \$271,291. Contract awarded to Guy F. Atkinson Co., South San Francisco, \$239,484.50.

HUMBOLDT COUNTY—Between North Scotia Bridge and Sixteenth Street in Fortuna, portions, about 2.8 miles in length, to be graded and surfaced with Portland cement concrete pavement and plant-mixed surfacing. District I, Route 1, Sections E, F, Fta. Piomba Construction Co. & Clements & Company & Underground Construction Co., San Francisco, \$683,540. Contract awarded to Mercer Frasier Company, Eureka, \$521,980.

KERN COUNTY—Between Cawelo and Famoso Underpass, furnishing and installing concrete barrier posts at various locations. District VI, Route 4, Section E. C. J. B. Construction Co., Oxnard, \$20,952; Taylor-Wheeler Commercial, Inc., Fresno, \$21,060; Harms Brothers, Sacramento, \$21,060; Clyde W. Wood, Inc., North Hollywood, \$21,330; Evans Construction Co., Berkeley, \$21,600; N. M. Saliba Company, Los Angeles, \$22,140; George von KleinSmid, Bakersfield, \$22,680; Louis Biasotti & Son, Stockton, \$23,706; Matthew & Jorgenson, Hughson, \$24,030; Griffith Co., Los Angeles, \$27,000; Dicco, Inc., & Dix-Syl Construction Co., Inc., Bakersfield, \$27,810; Charles T. Brown Co., San Fernando, \$46,440. Contract awarded to E. G. Perham, Los Angeles, \$20,466.

KERN COUNTY—One-half mile east of Monolith, about 0.2 mile to be graded and surfaced with bituminous surface treatment and plant-mixed surfacing. District VI, Route 58, Section G. George E. France, Inc., Visalia, \$13,527; Griffith Co., Los Angeles, \$13,714; Anderson Co., Visalia, \$13,992; Dicco, Inc., & Dix-Syl Construction Co., Bakersfield, \$15,731. Contract awarded to Oilfields Trucking Co. and Phoenix Construction Co., Bakersfield, \$12,683.

LAKE COUNTY—Reconstruction of a bridge across Burns Valley Creek, about 28 miles north of Napa County line. District I, Route 49, Section C. O'Connor Bros., Red Bluff, \$5,355; James H. McFarland, San Francisco, \$5,859. Contract awarded to C. C. Gildersleeve, Nevada City, \$4,774.63.

LOS ANGELES COUNTY—On Hollywood Park way, at Vendome Street and at Coronado Street, in the City of Los Angeles, two reinforced concrete undercrossings to be constructed. District VII, Route 2. Spencer Webb Co., Inglewood, \$354,762; Griffith Co., Los Angeles, \$361,515; Haddock Co., Pasadena, \$365,532; Guy F. Atkinson Co., Long Beach, \$368,350; Oberg Bros., Inglewood, \$374,661; W. J. Disteli, Los Angeles, \$380,141; Bates & Rogers Const. Co., San Francisco, \$390,331; Byerts & Dunn, Los Angeles, \$392,125. Contract awarded to Chas. MacClosky Co., San Francisco, \$332,786.70.

LOS ANGELES COUNTY—On Boston Street between East Edgeware Road and 271 feet easterly, about 0.05 mile to be graded and Portland cement concrete pavement, curbs and gutters to be constructed. District VII, Route 2. Jas. R. Mathews Excavating Co., Alhambra, \$16,944; Vido S. Price & Glenn Graham, Los Angeles, \$16,974. Contract awarded to McClain Construction Co., Los Angeles, \$15,195.

LOS ANGELES COUNTY—On Garvey Avenue, between New Avenue and Mountain View Avenue, about 3.9 miles, shoulders to be graded and surfaced with plant-mixed surfacing on untreated rock base. District VII, Route 26, Section A, E. Mte. Smith-Edmondson Co., Glendale, \$115,923; J. E. Haddock, Ltd., Pasadena, \$119,892; Griffith Co., Los Angeles, \$123,866; Vido Kovacevich Co., South Gate, \$124,984; C. R. Butterfield Co., San Pedro, \$143,775; C. O. Sparks, Inc., & Mundo Engineering Co., Los Angeles, \$146,595; W. E. Hall Co., Alhambra, \$159,435; Silva & Hill Construction Co., Los Angeles, \$159,551. Contract awarded to Wm. Radkovich Co., Inc., Los Angeles, \$112,993.50.

LOS ANGELES COUNTY—Between Lancaster and Kern County line, about 8.1 miles to be reinforced with plant-mixed surfacing and bituminous surface treatment to be applied to shoulders. District VII, Route 23, Section G. Hensler Construction Corp., Glendale, \$105,775; Cox Bros. Construction

Co., Stanton, \$109,482; Schroeder & Co., Roscoe, \$110,392. Contract awarded to G. W. Ellis Construction Co., North Hollywood, \$97,776.

MARIN COUNTY—North of Novato, a chain link fence to be furnished and installed. District IV, Route 1, Section A. Cyclone Fence Division (American Steel and Wire Co.), San Francisco, \$677; San Jose Steel Co., Inc., San Jose, \$921. Contract awarded to California Wire Cloth Corp., Oakland, \$623.70.

MARIN COUNTY—Between 1.65 miles north of Novato and Ignacio, about 2.2 miles, a portion to be improved by placing plant-mixed surfacing over the existing pavement and a portion to be improved by placing crusher-run base and plant-mixed surfacing over the existing pavement. District IV, Route 1. Brown-Ely Co. Contractors, El Cerrito, \$74,673. Contract awarded to A. G. Raisch Co., San Francisco, \$68,476.25.

MARIN COUNTY—Between Point Reyes Station and the junction with Novato road, about 9 miles west of Novato, about 9.9 miles to be graded and surfaced with plant-mixed surfacing on existing pavement and on imported borrow. District IV, Route FAS 879. Chas. L. Harney, Inc., San Francisco, \$225,573; Brown-Ely Co., Contractors, El Cerrito, \$289,006. Contract awarded to A. G. Raisch Co., San Francisco, \$199,447.25.

MENDOCINO COUNTY—Between 1.5 miles south of Forsythe Creek and 3.5 miles north of Forsythe Creek, about 5.2 miles to be graded and surfaced with plant-mixed surfacing on cement treated base and a steel beam bridge to be constructed. District I, Route 1, Sections C, D. George Pollock Co., Sacramento, \$918,344; H. Earl Parker, Inc., and Clements & Co., Marysville, \$999,055; Piombo Construction Co., San Francisco, \$1,030,429; Morrison-Knudsen Co., Inc., San Francisco, \$1,081,555; Chas. L. Harney, Inc., San Francisco, \$1,146,047. Contract awarded to Guy F. Atkinson Co., South San Francisco, \$876,058.70.

MONTEREY COUNTY—Between San Ardo and King City, about 3.6 miles, imported borrow to be placed over existing roadbed and surfaced with plant-mixed surfacing on crusher run base. District V, Route 2, Sections G, F. Brown-Doko, Pismo Beach, \$222,882. Contract awarded to Granite Construction Co., Watsonville, \$203,359.

PLACER COUNTY—In the city of Roseville between Jefferson Street and East City Limits, about 0.9 mile to be surfaced with plant-mixed surfacing. District III, Route 17. A. Teichert & Son, Inc., Sacramento, \$7,965; Brighton Sand & Gravel Co., Sacramento, \$9,132; McGillivray Construction Co., Sacramento, \$10,442; H. B. Folsom, Sacramento, \$10,480. Contract awarded to J. R. Reeves, Sacramento, \$6,907.50.

PLUMAS COUNTY—Between Rock Creek and Belden, about 1.9 miles, to be graded. District II, Route 21, Section A. Westbrook & Pope & Paul J. Tyler, Sacramento, \$997,395; George Pollock Co., Sacramento, \$1,065,517; H. Earl Parker, Inc., Marysville, \$1,571,054. Contract awarded to Piombo Construction Co. & M & K Corp., San Francisco, \$858,862.

PLUMAS COUNTY—Across Sulphur Creek, a reinforced concrete slab bridge to be constructed and approaches to be graded and surfaced with road-mixed surfacing on cement treatment. District II, Route 83, Section A. O'Connor Bros., Red Bluff, \$67,006; Jensen & Pitts, San Rafael, \$68,889; Charles McClosky Co., San Francisco, \$81,396. Contract awarded to Chittenden & Chittenden, Auburn, \$58,982.70.

SAN BERNARDINO COUNTY—Between Los Angeles County line and San Bernardino, about 9.0 miles, plant-mixed surfacing to be placed over existing pavement and shoulders and seal coat applied thereto. District VIII, Route 9, Section D, Upl., A. C. Griffith Co., Los Angeles, \$144,669; Morrison-Knudsen Co., Inc., Los Angeles, \$148,272; R. A. Erwin, Colton, \$154,496; Vido Kovacevich Co., South Gate, \$160,746; Geo. Herz & Co., San Bernardino, \$162,248; Peter Kiewit Sons Co., Arcadia, \$185,758; Baker & Pollock, Ventura, \$165,607; J. E. Haddock, Ltd., Pasadena, \$167,999; M. S. Mecliam & Sons, Lynwood, \$168,709; Oswald Bros., Los Angeles, \$169,230; Silva & Hill Construction Co., Los Angeles, \$172,665. Contract awarded to Match Bros., Colton, \$143,662.25.

SAN BERNARDINO COUNTY—2.7 miles west of Colton, replacing 0.1 mile of damaged portion of

highway with plant-mixed surfacing and Portland cement concrete pavement. District VIII, Route 26, Section D. Match Bros., Colton, \$6,460; Radich Construction Co., San Bernardino, \$7,481; Herz Paving Co., San Bernardino, \$11,915. Contract awarded to R. A. Erwin, Colton, \$4,890.

SAN LUIS OBISPO COUNTY—A bridge across Rocky Creek, about 15 miles east of Cambria, to be constructed. District V, Route 33, Section E. Thomas Construction Co., Santa Barbara, \$13,824; N. M. Saliba Co., Los Angeles, \$14,716; E. G. Perham, Los Angeles, \$14,748; O. R. Ochs & Son, San Luis Obispo, \$14,922; C. O. Bodenbamer, Redwood City, \$15,823; Geo. W. Peterson, Los Angeles, \$17,503. Contract awarded to D. M. Piburn, Oakland, \$13,592.

SAN LUIS OBISPO COUNTY—Between Pismo Beach and Miles Station, about 5 miles to be graded and surfaced with plant-mixed surfacing on crusher run base and a reinforced concrete girder bridge across San Luis Obispo Creek to be constructed. District V, Route 2, Section P, Bch, E. Griffith Co., Los Angeles, \$1,219,315; Granite Construction Co., Watsonville, \$1,268,853. Contract awarded to Fredericksen & Kasler, Sacramento, \$1,055,958.60.

SAN MATEO COUNTY—At Junipero Serra Boulevard and at Santa Inez Avenue, existing pavement to be widened to provide channelization at one intersection and traffic signals and highway lighting to be furnished and installed at the two intersections. District IV, Route 2, Section A. Charles L. Harney, Inc., San Francisco, \$41,261; Guy F. Atkinson Co., South San Francisco, \$45,437. Contract awarded to Jensen & Pitts, San Rafael, \$39,660.50.

SHASTA COUNTY—Between Fall River Mills and Dana, about 5.5 miles to be graded, surfaced with crusher run base and seal coat applied thereto. District II, Route FAS 1076. Claude C. Wood Co., Lodi, \$191,388; Louis Biasotti & Son, Stockton, \$194,962; Harms Bros., Sacramento, \$197,250; Chittenden & Chittenden, Auburn, \$199,781; A. Teichert & Son, Inc., Sacramento, \$207,919; Jensen & Pitts, San Rafael, \$210,726; J. P. Brennan, Redding, \$222,545. Contract awarded to W. C. Railing, Redwood City, \$185,909.

SHASTA COUNTY—Between Cottonwood and Anderson, about 5 miles to be graded and surfaced with plant-mixed surfacing on cement treated base, and a reinforced concrete slab bridge to be constructed. District II, Route 3, Section A. H. Earl Parker, Inc., & Clements & Co., Marysville, \$644,652; A. Teichert & Son, Inc., Sacramento, \$645,854; Harms Bros. & Baldwin Straub Corp., Sacramento, \$648,953; Fredrickson Bros., Emeryville, \$712,254; Westbrook & Pope, A. R. McEwen, C. M. Syar, Sacramento, \$775,696. Contract awarded to Fredrickson & Watson Construction Co., Oakland, \$611,709.73.

STANISLAUS COUNTY—Between 1.25 miles east of Oakdale and 1.8 miles west of Tuolumne County line, about 9.6 miles, a graded roadbed to be constructed on a portion of the project and untreated rock base and plant-mixed surfacing to be placed over the new roadway and existing surfacing. District X, Route 13, Section B. A. R. McEwen & E. A. Forde, San Anselmo, \$202,526; A. Teichert & Son, Inc., Sacramento, \$209,862; Clements & Co., Hayward, \$212,462; Beerman & Jones, Sonora, \$216,993; Geo. E. France, Inc., Visalia, \$218,236; Frank B. Marks & Son, Tracy, \$218,678; Harms Bros., Sacramento, \$279,431; M. J. B. Construction Co., Stockton, \$283,963. Contract awarded to M. J. Ruddy & Son, Modesto, \$191,470.20.

STANISLAUS COUNTY—Between Empire & Hughson, about 0.9 mile to be graded and surfaced with plant-mixed surfacing on untreated rock base. District X, Route FAS 912. George E. France, Inc., Visalia, \$37,146; Westbrook & Pope, Sacramento, \$39,464; M. J. Ruddy & Son, Modesto, \$39,558; Standard Materials Co., Modesto, \$40,925; Gordon L. Capps, Stockton, \$43,140; Harms Bros., Sacramento, \$47,793; Claude C. Wood Co., Lodi, \$50,650; M. J. B. Construction Co., Stockton, \$52,218. Contract awarded to Louis Biasotti & Son, Stockton, \$34,733.86.

VENTURA COUNTY—In the City of Oxnard on Oxnard Boulevard, at 7th, 5th, and 3d Streets, furnish and install fixed time traffic signals. District VII, Route 60. C. J. B. Construction Co., Oxnard, \$12,800; L. H. Leonardi Electrical Construction Co., San Rafael, \$13,189. Contract awarded to Electric & Machinery Service, Inc., South Gate, \$10,789.

Appreciation

AMERICAN ASSOCIATION
OF STATE HIGHWAY OFFICIALS
1220 National Press Building
Washington, D. C.

Mr. T. H. Dennis, Maint. Engr.
Department of Public Works
Division of Highways
P. O. Box 1499
Sacramento 7, California

Dear Mr. Dennis:

It is with keen regret that I received the copy of your letter of April 26 to Mr. Baldock, resigning as Chairman of the Association's Committee on Radio.

I shall always be deeply grateful to you for the very marvelous job you did in pulling this committee operation up to the level where it belongs. I feel sure the committee will miss you. However, you are the best judge of your own situation.

If I can be of service to you at any time, please do not hesitate to call upon me.

Sincerely yours,

HAL H. HALE
Executive Secretary

Mr. T. H. Dennis
Maintenance Engineer
Division of Highways
Sacramento, California

Dear Tom:

It is my desire to join with Mr. Hal H. Hale, Executive Secretary, American Association of State Highway Officials, in expressing regret that you have found it necessary to resign as chairman of the Association's Committee on Radio due to the increasing responsibilities California's extensive highway program has added to your department.

I am sure that every member of the American Association of State Highway Officials appreciates the time and effort you have given as chairman of the Committee on Radio.

Very truly yours,

C. H. PURCELL
Director of Public Works

Overhead Structure

Continued from page 12 . . .

bring all of the track crossings within one span.

The bridges consist of concrete deck slabs on four 36-inch steel wide flange beams. The bents are of a distinctive two-leg rigid frame design and rest on timber piles. The bridges also have tubular steel railing. All of the abutments and bents are on a 42-degree skew which brings them parallel to the tracks and the streets.

Owing to the uncertainty as to delivery dates and availability of structural steel, the structures were built under two separate contracts. The substructure contract under which everything below the anchor bolts was constructed was completed in December, 1947, and under a different contract the construction of the superstructure started early in February of this year.

As a portion of the substructure contract, seven timber piles and one steel pile were test loaded. A very convenient apparatus embodying a 35-foot tank which was filled with water to supply the necessary load was developed by the substructure contractor to make these tests. This pile loading equipment has been used very successfully on State jobs.

The steel was delivered directly to the point of erection by truck. Owing to the length of the girders, which were 82-foot maximum, a special permit was required for the movement of these trucks on the highways. The trucks normally left the plant at 5 a.m. and traveled in groups of four or more. Inasmuch as the steel design was relatively simple, much of the steel was set in place directly from the trucks and all the steel was usually erected on the same day as it was delivered. The erection of the 1437 tons of steel was completed in only 2½ weeks and was riveted in three weeks.

A unique arrangement is being used in the placing of the concrete deck which eliminates the necessity for runways. A 12-foot wide platform was constructed which rolls on steel shod tracks on each side of the bridge. These tracks are also being used as screeds. A hopper was erected on one end of the platform and the concrete delivered

A. H. Henderson And F. B. Durkee Are Promoted

IN RECOGNITION of 30 years of loyal state service, Governor Earl Warren on May 11th announced the appointment of A. H. Henderson, Deputy Director of the Department of Public Works, to be Director of the Department of Motor Vehicles.

Director of Public Works C. H. Purcell named Frank B. Durkee, Principal Attorney of the department, to succeed Henderson as Acting Deputy Director.

On January 12, 1918, Henderson went to work in the then Department of Motor Vehicles, transferring in July, 1920, to the Department of Engineering. In 1932, he went to the Division of Highways, serving five years in the Fresno district office. He was appointed Disbursing Officer in 1939 and in 1943 became Assistant Director of the Department of Public Works. When this position was abolished, he became Deputy Director.

Thus after three decades, Henderson returns as chief to the Department of Motor Vehicles of which he became an employee as a youth.

Durkee, a former newspaper man, first entered state service in November, 1923, as editor of *California Highways and Public Works* and public relations representative for the California Highway Commission. He first became a member of the legal staff of the Department of Public Works in 1927. His present civil service position is that of Principal Attorney.

Durkee is a native of Oregon but most of his boyhood was spent in Chico, Butte County, where for several years he was manager of the Chamber of Commerce. He attended local schools in Chico and studied law at the University of Southern California.

to the hopper by a crane. The concrete is then distributed to the deck by buggies moving back and forth on the movable platform.

At the present time all of the structural steel has been erected and work is progressing in the placing of the concrete deck. It is anticipated that the structures will be completed late next fall.

Miss Mattie McComber Retires From State Highway Department

BACK IN 1913, when State Highway Engineer Austin B. Fletcher was laying the foundations for the present Division of Highways young Miss Mattie McComber became a member of his secretarial staff. The little group of those days, chosen by Fletcher, included C. C. Carleton, now Chief Attorney of the Department of Public Works, as legal adviser, and the late Miss Myrtle V. Murray, who was Fletcher's secretary.

On April 30th last, Miss McComber retired after 35 years of continuous state service.

When Governor Hiram Johnson in 1913 transferred Miss Murray from the Highway Department to his office, Miss McComber took over Miss Murray's work until 1923, when Miss Murray returned to her highway duties. Thereupon Miss McComber joined the secretarial staff of the State Highway Commission, a position she held until her retirement.

From Australia

59 McCrae St., Bendigo
Victoria, Australia

Director, Department
of Public Works

Dear Sir: I am an engineer in the road's board in Victoria and your journal "California Highways and Public Works" has come into my hands several times. I think that it is the best of its type that I have ever come in contact with and I am wondering if it is possible to have a copy sent to me. If there is any yearly fee to be paid, I will be glad to send same.

Yours sincerely,

(Signed) MR. H. MASON

EARL WARREN
Governor of California

CHARLES H. PURCELL
Director of Public Works

FRANK B. DURKEE
Acting Deputy Director

HIGHWAY COMMISSION

C. H. PURCELL Chairman
HARRISON R. BAKER Pasadena
HOMER P. BROWN Placerville
JAMES A. GUTHRIE San Bernardino
F. WALTER SANDELIN Ukiah
C. ARNHOLT SMITH San Diego
CHESTER H. WARLOW Fresno
GEO. W. SAVAGE, Secretary Sacramento

DIVISION OF HIGHWAYS

Central Office

GEO. T. McCOY State Highway Engineer
FRED J. GRUMM Deputy State Highway Engineer
J. G. STANDLEY Assistant State Highway Engineer
R. M. GILLIS Assistant State Highway Engineer
F. W. PANHORST Assistant State Highway Engineer
J. W. VICKREY Assistant State Highway Engineer
R. H. WILSON Assistant State Highway Engineer
T. E. STANTON Materials and Research Engineer
T. H. DENNIS Maintenance Engineer
A. M. NASH Engineer of Surveys and Plans
EARL WITHYCOMBE Construction Engineer
H. B. LA FORGE Engineer of Federal Secondary Roads
L. V. CAMPBELL Engineer of City and Cooperative Projects
R. H. STALNAKER Equipment Engineer
H. C. McCARTY Office Engineer
J. C. YOUNG Traffic Engineer
I. O. JAHLSTROM Principal Bridge Engineer
STEWART MITCHELL Principal Bridge Engineer
E. R. HIGGINS Comptroller

Right of Way Department

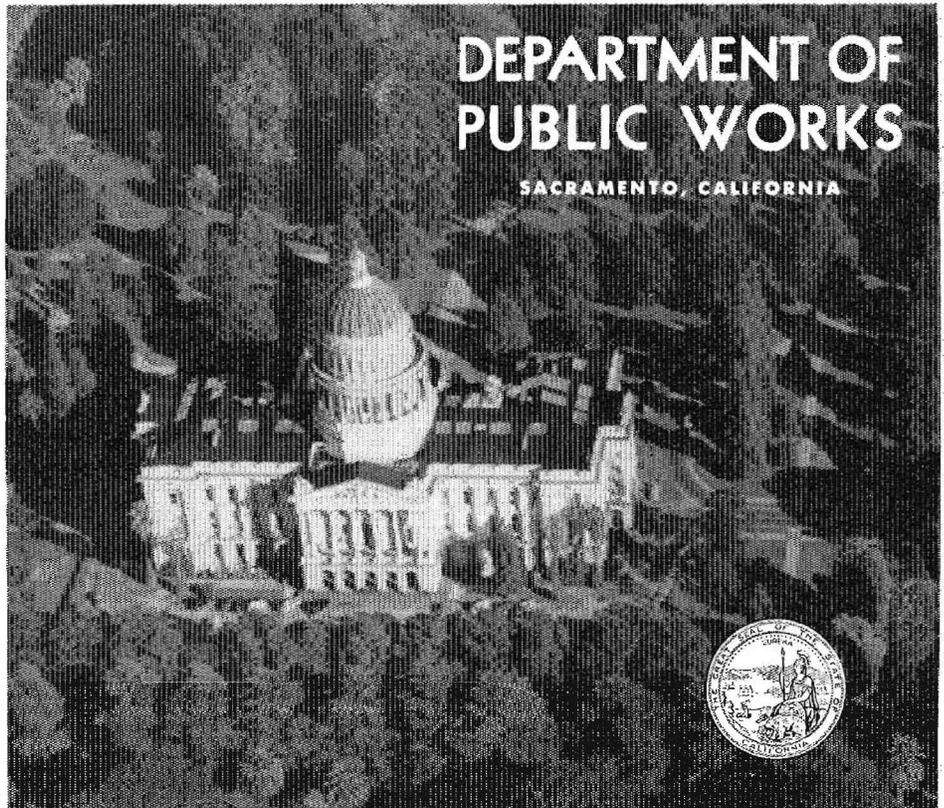
FRANK C. BALFOUR Chief Right of Way Agent
E. F. WAGNER Assistant Chief
R. S. J. PIANEZZI Assistant Chief
E. M. MacDONALD Assistant Chief

District IV

JNO. H. SKEGGS Assistant State Highway Engineer

District VII

S. V. CORTELYOU Assistant State Highway Engineer



DIVISION OF HIGHWAYS

District Engineers

GEORGE F. HELLESOE District I, Eureka
F. W. HASELWOOD District II, Redding
CHARLES H. WHITMORE District III, Marysville
B. W. BOOKER District IV, San Francisco
L. A. WEYMOUTH District IV, San Francisco
L. H. GIBSON District V, San Luis Obispo
E. T. SCOTT District VI, Fresno
P. O. HARDING District VII, Los Angeles
A. D. GRIFFIN District VII, Los Angeles
E. O. SULLIVAN District VIII, San Bernardino
S. W. LOWDEN District IX, Bishop
C. E. WAITE District X, Stockton
E. E. WALLACE District XI, San Diego
HOWARD C. WOOD Bridge Engineer, San Francisco-Oakland Bay Bridge and Carquinez Bridge

DIVISION OF CONTRACTS AND RIGHTS OF WAY

Legal

C. C. CARLETON Chief

DIVISION OF SAN FRANCISCO BAY TOLL CROSSINGS

RALPH A. TUDOR Chief Engineer

DIVISION OF WATER RESOURCES

EDWARD HYATT, State Engineer Chief of Division
A. D. EDMONSTON Assistant State Engineer
GORDON ZANDER Principal Hydraulic Engineer, Water Rights
T. B. WADDELL Principal Hydraulic Engineer, Central Valley Project
G. H. JONES Principal Hydraulic Engineer, Sacramento River Flood Control Project
W. H. HOLMES Principal Engineer, Design and Construction of Dams, Supervision of Dams
P. H. VAN ETEN Principal Hydraulic Engineer, State-Wide Water Plan
GEORGE B. GLEASON Supervising Hydraulic Engineer, Los Angeles Office
SPENCER BURROUGHS Principal Attorney
T. R. MERRYWEATHER Administrative Assistant

DIVISION OF ARCHITECTURE

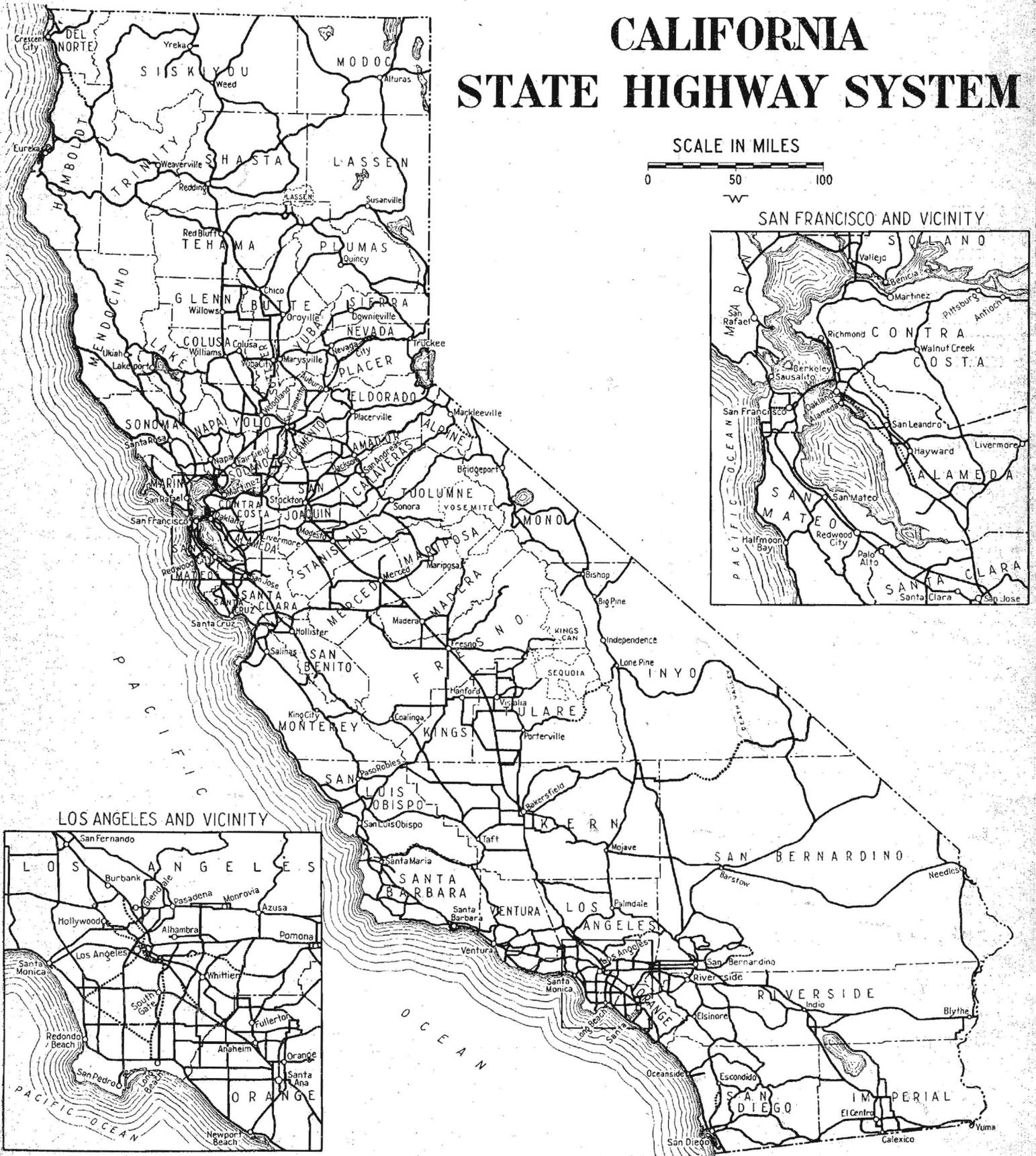
ANSON BOYD State Architect
W. K. DANIELS Assistant State Architect (Administrative)
P. T. POAGE Assistant State Architect (Design and Planning)

Headquarters

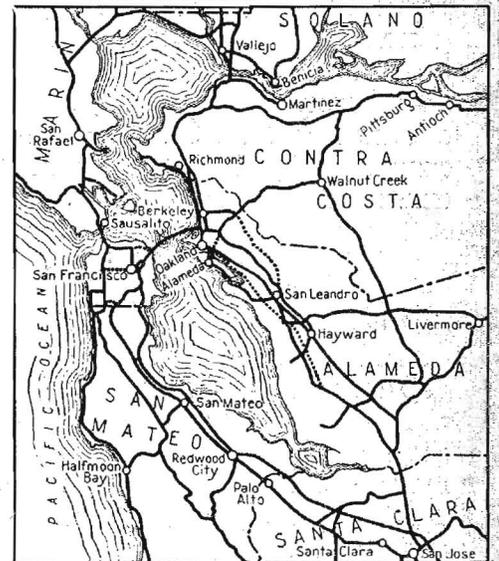
H. W. DeHAVEN Supervising Architectural Draftsman
D. C. WILLETT Chief Construction Engineer
CARLETON PIERSON Supervising Specification Writer
FRANK A. JOHNSON Principal Structural Engineer (State Buildings)
C. A. HENDERLONG Principal Mechanical and Electrical Engineer
WADE HALSTEAD Supervising Estimator of Building Construction

CALIFORNIA STATE HIGHWAY SYSTEM

SCALE IN MILES



SAN FRANCISCO AND VICINITY



LOS ANGELES AND VICINITY

