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CHARLES H. PURCELL, *Director*
GEORGE T. McCOY, *State Highway Engineer*
KENNETH C. ADAMS, *Editor*
HELEN HALSTED, *Associate Editor*

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Fairfield Study

About 75 Percent of Businesses Bettered by Highway Realignment

By W. STANLEY YOUNG, Headquarters Right of Way Agent

CONTINUING our policy of publishing the results of economic studies of the effects of freeway construction on abutting and by-passed properties, we are presenting an analysis of the findings in Fairfield, Solano County, the third by-passed city to be studied and reported on by the California Division of Highways.

Fairfield was a growing community that had reached the stage of growth common to all progressive highway cities, where it was necessary to decide whether the business district was to move away from the through traffic or whether through traffic was to be removed from the business district.

Also, like many other highway cities, Fairfield was confronted with the question of whether or not the advantages to the community as a whole resulting from conjestion alleviation would offset the possible loss of sales to the motorist-catering businesses.

Fairfield Presented Problem

However, the problem in Fairfield was more serious than in many comparable cities, because it was a community enjoying a particularly strategic location, fifty miles east of San Francisco and 50 miles west of Sacramento on U. S. Highway 40, which carries at this point an average of 12,000 vehicles daily.

Because of this strategic location, cafes, bars and service stations, comprising 27 percent of the total number of retail businesses, were enjoying a very large highway patronage.

With full knowledge of the probable adverse nature of the immediate effects on this type of business, the Fairfield merchants, including cafe, bar and service station owners, apparently held no doubts concerning the long term benefits to business and property values.

Recognizing the growing gravity of the traffic situation and the ultimate strangling of all business growth by traffic congestion, they had exerted every effort to accomplish removal of through traffic.

Judgment Sound

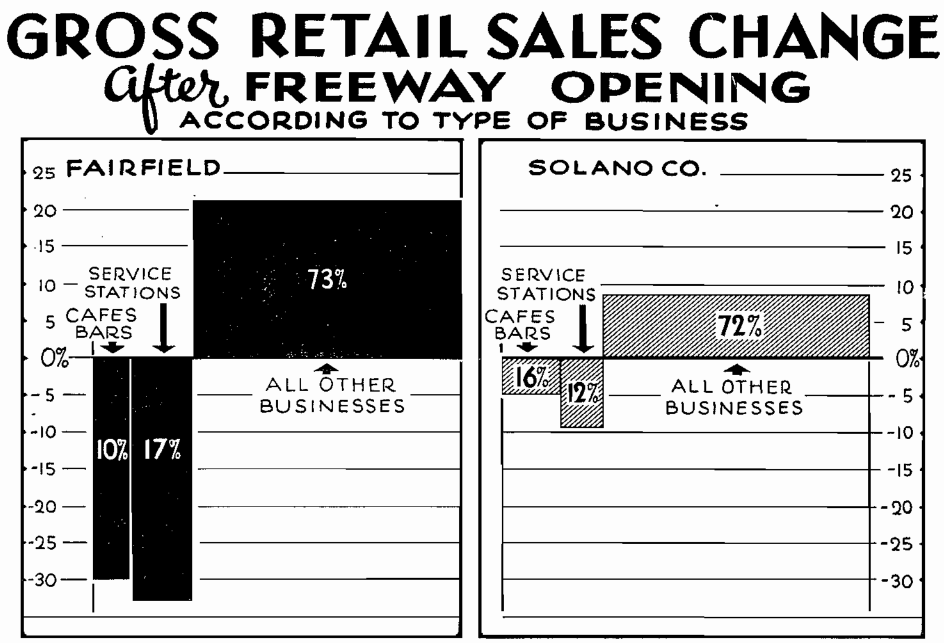
Now that the freeway construction has been completed and through traffic has been removed since July 2, 1949, the following facts prove the soundness of their judgment.

The cafes and bars, or 17 percent of the retail outlets, showed a 24.4 percent drop below the county average. The service stations, comprising 10 percent of the retail outlets, disclosed a 23.2 percent greater decrease than the county.

From this graph it is readily apparent that gains by the majority of the businesses more than offset the losses to the minority.

Effect on Service Stations

A further comment should be made at this point concerning service stations, which averaged a 23.2 percent net decrease. As in our studies of other locations, the service stations owned and operated by the petroleum companies were found to decrease considerably more than the locally operated outlets, and their over-all business



volume and subsequent substantial decreases have weighed heavily in the average over-all service station business decrease attributable to the freeway.

However, all other retail outlets, or the 51 stores catering to the general needs of the community and representing 73 percent of the retail outlets, showed an increase of 14.1 percent above the county average. In other words, 73 percent of the community definitely benefited financially by through traffic removal.

The accompanying graph illustrates the effects on each type of retail business by comparing the retail business volume change in Fairfield with Solano County during the year after the freeway opened. Also compared is the percentage of the total number of businesses contained in each class.

In order to determine just what the net effects of the freeway by-pass were on the various business types, it was necessary for us to have some yardstick for measurement. Since our investigations indicated that populations and per capita income in Fairfield and in Solano County as a whole had increased at approximately the same rates and that other influencing factors had remained relatively constant during the period, Solano County figures provided the accurate measuring device used in this study.

Some Facts

Principally from the following facts brought out in our Fairfield study we have been able to estimate the effects on retail business during the year after the by-pass opened in a city which was ideally located to siphon the maximum amount of business from travelers passing through the city.

Traffic reduction within the city, approximately 40 percent.

Parking meter use, 3.1 percent increase.

Population (3,607—1950 census), indicated increase approximately same as county rate.

Gross income, indicated increase approximately same as county rate.

Retail business	Total number of businesses	Fairfield volume	Solano County volume
All	70	4.5% increase	5.0% increase
Cafes and bars	12	30.0% decrease	5.6% decrease
Service stations	7	33.0% decrease	9.8% decrease
All other businesses	51	22.6% increase	8.5% increase

Comparison of average retail dollars per capita spent during year after freeway opening:

	Fairfield	Solano County
All businesses	$1,027.80	$691.87
Cafes and bars	112.97	83.40
Service stations	109.47	57.13
All others	805.36	551.34

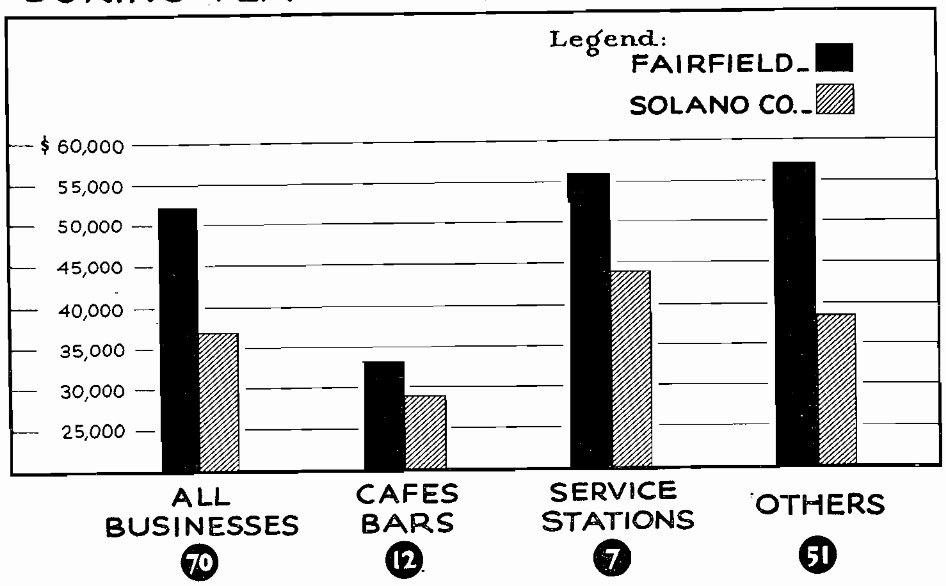
Situation Unusual

The situation of Fairfield was different than the typical highway city which is by-passed because of the unusually large percentage of the highway users having the same destinations, and because traffic and road conditions in the past had contributed to the forming of a habit on the part of these travelers of stopping in Fairfield for a bite to eat and automobile service.

That Fairfield's situation is unusual is further brought out by the fact that no modern motels had been built along the highway in the city, apparently because it was commonly known that most of the motorists were not traveling great distances and did not require overnight facilities.

Since the retail sales figures have disclosed that the class of businesses representing 73 percent of the total number in Fairfield enjoyed an average net increase of 14.1 percent, the question immediately arises as to the source of this increase—that is, whether the increase is attributable to increased local spending or new customers from rural districts and other communities formerly trading elsewhere. The subsequent analysis is an attempt to answer this question.

COMPARISON OF DOLLAR GROSS VOLUME PER RETAIL OUTLET DURING YEAR AFTER FREEWAY OPENING



Premise of Findings

Following in line with our assumption that Solano County fgures are a satisfactory basis for comparison to determine the net freeway effects, it is also reasonable to accept the premise that the per capita business volume attributable to the residents of Fairfield should be about the same as the county average per capita figure. Therefore, the difference between the average per capita expenditure in Solano County and the average per capita expenditure in Fairfield during the year represents the amount of business in Fairfield which is attributable to purchasers living outside the city.

This premise holds true for the ordinary types of retail business which do not cater to, or enjoy only to a minor extent, trade from the highway traveler. However, it is obvious that such businesses as cafes, bars and service stations in Fairfield, where a very large percentage of their business came from highway travelers, cannot be measured in this manner. This is because such a large part of the highway traffic in the vicinity of Fairfield consists of people who are not Solano County residents.

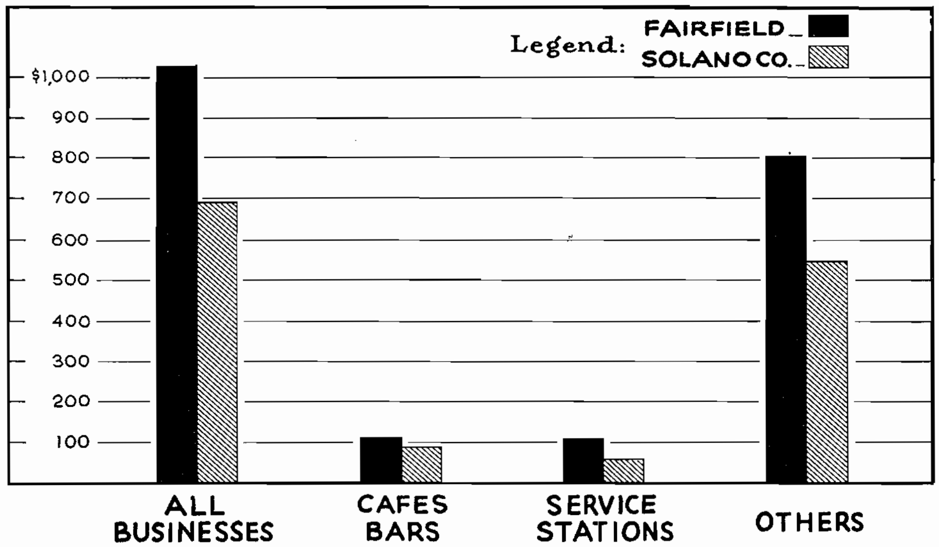
Dollar Spending Increases

By eliminating these specific businesses from the over-all picture and considering only the other types of retail businesses we find that the dollars per capita spent in Fairfield during the one-year period after the freeway opening was 46 percent above that of the county. Please refer to the accompanying graph for a comparison of per capita business volume. Applying this percentage to the population of Fairfield, 1,659 people are indicated as being potential customers living outside the city.

By applying the 14.1 percent net increase in retail business volume of these pedestrian-catering types of businesses to the total number of potential customers, we find that the net increase in number of potential customers has been 743, as a direct result of the 40 percent reduction in city traffic.

These are regular customers of all businesses in the city or a year around basis, which will be lost only because of personal failures on the part of merchants to maintain competitive prices, service and quality merchandise.

COMPARISON OF
PER-CAPITA BUSINESS VOLUME
DURING YEAR AFTER FREEWAY OPENING.



Outside Customers Increase

The attributing of this increase primarily to new customers outside the city appears reasonable because Fairfield's business district is situated entirely along the superseded highway and is within walking distance of most of the residential section. Therefore, alleviation of congestion would not show an appreciable increase in the volume of purchases by the city dwellers.

The unusually heavy weight of cafe, bar and service station business in Fairfield in the over-all retail picture is evidenced by the fact that despite an average net benefit of 14.1 percent to 73 percent of the total number of businesses in Fairfield, the over-all volume of business in the city showed an increase approximately the same as the county.

No Business Failures

Our study of business also disclosed that the 27 percent in number, consisting of cafes, bars and service stations, were formerly transacting approximately 33 percent of the total business volume. This ratio was not found to exist in either of our two previous studies of by-passed cities where the ratio of the number of these types of businesses to the total number of businesses was about the same as the ratio of business volume of these types to the total business volume. After the freeway opened, Fairfield businesses of these types were found to be transacting approximately 27 percent of the total city business.

The unusually high ratio of business, as well as the high ratio of per capita business volume to that of the county on the part of cafes, bars and service stations, may explain the reason why there have been no business failures in these types of businesses in Fairfield since the freeway opening despite the approximately one-third reduction in total volume. A casual observer, upon seeing an average decrease of 33 percent in any class of business on an average, would expect at least one failure as a result; inasmuch as this figure is an average and there must have been greater as well as some lesser losses.

A reference to the accompanying two graphs showing a comparison of per capita business volume and dollar gross volume per establishment to Solano County figures during the year after the freeway opened may be of considerable aid in picturing the excellent business conditions in Fairfield despite severe reductions in the particular business types previously mentioned.

Real Estate

The 66 real estate transactions which had taken place along the superseded route within the past three years indicate that the freeway had little or no effect on property values. Of the 66 properties which were sold during this period, 12 were vacant property sales which took place prior to the freeway opening and nine were vacant property sales which took place following its opening. A comparison of the average of these sales indicates a 13.8 percent increase in sales price after the freeway opened.

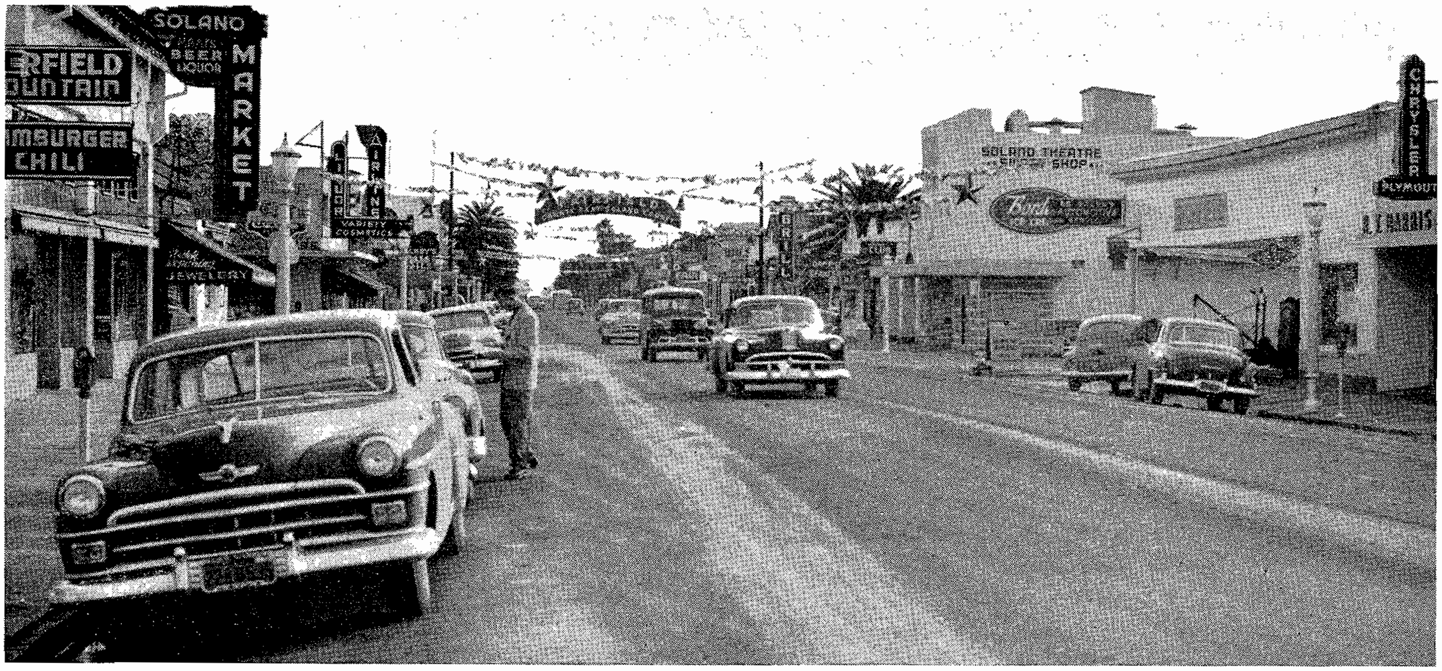
However, greater fluctuations in value were found between similarly located properties having similar highest and best uses than between the periods before and after the opening, so that the average increase in sales price should not necessarily be attributed to benefits of the through traffic removal. Nevertheless, all of these real estate transactions indicate that there has been no decrease in value of any properties along any section of the superseded route.

Present values along the sections outside the city limits are indicated to be approximately $800 to $1,000 per acre for road frontage. Highest and best uses of these properties remained identical, being either for residential subdivisions or commercial establishments catering primarily to local residents.

City Continues to Grow

It is interesting to note at this point that the lower valued business establishments catering to motorists outside the city did not generally disclose as great a decrease in business volume as did the downtown businesses of the same types. This is contrary to our findings in other by-passed cities where the downtown businesses have enjoyed greater benefits than the ribbon developments along the outskirts.

In the main business section, front foot values near the 100 percent locations presently range from $350 to $400 per front foot with no vacant property available for purchase. These values compare closely to the values found to exist in the cities of North Sacramento and Auburn, which have been previously reported, and whose businesses of all types disclosed benefits from through traffic removal.



Scene typical of the congestion in the heart of the Fairfield business district prior to the freeway construction. The benefits of the alleviation of this situation were made apparent by the increase in parking meter returns after the freeway by-pass opened

Like almost all other California cities, Fairfield is continuing to grow at a rapid rate with new businesses being established to take care of the expanding area population.

Excellent Background

The city has a well rounded background for economic stability. It is the county seat of Solano County in the center of a large agricultural area producing grain, fruits and livestock; a large Army Air Force base exists within a few miles and there are considerable recreational facilities, such as duck hunting and fishing close by.

There is little doubt that the construction of the freeway by-pass has removed a large obstacle in the way of Fairfield's transition from a small highway city to an economically sufficient unit.

Since completion of the freeway there is no longer the tendency for inexpensive ribbon commercial developments to spring up along the highway outside the city to provide more and more competition to the downtown merchants and to deteriorate the stability of downtown property values.

Conclusions

In arriving at our conclusions concerning the effects of the freeway by-pass on business and property values in the City of Fairfield, we must recognize that specific classes of businesses enumerated previously have suffered substantial reductions in volume of business transacted directly attributable to the removal of through traffic. This fact is tempered somewhat by the fact that the results during the first year after a city is by-passed are the most drastic to be expected and that, as the highway is completed to freeway standards along its entire length and as the habits of the travelers who, at least temporarily, have ceased trading in the city are changed, the cafe, bar and service station business should improve along with other business types. Our studies in other locations have borne out this statement.

As for the effects of the freeway on approximately three-quarters of the business establishments in Fairfield, the statistics make it apparent that they have been greatly benefited by the removal of through traffic and the accompanying alleviation of traffic congestion.

There have been no readily apparent immediate effects on real estate values resulting from the freeway by-pass during the year following its opening. However, the inherent stability of real estate, supported almost entirely by local economy, tends to increase values because of this stability and the subsequent increased demand. With the passing of sufficient time this principle should be manifested in the properties along the superseded route in Fairfield.

In the event that the principles evolved from the Fairfield study are to be applied to another small highway city, which is also strategically located for the maximum realization of income from highway travelers, it will be necessary to decide whether the benefits to approximately 75 percent of the total number of retail businesses, and a considerably larger number of local residents, outweigh the detrimental, though not fatal, effects on the remaining 25 percent of the enterprises.

It should be borne in mind in making such a decision that the bonus value of a particular location along any section of conventional highway diminishes as each new competitive establishment is opened along the highway, and that, therefore, the extended projection of this bonus value into the future cannot be justified.

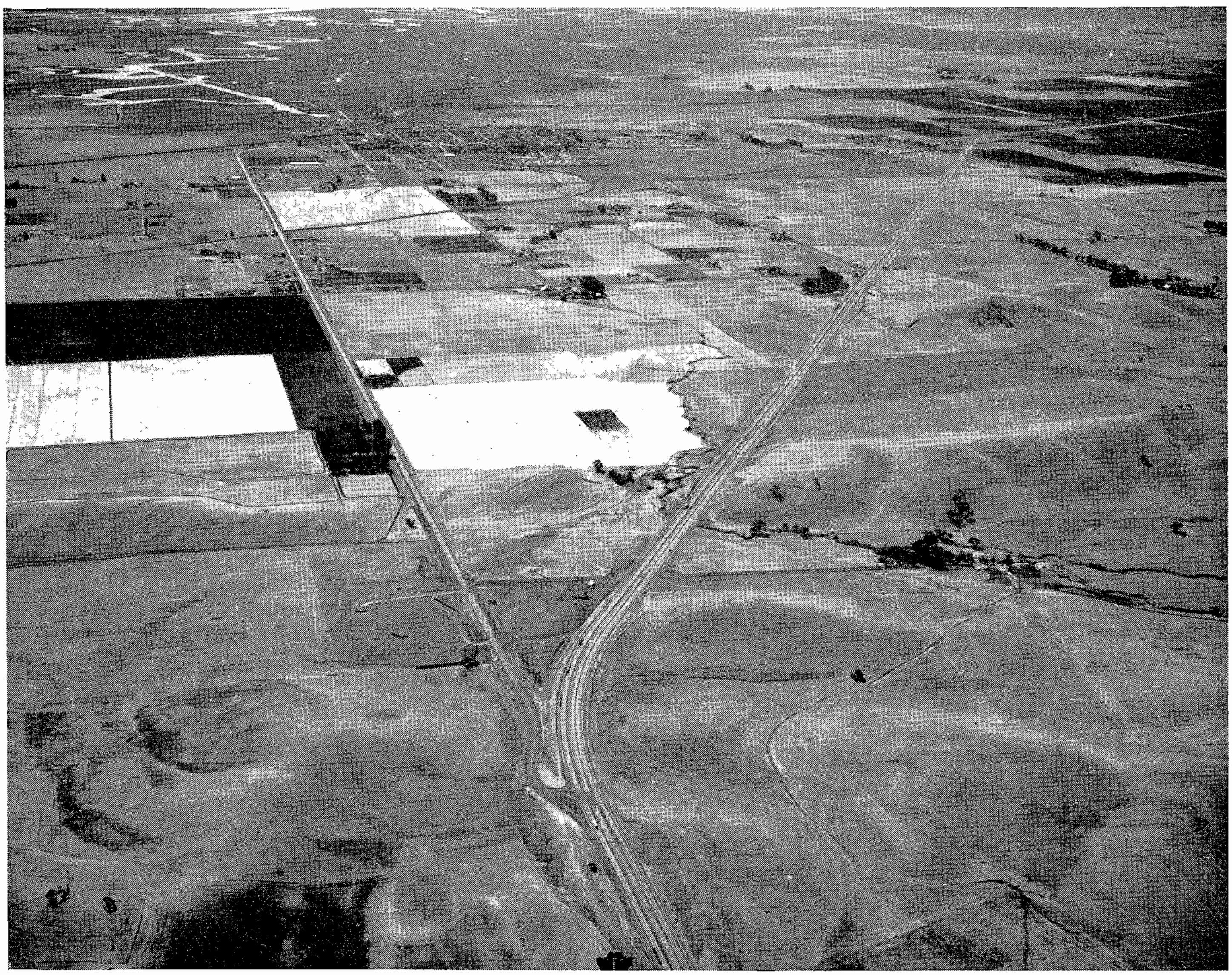
It should also be recognized that in any public improvement there is a varying percentage of the affected people to whom the improvement will be detrimental.

OUR TASK

To build a road
To bear the load
Between Point Here and There,
Barriers are crossed
At least time and cost;
TO ARRIVE is the builder's care.

S. R. OFFUTT,
Assistant Highway Engineer

Aerial view looking southerly over the city of Fairfield toward Suisun Bay in the background. The six-mile long superseded route is the road which makes a right angle turn near the upper left hand corner of the picture and passes along the main business street to a connection with the new freeway near the upper right hand corner in the direction of San Francisco. The length of the new section passing diagonally across the picture is 4.7 miles



Sign Legibility

Tests Show Lower Case Letters on Highway Signs Slightly More Readable

By KARL MOSKOWITZ, Traffic Department, and
GLEN MORGAN, Materials and Research Department

In order to settle a spirited controversy among technical experts regarding the legibility of lower case lettering on highway directional signs in comparison with that of capitals, the Division of Highways last summer made some controlled measurements of reading distances of both styles, using large numbers of observers.

The research was conducted as a joint project of the division and the Institute of Transportation and Traffic Engineering of the University of California, represented by Dr. T. W. Forbes, a national authority on sign legibility. Dr. Forbes presented a technical paper on the tests at the January (1951) meeting of the Highway Research Board, National Research Council.

IN 1949 the California Division of Highways began to use lower case letters for the large destination signs marking exit ramps on freeways in the Los Angeles area, as shown in *Photo 1.* The lower case alphabet distinguishes these signs from other directive, regulatory, and warning signs on the California Highway System, and their use so far has been reserved for marking points of exit from freeways, where traffic is dense and fast-moving, and the motorist has very little time to ponder what a sign says; in other words, where recognition must be instantaneous.

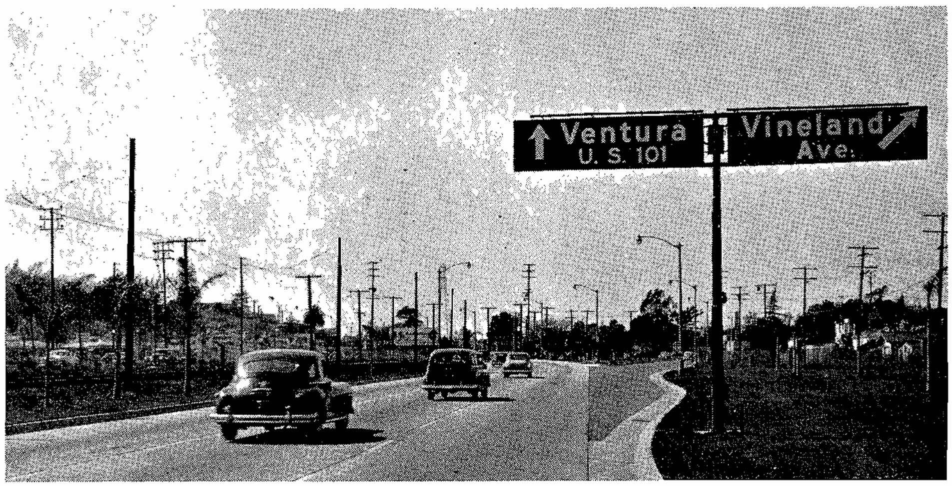
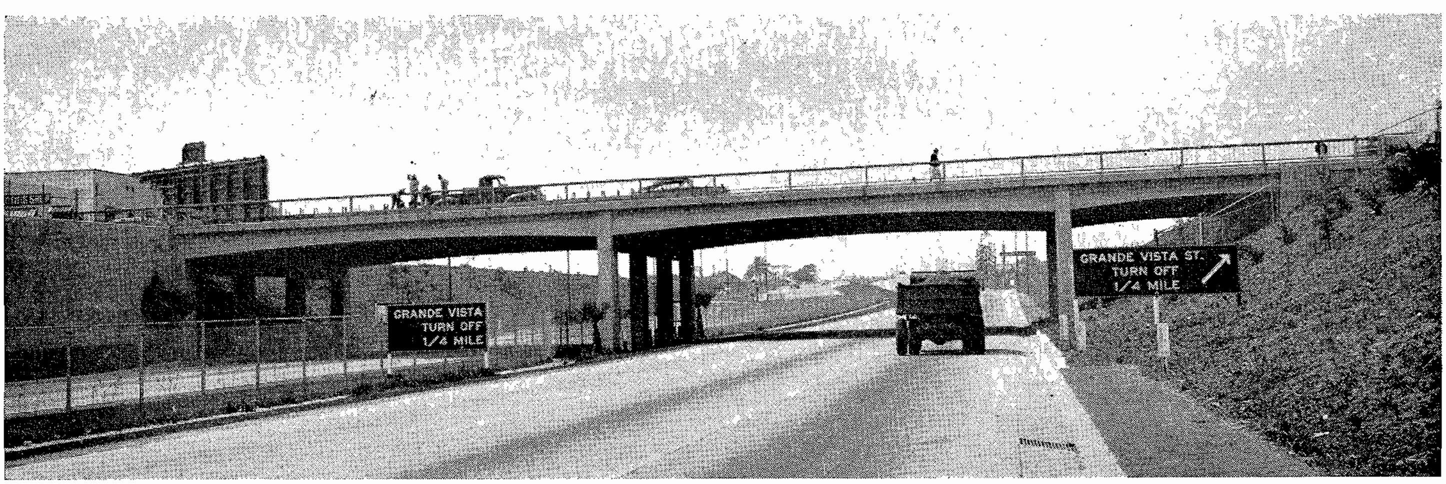


PHOTO 1 *Sign marking exit ramp on Hollywood Freeway*

The signs are mounted overhead because of their size and to make them visible from all lanes over the tops of preceding vehicles; they are illuminated because as landmarks they are even more necessary at night than in the daytime, and because it is not considered desirable to depend on reflected light which would have to be aimed so high in the air; and they are white-on-black because it has been found that the glare from black-on-white signs completely obliterates the message in many areas along the road.

PHOTO 2 *Advance "Get Ready" signs on Santa Ana Freeway*



Drivers Need Guidance

An overwhelming majority of the users of metropolitan freeways are habitual users. Driving a freeway differs from driving ordinary streets where buildings, commercial signs, traffic signals, and otherwise continuously varying landscapes keep drivers informed of the exact location at all times. They know what exit they are going to use, but due to the continuity of design and high speeds, they need precise guidance in order to make preliminary maneuvers and the actual exit smoothly. Reflectorized "get ready" signs are placed to face left and right lanes at headlight level, in advance of the exits *(Photo 2)*, and the large overhead sign marking the spot is visible practically from the moment the driver has passed the preliminary signs. Even the stranger knows what the wording is on the junction sign, because like the habitual user he has just seen the advance sign.

Divergent Views

In addition to the advantage of distinction for a distinctive use, it was held in some quarters that words in lower case letters could be read more easily than capital letters. This viewpoint had some scientific support, e.g., Chapanis, Garner, and Morgan state:

"We read material in capital letters much more slowly than material in lower case printing. Results of objective tests on this point agree with how readers feel about it. Most readers definitely do not like to read material printed entirely in capitals. The reason is probably that we destroy word form when we use capitals. If we take another look at the word 'destroy,' we will notice that the 'd,' 't,' and 'y' stand out because they are either above or below the body of the word. When we print DESTROY in capital letters, however, those cues are lost. All in all, therefore, a safe rule is that we should AVOID PRINTING IN CAPITALS." [1]

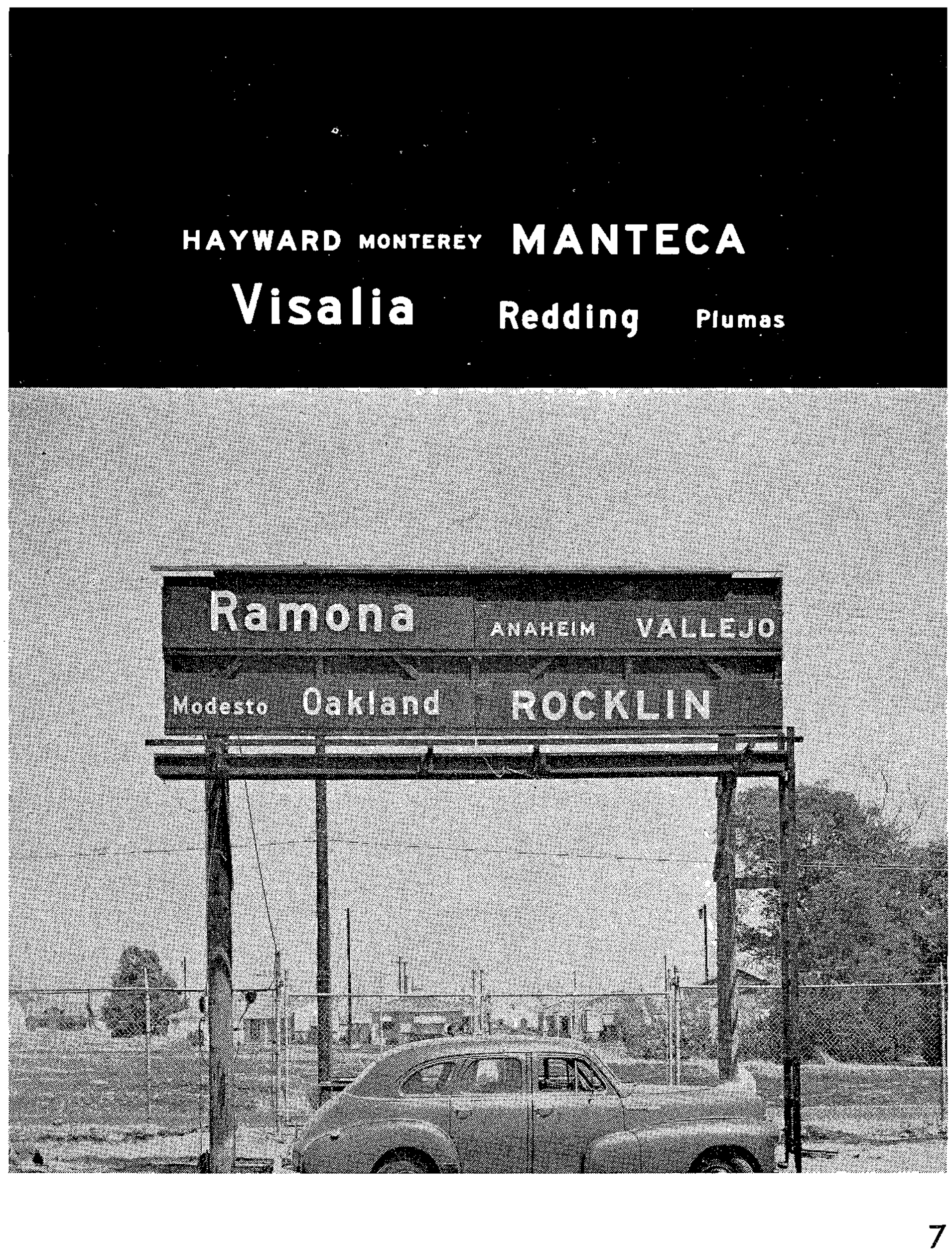
However, in other quarters it has been contended that the unused space between stems and between descenders of the lower case alphabet could be filled up by using larger letters of uniform height (i.e. capitals) and the very fact that the letters would then be larger would make the signs more legible.

Question of Uniformity

The further argument has been advanced that signs preferably should be uniform, even to having uniform lettering on signs having entirely different purposes. Uniformity of signs and devices, simply for the sake of uniformity, has become practically a fetish in the traffic engineering profession, but the original reasoning has gradually been lost sight of; there is no particular logic in insisting on uniformity between devices having opposite or dissimilar purposes. Rather, distinction, the exact opposite of uniformity, conceivably can be a greater virtue. The latter reasoning is used by the Committee on Uniform Traffic Control Devices in their designating diamond, square, and round shapes for signs with different meanings, and by all official sign authorities in California in utilizing red background for STOP signs.

In order to resolve these two points of view, experiments were conducted to determine the relative legibility of lower case and capital letters in large highway signs.

PHOTO 3 *Sign bridge during observation. Top, night. Bottom, daylight*



[1] *"Applied Experimental Psychology"* (p. 171), by A. Chapanis, W. R. Garner, and C. T. Morgan. New York, John Wiley & Sons (1949).

Procedure

At the time the experiments were being planned, it was not known (a) what sizes of each style would be equal in legibility, or (b) what dimensions of each style would produce equal-sized signs. It was surmised from previous work[2] that a relationship between letter size and reading distance could be established, and therefore observations were planned for three different sizes in each style, which would establish the size-distance relationship, following which comparisons could be made under various assumptions (equal legibility, equal height, equal width, equal sign length, or equal sign area).

A list of 24 California names was selected, and sufficient letters were made in three sizes of each style of alphabet to put them up on a sign bridge, six names at a time (see *Photos 3* and *5*).The capital letters were U. S. standard series E, with the stroke thickened to 0.20 of the height (standard stroke is 0.172 of the height). The lower case letters were as shown in *Photo 4*. In this alphabet the letter "o" is 5 wide to 6 high, the "b," "h," "k," "l," etc., are 17/12 the loop height, and the first letter of each word is a series D capital 1.5 the height of the loop. Stroke is approximately 0.22 of the loop height. All the letters were made by photographic enlargements so that each size was of identical proportions. To facilitate assembly, each letter was mounted on a piece of ⅛-inch masonite which included a variable "shoulder" on each side of the letter to compensate for vertical, diagonal, or shapes so that when letters were placed side by side the spacing appeared uniform. By using these shoulder widths, it matters not what combinations of letters are juxtaposed; the spacing will still "look right." The widths and spacing of each alphabet are shown in *Table 1*. The effectiveness of the mathematical spacing in producing an acceptable appearance can be judged from *Photo 3*. If it is desired to expand or contract the length of a word in order better to fit the sign length available, a constant amount (not a pro rata

PHOTO 4 *The lower-case alphabet used in tests*

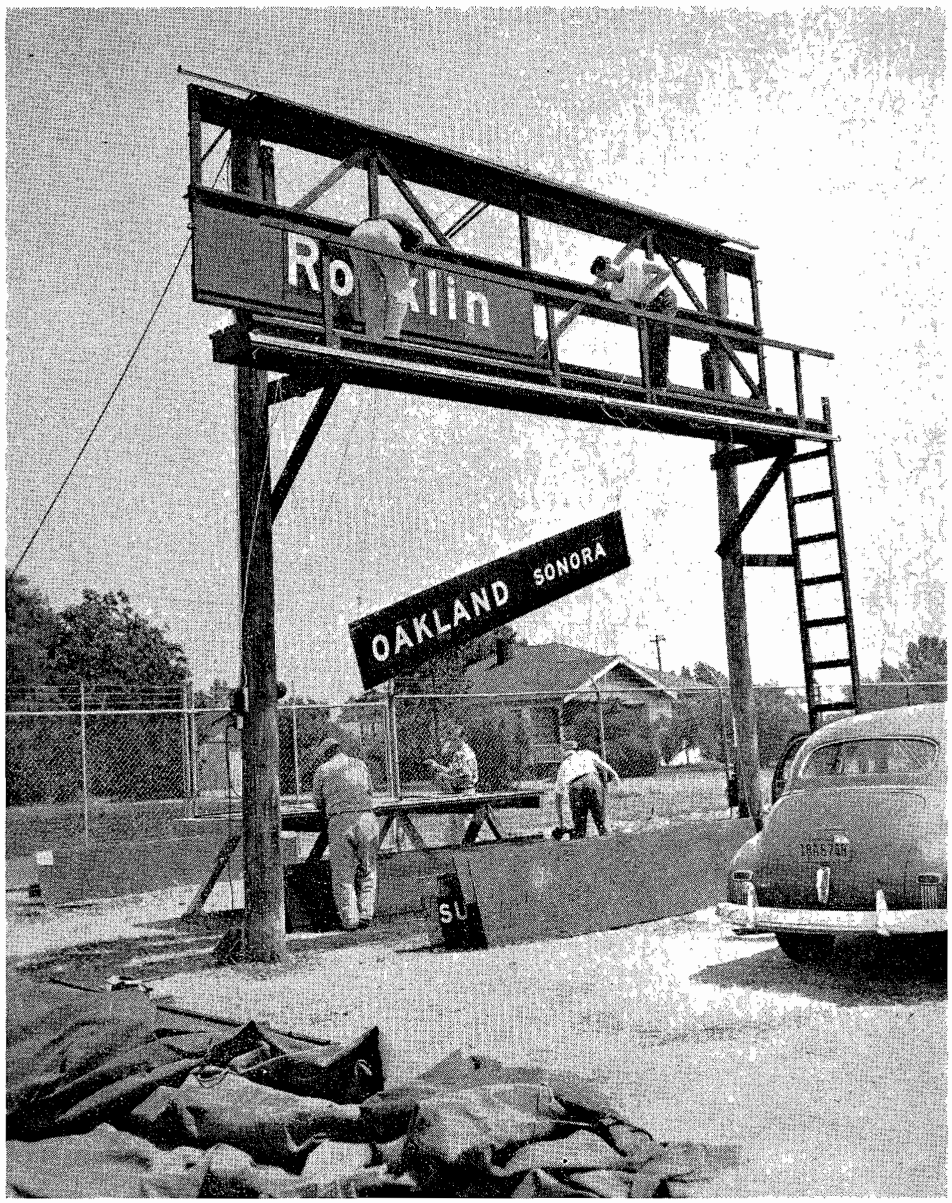
of the spacings tabulated) should be added between each letter. Readers are warned, however, that if the spacing is decreased appreciably, the letters will begin to merge and the legibility will be greatly reduced.

Groups of Observers

In addition to the 24 names, 24 six-letter "scrambled" words were invented in which all letters except Q and X were used an equal number of times.

The 48 words were divided into two schedules, one for day and one for night. The observers were divided into two groups. Each group saw half of the words in lower case and half in capitals, but group "B" saw the lower case counterparts of the words which group "A" saw in capitals, and vice

PHOTO 5 *Assembling and placing test signs*



[2] *"Legibility Distances of Highway Destination Signs in Relation to Letter Height, Letter Width, and Reflectorization,"* by T. W. Forbes and Robert S. Holmes. *Proceedings,* Highway Research Board, Vol. 19 (1939).

TABLE 1

Letter Widths and Spacing as a Proportion of Height

CAPITAL LETTERS Inches per inch of letter height					LOWERCASE Inches per inch of loop height				
	Left shoulder	Neat letter	Right shoulder	Total		Left shoulder	Neat letter	Right shoulder	Total
A	0.11	1.02	0.12	1.25	a	0.15	0.85	0.25	1.25
B	0.22	0.81	0.15	1.18	b	0.26	0.86	0.14	1.26
C	0.12	0.80	0.14	1.06	c	0.15	0.85	0.16	1.16
D	0.22	0.81	0.13	1.16	d	0.15	0.84	0.25	1.24
E	0.22	0.77	0.14	1.13	e	0.15	0.85	0.16	1.16
F	0.22	0.74	0.10	1.06	f	0.13	0.55	0.14	0.82
G	0.12	0.80	0.14	1.06	g	0.15	0.85	0.25	1.25
H	0.22	0.82	0.23	1.27	h	0.26	0.84	0.25	1.35
I	0.22	0.20	0.23	0.65	i	0.26	0.25	0.25	0.76
J	0.08	0.77	0.23	1.08	j	0.04	0.47	0.25	0.76
K	0.22	0.84	0.09	1.15	k	0.26	0.83	0.14	1.23
L	0.22	0.77	0.09	1.08	l	0.26	0.25	0.25	0.76
M	0.22	1.04	0.23	1.49	m	0.26	1.42	0.25	1.93
N	0.22	0.84	0.23	1.29	n	0.26	0.85	0.25	1.36
O	0.12	0.84	0.13	1.09	o	0.15	0.88	0.14	1.17
P	0.22	0.82	0.13	1.17	p	0.26	0.84	0.14	1.24
Q	0.12	0.84	0.13	1.09	q	0.15	0.86	0.25	1.26
R	0.22	0.82	0.13	1.17	r	0.26	0.65	0.11	1.02
S	0.12	0.82	0.11	1.05	s	0.12	0.83	0.14	1.09
T	0.09	0.75	0.10	0.94	t	0.12	0.67	0.15	0.94
U	0.22	0.83	0.23	1.28	u	0.26	0.85	0.25	1.36
V	0.11	0.92	0.12	1.15	v	0.12	1.01	0.11	1.24
W	0.11	1.08	0.12	1.31	w	0.13	1.32	0.12	1.57
X	0.11	1.01	0.12	1.24	x	0.14	1.03	0.13	1.30
Y	0.10	1.01	0.11	1.22	y	0.14	1.07	0.11	1.32
Z	0.20	0.82	0.21	1.23	z	0.16	0.87	0.15	1.18
Average width, weighted according to frequency of occurrence				1.13					1.15

versa. The positions on the board of each size and style were systematically distributed, in order to eliminate any bias due to position or association of words. This is illustrated in *Figures 1* and 2, which also show what words were used.

Legibility Distances

It was desired to determine the legibility distances of place names; however, it was known in advance of the observations that the distance at which the shape of a word is recognized depends not only on what word it is, but upon how familiar the observer is with that particular word. To each group of observers, therefore, 12 names were presented, which included two each of three sizes and two alphabet styles (2 x 3 x 2 = 12). Prior to seeing these words the observers were told only that they were California place names. This set of observations was called "without knowledge." Then the same words were presented again, in the opposite alphabet, and as was expected, all the words were seen farther. This set was called "with knowledge." Finally, the alphabet (less Q and X) was presented in scrambled six-letter combinations, in both capitals and lower case. On the following day, the other set of observers followed the identical schedule but in the opposite alphabet throughout.

Types of Observation

Although the "with knowledge" names were more realistically related to actual sign reading than either of the others, it was thought that the "without knowledge" might correspond perhaps to the reactions of strangers who missed the advance signs, did not consult a map, and had no previous idea of where they were going anyway. The "scrambled" observations were made for control. In this type of observation, recognition is governed by letter patterns instead of word patterns, and the weakest letter in the six-letter group controls the distance at which the "word" is seen. (In scoring these observations, however, the distance of a given word was admitted to the results if one letter was wrongly seen.) The distances for scrambled "words" therefore generally represent the least legible one-sixth of the letters, and are far less than those for real words, which could be recognized by their larger over-all shape and in which observers were able to guess the weak letters.

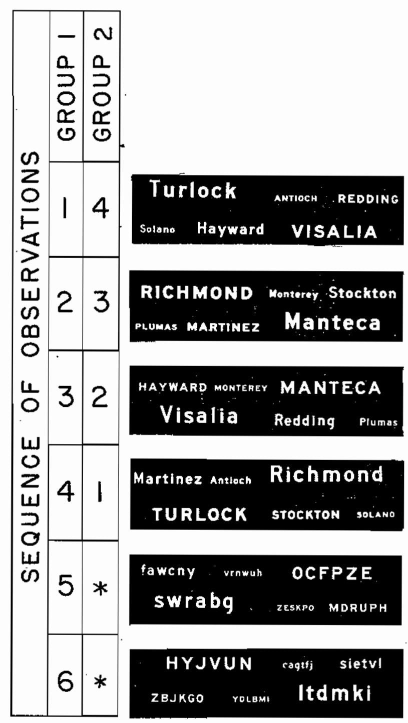
Daylight Observations

Daylight observations were made between 1.30 and 4.30 p.m. on a sunny day in July, with the observers facing east. For the night observations fluorescent tube (slimline) lights encased in showcase fixtures were mounted top

Fig. 1. Schedule of words observed, daylight—1 and 2, without knowledge; 3 and 4, with knowledge

* Group 2 observed other half of alphabets

Fig. 2. Schedule of words observed, night—1 and 2, without knowledge; 3 and 4, with knowledge



* Group 2 observed other half of alphabets

and bottom at a distance of three feet from the signboard, and were darkened by partial masking with friction tape so that the intensity of illumination on the letters was between 12 and 18 foot lamberts. It was found that higher illumination caused halation which reduced visibility.

Each group consisted of from 25 to 29 observers (*Photo 6*). Each size, style, and degree of knowledge was represented by two words for each group of observers, or four words for both groups, so that the mean or median distance for a given size, style, light condition, and degree of knowledge represented 110 to 112 individual observations.

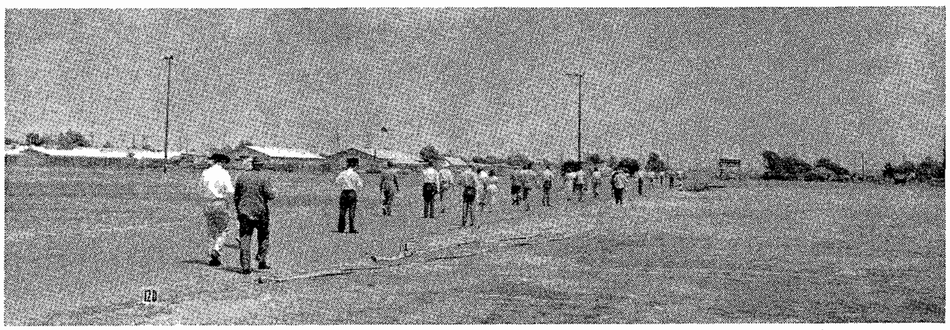


PHOTO 6—Observers recording reading distances (1,200-foot marker in foreground)

The observers walked toward each setup of six words, recording what they saw and the distance at which they saw it, as illustrated in *Photo 7*, starting from 2,000 feet away. Due to the varying sizes on each setup it was very seldom that two words were seen at equal distances, and due to the slight difference in sizes of the capitals and lower case, observers were unaware of which they were "supposed" to see first, and unable to reflect any conscious or unconscious prejudice for either kind of letter. However, observations made by representatives of the Traffic Department of the Division of Highways and by others professionally interested in signs were disregarded in the analysis.

The observers were male and female, ranging in occupation from junior clerks to principal engineers and in age from 18 to 70. Their vision was tested by reading a Snellen eye test chart at 20 feet in a brightly-lit office with both eyes open and wearing glasses if they had them. Under these conditions, vision varied from line 7 to line 11 on the chart, with line 9.2 being the average and line 10 being the median. Line 8, with one eye, is considered to be "20/20" vision, so it is concluded that the vision of the observers was somewhat better than "average." However, on the full-size signs, it was found that the observers who had a Snellen rating of 8, recorded exactly the same average distances for "scrambled" letters as did the whole group.

Results

An average California name having seven letters and a horizontal length of eight feet can be read by the average office employee at the following distances:

	Lower case (11.9-in. loops)	Capitals (12.1-in. high)
By daylight	1,560 feet	1,380 feet
By night illumination	1,130 feet	1,050 feet

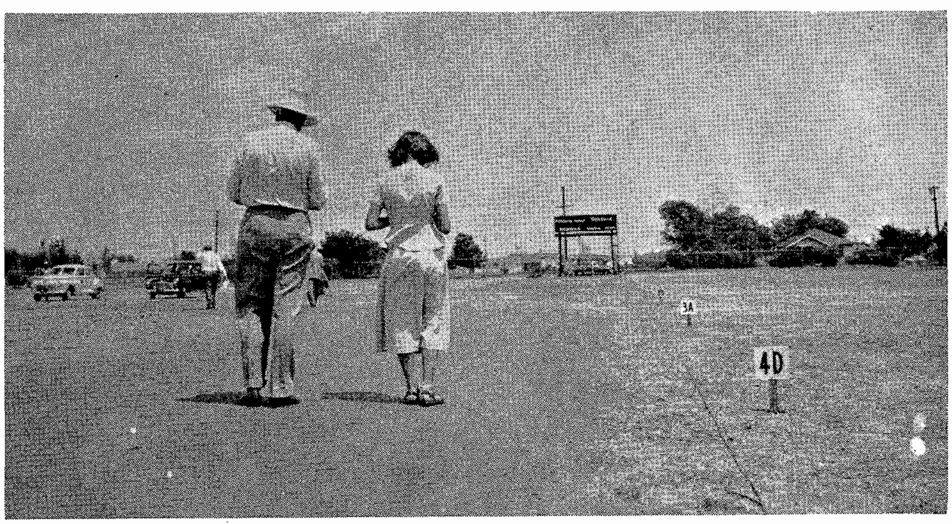
The choice of a parameter for purposes of comparing different alphabets can be argued interminably. Previous studies (2) have used letter height, because the height of all the capital letters of a given nominal size is nearly constant (letters with round tops and bottoms are about 3 percent higher than the others). These studies have established height-distance relationships for a constant height-width ratio, obtaining a different relationship for each different letter proportion. A rule-of-thumb which has been in use for many years is "50 feet per inch of height." * This is for a series D letter, but the value for a series E was greater and for a series C was less. For comparing the efficiency of alphabets having different proportions, therefore, letter height cannot be used, since the tall thin letters appear at a disadvantage compared with more "square" letters. Another way of stating the problem is: that height is a satisfactory parameter for comparing different sizes of the same series, or proportions, but it is unsatisfactory for comparing different proportions with each other. The same difficulty arises in attempting to compare lower case with capitals, but is even further complicated by the fact that one font of lower case contains letters of several different heights.

Two Approaches Used

To resolve this problem, two approaches may be used: (1) it may be assumed that physical controls exist at the site of the sign, and that this

* For estimating distance at which road signs are read by the average person, 100 feet per inch would be closer, according to the results of the present investigation. The previous tests determined distances at which observers detected misspellings of place names, instead of distances at which they recognized the words.

PHOTO 7—Sign bridge from 400-foot marker



control is the maximum length of sign for which there is room. In cantilevered signs, the length is also the most important consideration in computing wind and gravity stresses, and costs resulting therefrom; or (2) it may be assumed that the cost of the sign varies with the number of square feet of enamel, and that the most efficient sign is that which uses the least area for a given legibility distance.

For the purpose of sign design, it may be desirable to know the legibility distance of a given alphabet in terms of neat letter height, or loop height of lower case; in terms of gross height (guide line to guide line), depending on various assumption of line spacing; or in terms of sign length (center-to-center width of letters, including spacing, multiplied by the number of letters).

The results of our observations of lower case letters are shown in *Figures 3 (daylight) and 5 (night)*. Those for series E capitals are shown in *Figures 4 (daylight) and 6 (night)*.* These graphs are superimposed in *Figure 7* for comparison of lower case with capitals on the basis of sign length (approach No. 1, above). They are superimposed on the basis of sign area with different allowances for margins in *Figure 8*.

Lower Case Letters Favored

It will be seen that the differences are slightly in favor of the lower case letters unless very narrow horizontal margins are used on the capital letters, in which case capitals require less total area. These differences either way are not enough to be economically significant. However, the observations definitely prove that capital letter words are not significantly more legible on any basis, but on the contrary are slightly less eligible by most criteria.

It must be borne in mind that measurements were not made of time involved in reading either style; the glance legibility was not determined, either in terms of distance or glance time. This is an extremely important factor in freeway signs where split seconds of eyes-off-the-road are very important. The reason for not making these tests is simply that we did not

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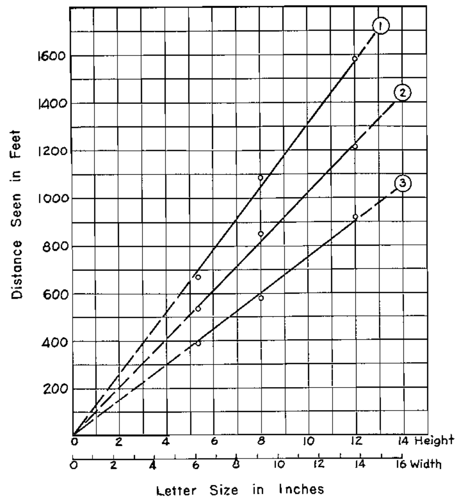


Fig. 3. Lower case, daylight. Average reading distance vs. letter size. (1) with knowledge; (2) without knowledge; (3) least legible single letters of six-letter groups

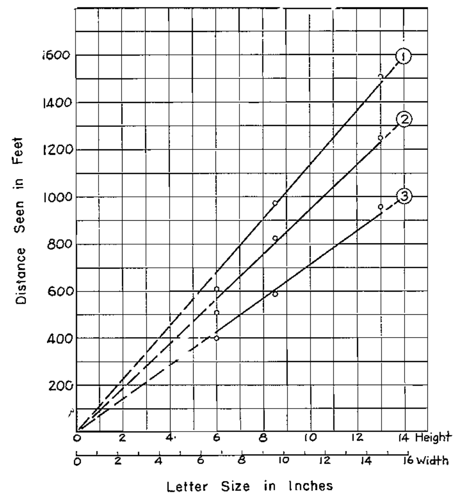


Fig. 4. Capitals, daylight

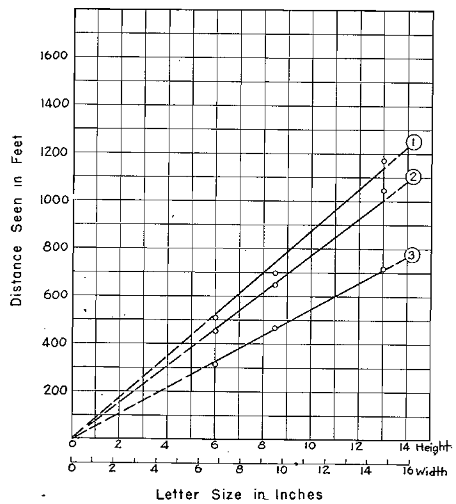


Fig. 5. Lower case, night

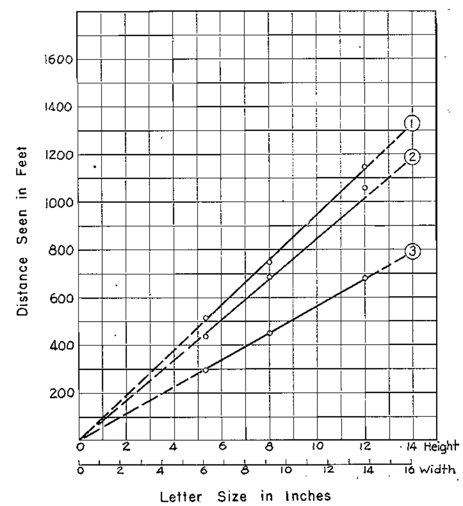


Fig. 6. Capitals, night

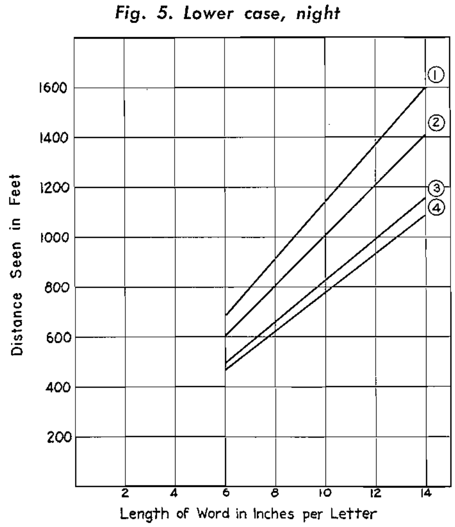


Fig. 7. Capitals vs. lower case, equal sign length, familiar place names. (1) lower case, daylight, (2) capitals, daylight, (3) lower case, night, (4) capitals, night

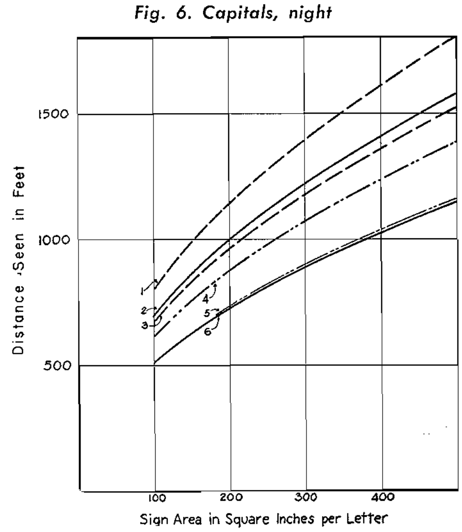


Fig. 8. Capitals vs. lower case, equal areas. (1) Capitals, daylight, 2 letter-heights per line. (2) Lower case, daylight, 3 loop-heights per line. (3) Capitals, daylight, 2½ letter-heights per line. (4) Capitals, night, 2 letter-heights per line. (5) Capitals, night, 2½ letter-heights per line. (6) Lower case, night, 3 loop-heights per line. (See Photo 8)

* Straight lines were fitted to the 3,939 individual observations by the method of least squares, using zero distance for zero height as one of the points on each line. Lines connecting group averages varied, as can be seen on the graphs, both upward and downward from straight, and both above and below zero at the zero abscissa.

Hollywood Freeway

Third Unit of Construction Between Grand Avenue and Silver Lake Boulevard Dedicated and Opened to Public Traffic

By HARRISON R. BAKER, California Highway Commissioner

CULMINATING a long period of planning, preparation and construction, the first unit of the important Hollywood Freeway was thrown open to traffic following dedicatory ceremonies on Wednesday morning, December 27, 1950.

This first unit comprised the 2½ mile section of the Hollywood Freeway, extending from Grand Avenue to Silver Lake Boulevard, and represented a cost in excess of $12,000,000. The over-all financing allocated to the Hollywood Freeway project, of which this section is a part, has been approximately $44,850,000.

The dedication ceremony was held under the auspices of the Los Angeles Chamber of Commerce and was attended by officials of the State of California, the California Highway Commission, members of the staff of the Division of Highways, officials of the City of Los Angeles, the County of Los Angeles, and many civic organizations which have been instrumental in furthering the freeway program of the State Highway System.

Praise for Petree

Presiding at the ceremony was A. J. Gock, President of the Los Angeles Chamber of Commerce. Neil Petree, former Chairman of the Metropolitan Traffic and Transit Committee of the chamber, who for more than a decade has been an indefatigable worker for freeways. He was praised by all the speakers for his outstanding efforts which are bearing fruit as evidenced by the steady progress being made in the development of the Los Angeles metropolitan freeway system.

Lieutenant Governor Goodwin J. Knight represented Governor Earl Warren. He expressed the hope that the Hollywood Freeway and other freeways will reduce traffic accidents.

Highway Commissioner Harrison R. Baker speaking at ceremonies dedicating Hollywood Freeway

"I am grateful that I have the opportunity to dedicate this section of the Hollywood Freeway to the people of Los Angeles," said Director of Public Works C. H. Purcell, who is chairman of the California Highway Commission. "It is a tribute to those who gave their time and efforts to make it a reality. The remainder of the freeway connecting downtown Los Angeles with the San Fernando Valley should be completed by 1953."

It was my pleasure as a member of the Highway Commission to point out that already $44,500,000 has been expended on the freeway and many more millions will be spent. The commission expects to spend $17,500,000 during the next year.

"Here, at last," said Mayor Fletcher Bowron, "we find our dreams come true. This project is the result of cooperation between state and city governmental agencies. It is the beginning of a great freeway system."

Other speakers were Highway Commissioner James A. Guthrie of San Bernardino and Charles T. Leigh, San Diego; State Highway Engineer George T. McCoy, Senator Randolph Collier, co-author of the Collier-Burns Act and Chairman of the Senate Interim Committee on Highways, Streets and Bridges; Harold Henry, President of the Los Angeles City Council; Roger Jessup, Chairman of the Los Angeles Board of Supervisors; Sheriff Eugene Biscailuz and Spencer V. Cortelyou, retired assistant State Highway Engineer who launched construction of the freeway.

After the speech making, some 200 officials and other participants in the dedication ceremony entered autos and led by a car driven by Felix Chappelet, Chairman of the Chamber of Commerce Freeway Subcommittee, and containing Lieutenant Governor Knight, Mayor Bowron and Gock, drove through a crepe barrier and made a round trip from Grand Avenue to Silver Lake Boulevard. Hundreds of motorists followed them.

A $13,000,000 section of Hollywood Freeway was open to traffic.

Backbone of Freeway System

For the past 10 years the District VII organization of the State Division of Highways has considered the Hollywood Freeway as its number one freeway project. The Hollywood Freeway is what might be called the "backbone" of the Metropolitan Los Angeles Freeway System. It is 10 miles in length, extending from Spring Street in the Los Angeles Civic Center area northwesterly to Vineland Avenue in the San Fernando Valley. The first unit of completed construction, 1½ miles in length, extending from Highland Avenue to Barham Boulevard in the Cahuenga Pass area, was opened to traffic the first of the year 1940. This was a Los Angeles City contract financed cooperatively with city, federal and state highway funds. Further construction on this important freeway was delayed until additional state highway funds could be provided as was done under the Collier-Burns Highway Act of 1947. With the additional financing thus made available, it was possible to proceed with the acquisition of rights of way and construction on the Hollywood Freeway.

Seventeen Contracts

The second unit to be completed was opened to traffic outbound in November, 1948, and inbound in January, 1949. This contract was two miles in length, extending from Barham Boulevard in Cahuenga Pass to Vineland Avenue in the San Fernando Valley, and was completed at a cost of $2,105,000.

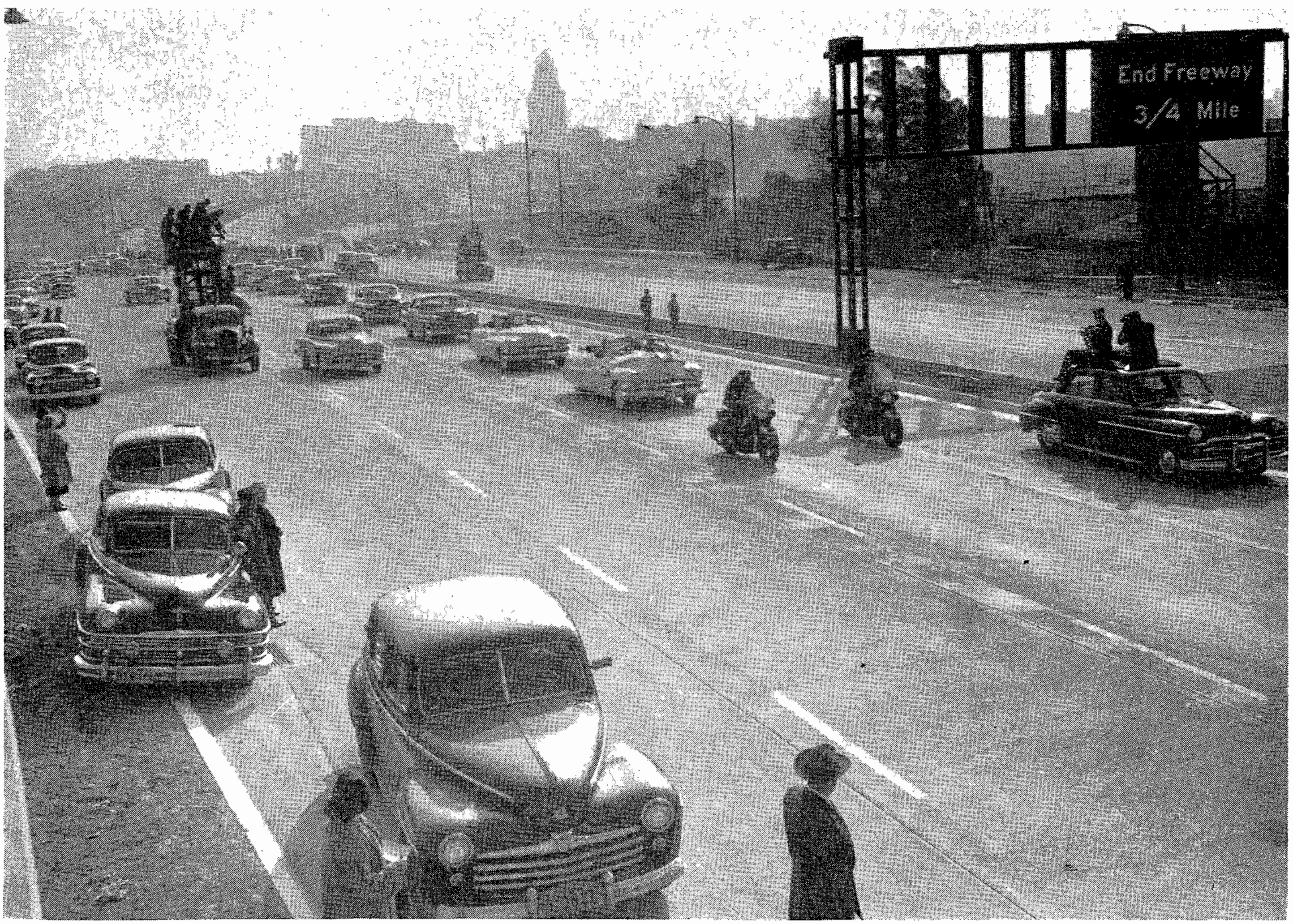
The third unit of construction on the Hollywood Freeway just recently completed and opened to traffic, extending 2½ miles from Grand Avenue to Silver Lake Boulevard, cost a total of $12,000,000, and required the carrying out of 17 construction contracts.

Four-level Structure

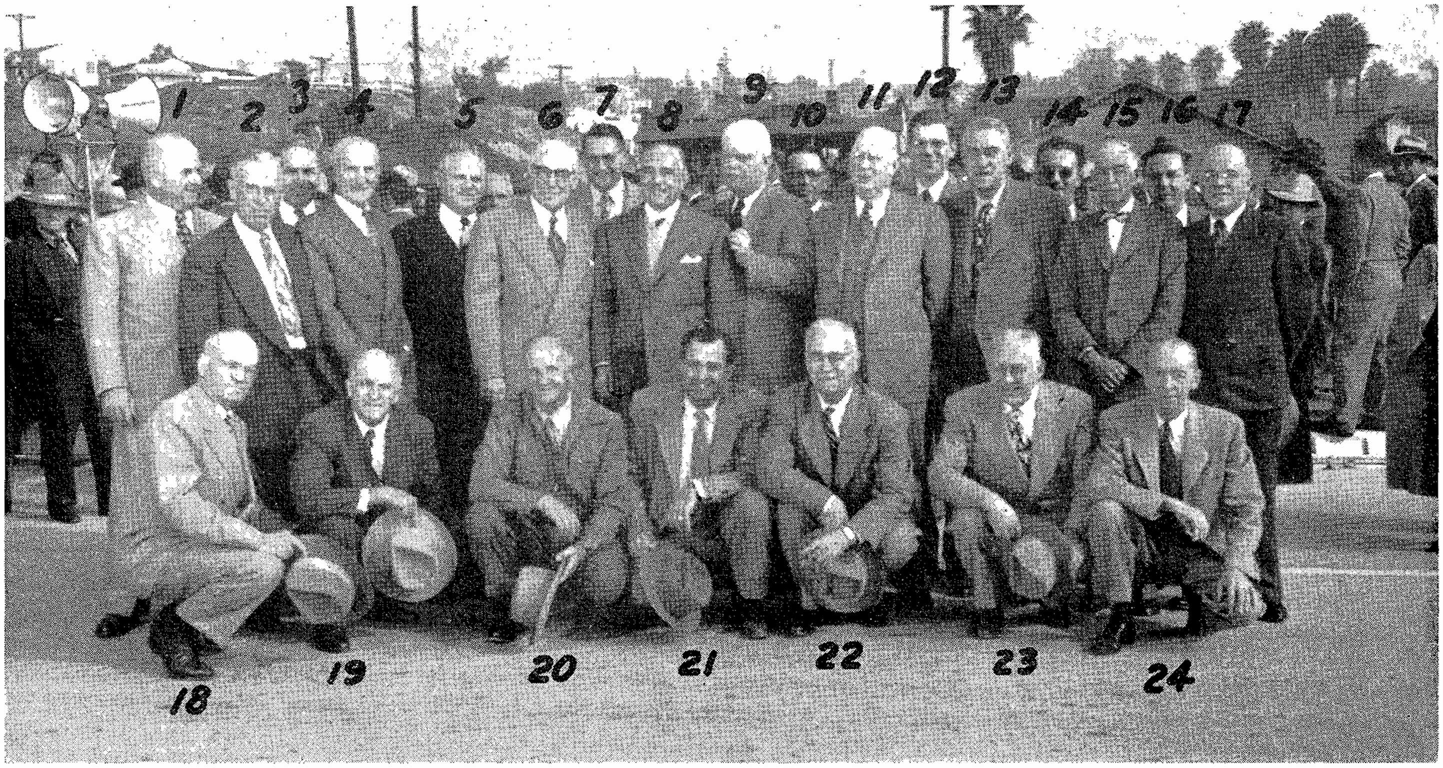
The necessity for having so many separate contracts was to carry out the work in the most economical and expeditious manner. In general, the procedure has been to advertise and let the construction contracts for bridge structures at grade separations first, and then to follow up later with grading and paving contracts.

Mention should be made that in this third section that is now open and being used by public traffic is the unique 4-level grade separation structure at the junction point of the Hollywood Freeway with the Harbor Freeway and the Arroyo Seco Freeway. This arrangement for handling grade separation and interchange traffic provides four separate roadway levels that pass or cross one another in a single bridge structure. The result is economy of construction cost and greater facility in the handling of traffic flow through the interchange. As of the present time, only the highest level of the 4-level grade separation structure is in use. Other levels of this bridge will be utilized later on as future

Official cars leading traffic over newly completed Hollywood Freeway following dedicatory ceremonies



Looking westerly over Alvarado Street interchange structure. In center is Rosemont Avenue bridge crossing with Benton Way bridge crossing in extreme background

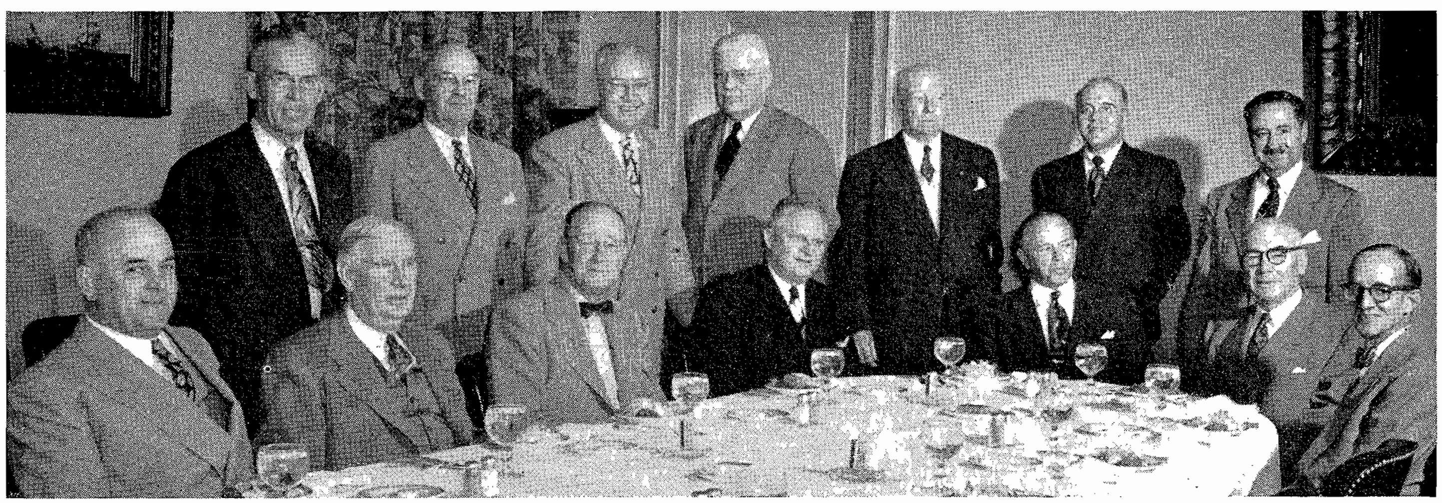


In this group are the men who conceived and constructed the new Hollywood Freeway. BY NUMBERS THEY ARE: 1. Frank C. Balfour, Chief Right of Way Agent; 2. W. L. Fahey, District Highway Engineer, Los Angeles; 3. J. W. Green, Supervising Bridge Engineer; 4. S. V. Cortelyou, Assistant State Highway Engineer, retired; 5. Harrison R. Baker, Highway Commissioner; 6. C. H. Purcell, Director of Public Works; 7. G. Langsner, Supervising Highway Engineer; 8. Harold A. Henry, President Los Angeles City Council; 9. F. W. Panhorst, Assistant State Highway Engineer (Bridges); 10. F. B. Cressy, Supervising Highway Engineer; 11. Jas. A. Guthrie, Highway Commissioner; 12. G. T. McCoy, Jr., Senior Highway Engineer; 13. G. T. McCoy, State Highway Engineer; 14. E. G. Bower, Senior Highway Engineer; 15. L. H. Gibson, District Highway Engineer, retired, San Luis Obispo; 16. J. W. Greeley, Associate Highway Engineer; 17. E. F. Wagner, Deputy Chief Right of Way Agent; 18. R. C. "Cass" Kennedy, Secretary of the Highway Commission; 19. Earl A. Parker, Senior Highway Engineer; 20. Herb Belford, Associate Highway Engineer; 21. Haig Ayanian, Senior Highway Engineer; 22. Alex Black, Assistant Highway Engineer; 23. P. O. Harding, Assistant State Highway Engineer in charge of Los Angeles office; 24. E. B. Curry, Senior Highway Engineer

connecting construction with Arroyo Seco and Harbor Freeways is carried out. On page 16 the 17 contracts are listed.

Unusual Economies

The last two contracts to be completed on this section of the Hollywood Freeway that is now open to public traffic were the two contracts with the N. M. Ball Sons Company. The first of these contracts extended from Grand Avenue to Glendale Boulevard



Following the dedication of the Hollywood Freeway, engineers of the Division of Highways and members of the California Highway Commission were tendered a luncheon by the Los Angeles Department of Airports. STANDING (left to right): W. L. Fahey, District Engineer, Los Angeles; R. C. Kennedy, Secretary, Highway Commission; Paul Harding, Assistant State Highway Engineer; F. W. Panhorst, Assistant State Highway Engineer; Joe Hartley, Commissioner of Airports; E. F. Wagner, Deputy Chief of Right of Way; Woodruff De Silva, Department of Airports. SEATED (left to right): Frank C. Balfour, Chief Right of Way Agent; Highway Commissioners James A. Guthrie, San Bernardino; Chas. T. Leigh, San Diego; Harrison R. Baker, Pasadena; Admiral Reeves, Department of Airports; C. H. Purcell, Director of Public Works; Airport Commissioner Ray Smith

Type of Construction	Contract	Resident Engineer
Grand Avenue Overcrossing	Oberg Brothers	W. V. Cryderman
Storm Drain	Chas. T. Brown Co.	B. N. Frykland
Four-level Grade Separation Structure	Jas. I. Barnes Construction Co.	H. R. Lendecke
Figueroa Street Undercrossing	Carlo Bongiovanni	J. M. Curran
East Edgeware Road Overcrossing	J. E. Haddock, Pasadena	E. B. Brier
Glendale Boulevard Overcrossing	J. E. Haddock, Pasadena	Jack Sylvester
Benton Way Overcrossing	Byerts & Dunn, Los Angeles	Jack Sylvester
Bonnie Brae Overcrossing and Beaudry Avenue Undercrossing	J. E. Haddock, Pasadena	E. B. Brier
Alvarado Street Undercrossing	Guy F. Atkinson Co., Long Beach	W. B. James
Rosemont Avenue Overcrossing	Spence Webb Co., Inglewood	A. K. Gilbert
Vendome Street Undercrossing and Coronado Street Undercrossing	Chas. McCloskey Co., San Francisco	W. H. Johnson
Silver Lake Boulevard Undercrossing	Guy F. Atkinson Co., Long Beach	W. H. Johnson
Boston Street and Edgeware Road Grade and Pave	McClain Construction Co., Hawthorne	B. N. Frykland
Boston Street Extension Grade and Pave	Dragline Rentals Co., Wilmington	B. N. Frykland
Virgil Avenue to Glendale Boulevard Grade and Pave	N. M. Ball Sons, Alhambra	H. E. Belford
Glendale Boulevard to Grand Avenue Grade and Pave	N. M. Ball Sons, Alhambra	Haig Ayanian
Virgil Avenue to Grand Avenue Lighting and Signs	Newberry Electric Corp., Los Angeles	R. E. DeGroff

and the second extended from Glendale Boulevard to Virgil Avenue. The fact that this company was the low bidder on two adjoining contracts of a similar nature made possible the working out of unusual economies in construction operations and gave the State the benefit of having construction more expeditiously completed than might have otherwise been the case. For details concerning the construction of these two contracts, reference may be made to page 17 of the July-August 1950 issue of *California Highways and Public Works*.

The completed construction provides four lanes in both directions for moving traffic. These lanes are 12 feet in width, consisting of 8-inch thickness of Portland concrete cement pavement on cement treated subgrade. Acceleration and deceleration lanes of adequate length are provided for all on and off ramps to the freeway. In general, rolled type combination curbs and gutters are provided throughout so that emergency parking entirely off the pavement can be obtained by drivers who find stopping necessary because of mechanical difficulties. The freeway is prohibiting parking or stopping of vehicles on the pavement throughout its entire length. Barrier type curbs are provided where bridge piers or other obstructions make it impossible to provide for safe off pavement parking and also at points where it is necessary to guide and direct traffic at the location of on and off ramps.

An engineering feature of great importance that should be mentioned is the construction of additional roadways for busses at the Alvarado Boulevard undercrossing. At this location the State was informed by the City of Los Angeles that bus companies to operate on the freeways required facilities of tranfer of passengers at this location. The city entered into an agreement with the State that the additional cost of constructing the bus turnout roadways and the stairways for the convenience of passengers would be paid for by the city. It is the intention of the city to seek reimbursement for the amount so expended from franchise fees which will be assessed against the bus companies utilizing these facilities.

The next and fourth unit of the Hollywood Freeway to be completed and opened to traffic will be a northwesterly extension between Virgil Avenue and Western Avenue. This 1.7 miles of construction is now in progress under contract with the Griffith Company. It is anticipated this construction will be completed during September of this year.

Including the Griffith Company contract, construction work now in progress on the Hollywood Freeway is as follows:

Description	Contractor	Resident Engineer	Estimated construction cost (including engineering)
Eight-lane Freeway, Western Avenue-Virgil Avenue	Griffith Company	John Ritter	$1,719,000
Wilton Place Overcrossing	Geo. W. Peterson and Jack W. Baker	W. B. James	352,000
Hollywood-Santa Monica Grade Separation	Chas. MacClosky	W. A. McIntyre	592,000
Fountain Avenue Overcrossing	Oberg Constr. Co.	C. B. Oustad	362,000
Sunset Boulevard Overcrossing	Lars Oberg	J. M. Peterson	343,000
Van Ness Avenue Overcrossing	J. E. Haddock	L. E. Crayne	358,000

Big Right of Way Job

The District VII right of way organization is to be commended for the fine work done in obtaining and clearing rights of way for the Hollywood Freeway. As of this date, substantially all of the right of way needed for the Hollywood Freeway throughout its entire length has been obtained excepting for a few parcels largely in the Hollywood area that are yet to be acquired. Most of the parcels of land needed for the right of way were settled for by negotiation and only in a very few instances has it been necessary to resort to eminent domain proceedings. Indicating the extent and importance of the right of way work it is interesting to note that 1,643 buildings have been moved from the right of way and 76 buildings which it was not possible to move, have been demolished, and that the expenditure for right of way and utilities to date has been over $23,000,000.

The approved State Highway Budget for the next fiscal year (July 1, 1951 to June 30, 1952) which is now before the Legislature for adoption as a part of the Governor's Budget, contains allocation of funds for expenditure on the Santa Ana and Hollywood Freeways from the Los Angeles River to Vineland Avenue, as follows: For right of way acquisition, $1,000,000; for construction, $3,785,000.

These freeways join at Spring Street in the downtown Civic Center area and while these sums will be jointly available for both freeways it is anticipated that the larger portion of these funds will be expended on the Hollywood Freeway section. It is the intention of the State Division of Highways and the State Highway Commission to allocate sufficient funds in subsequent budgets so that the Hollywood Freeway can be completed throughout and opened to traffic by the end of 1953.

The California Highway Commission has allocated for the Fiscal Year 1951-52 on the Hollywood, Harbor, Santa Ana and Ramona Freeways a total in excess of $17,500,000.

OLD FORT MOORE HILL IN LOS ANGELES GIVES WAY TO FREEWAY

ONCE the scene of battle, later the site of the town's gallows, and still later the center of the social life of the lusty, growing City of Los Angeles, old Fort Moore Hill has disappeared before the march of freeway progress.

Costing over $1,000,000, the contract to remove some 900,000 cubic yards of material has been completed. The contract, signed in January, 1949, included the construction of the Broadway overcrossing bridge. Work on this immense project started on March 31, 1949, and the completion date for removal of all this material has finally arrived.

It was no easy job to do. Much planning was done before the original specifications were written. More planning was done by all the contractors who placed their bids for doing this job.

The Guy F. Atkinson Co. won the contract and installed a six cubic yard electric shovel to do the work. A special substation was installed by the Los Angeles Bureau of Power & Light as this shovel used 2,300 volts of electricity instead of the usual household current of 110 volts or the 600 volts of direct current used by streetcars.

This immense undertaking resulted from a three-way cooperative contract between the City of Los Angeles, the County of Los Angeles and the State Division of Highways. Under the agreement the city and the county allotted certain sums of moneys to the State Division of Highways, and the Division of Highways was given full control over the entire project.

Much of the preliminary work was done under the supervision of S. V. Cortelyou, Assistant State Highway Engineer in charge of District VIII. After Cortelyou retired, the final work

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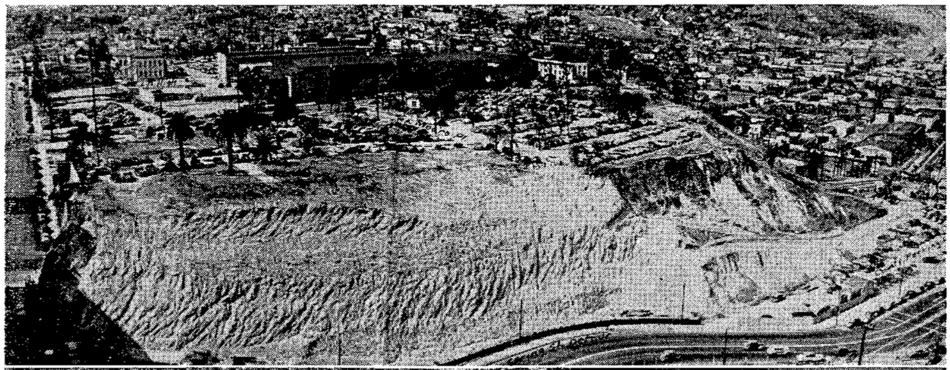
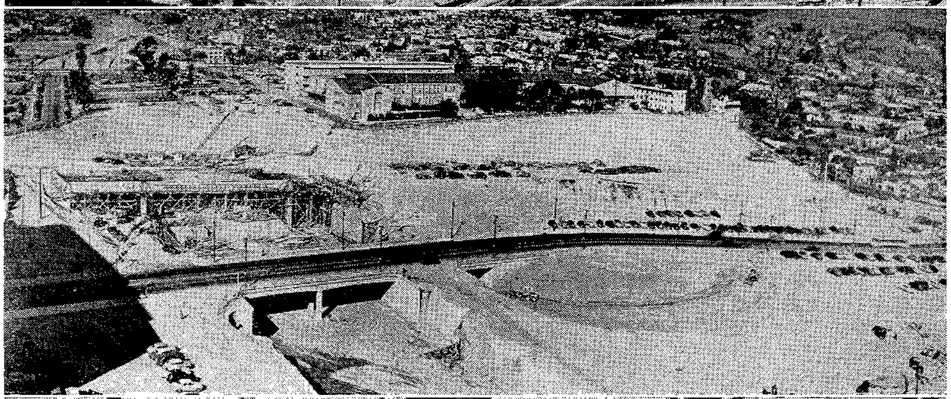
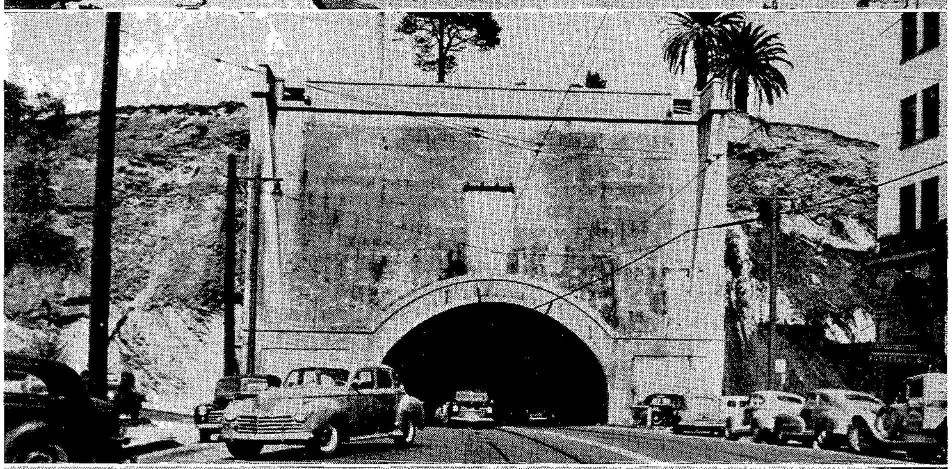






UPPER—Site of original Fort Moore as it looked a year ago. CENTER—Fort Moore Hill today showing Hollywood Freeway crossed by Broadway in foreground and above it, Hill Street under construction. LOWER—The old Broadway Tunnel looking north and below it the modern highway which replaced it. Both photographs taken from same location looking north

Panamint Road

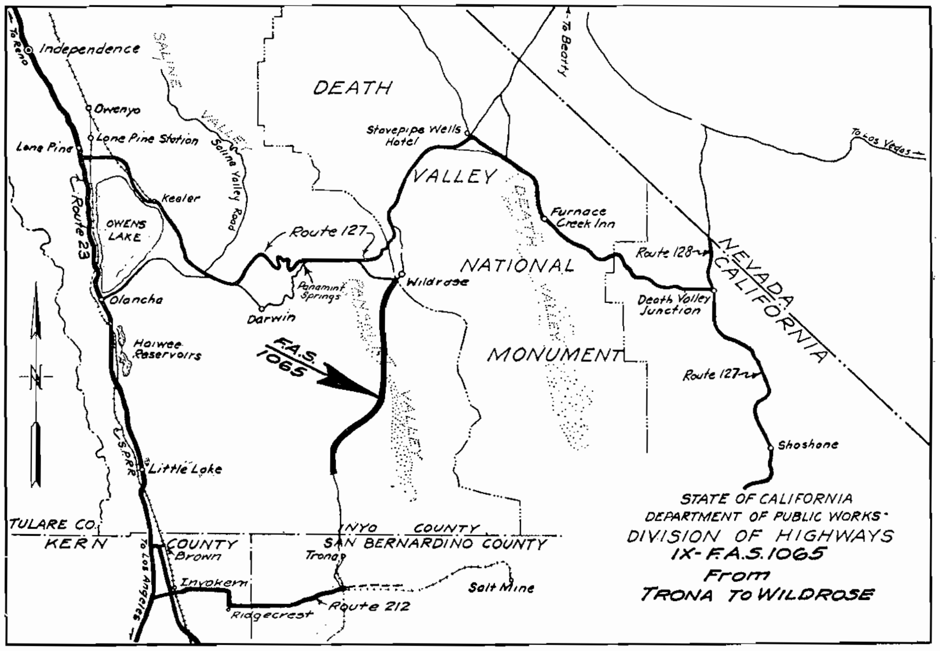
Inyo County Constructs 25.6 Miles of Federal Secondary Route 1065 Into Death Valley

By F. N. ROBERTS, Associate Highway Engineer

LYING just west of the Panamint Mountains and famous Death Valley, the recently completed Trona to Wildrose road provides a much needed improvement in one of the two westerly entrances to Death Valley National Monument. The improvement begins 11 miles north of Trona, end of an old oiled surface, crosses the Slate Range and Panamint Valley and enters the monument at the mouth of Wildrose Canyon.

It was financed from Federal Aid Secondary funds with supporting funds from Inyo County and was divided into three contracts.

The first contract, five miles in length, crosses the Slate Range and ends at Water Canyon at the foot of the north slope of the Slate Range. It was constructed by the Swedlow Engineering Company of Van Nuys. Arthur A. Johnson of Laguna Beach was the contractor on the second unit, 15 miles through Panamint Valley, leaving the five miles into Wildrose Canyon for the final contract completed later in 1949 by Dicco Inc. & Dix-Syl Construction Co. Inc., of Bakersfield.



Hard Rock Formations

On the north side of the Slate Range the slopes are precipitous and a great many different formations of rock were encountered during construction, some of which were so hard and abrasive that the ordinary pneumatic drill bit would hardly make an impression.

Ordinary roadway excavation was accomplished by bulldozers and carry-alls. In the rocky areas it was done by power shovels with bulldozers pioneering the cuts and making construction roads.

The second and third units were constructed by carry-alls and dozers. No water was used on the project as the distance to water made its cost prohibitive. A minimum of 85 percent compaction was maintained. Owing to the prevailing low rainfall it is probable that the condition of the roadbed will not be affected by moisture.

Eight percent is the maximum grade and 168 feet is the minimum radius of curvature. A penetration treatment of three-fourths gallon of SC-2 or SC-3 per square yard was used. Imported borrow as topping material covers almost the entire project. The county proposes to place a blanket of road-mixed surfacing on top of the penetration in the near future.

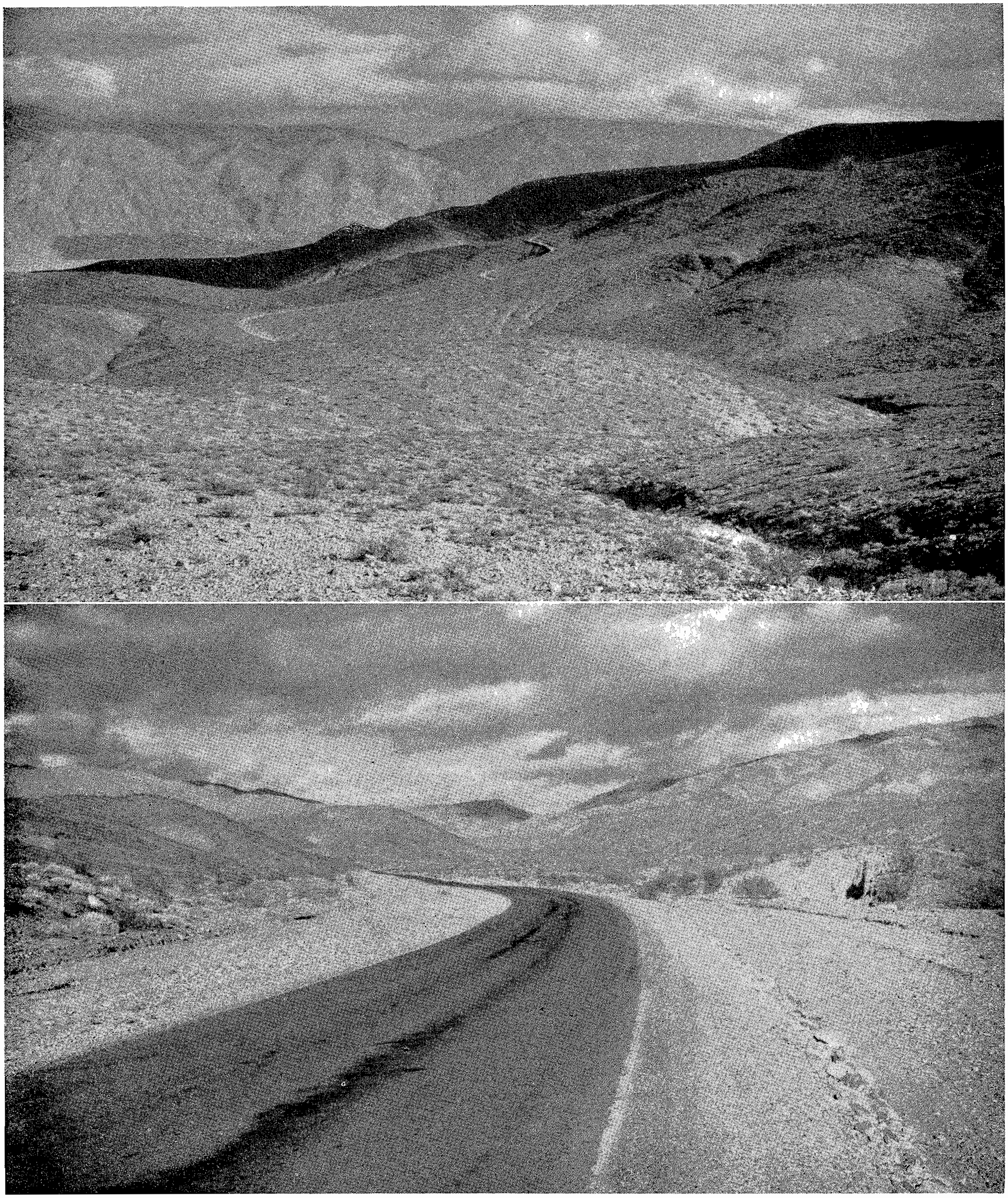
High Grades Eliminated

The new road replaces several existing roads which were used at different times in prior years and which have grade as high as 20 percent and are one-way with only occasional turnouts for passing.

Panamint Valley and the mountains on each side were the scene of much mining activity in earlier days. It is only a short distance from Bad Water in Death Valley to the scene of construction as the crow flies, but the towering Panamint Mountains with Telescope Peak rising to an elevation above 11,000 feet present an almost impassable barrier between the two valleys. Some of the famous old mines are the Modoc, the Panamint, the Minnietta, the Burro and the World Beater. The ghost town of Ballarat is located in the valley while Panamint City was located high in Surprise Canyon in the Panamint Mountains. The first ore from the Modoc mine was transported over the Argus Range to San Pedro and shipped to Swansea, England, where the only process which would extract the value was in operation at that time. Later it was shipped to Darwin when the smelter was built there and still later it had its own smelter at the mine.

Old Kilns Restored

There was also a smelter at Panamint City. Charcoal for all the smelters was supplied from the kilns at the head of Wildrose Canyon. These kilns have been restored to their original condition and are now one of the main points of interest in Death Valley National Monument.



UPPER—Looking north into Panamint Valley from north side of Slate Range, showing old Nadeau Road. LOWER—New road climbing out of Panamint Valley toward Wildrose

History of the roads in this area is as colorful as the mining activity. In the early days it was a gigantic task to supply the mining towns and to transport the ore or bullion out. A stage line ran from Mojave through what is now Trona, over the Slate Range at the site of the present crossing, to Ballarat and Panamint City on the east side of the valley, crossing the north end to the Modoc, thence south to Shepard Canyon, across the Argus Range to Darwin which in those days was larger than the City of Los Angeles.

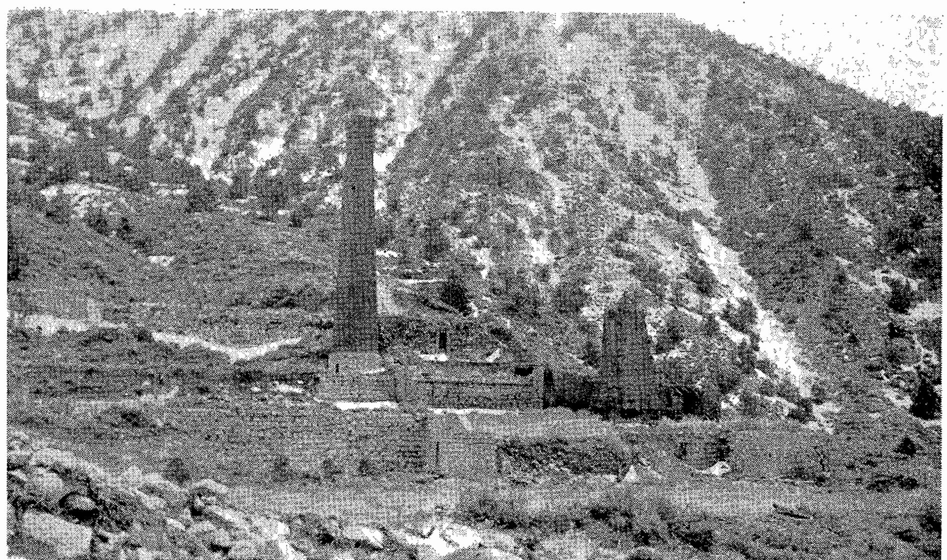
First Road

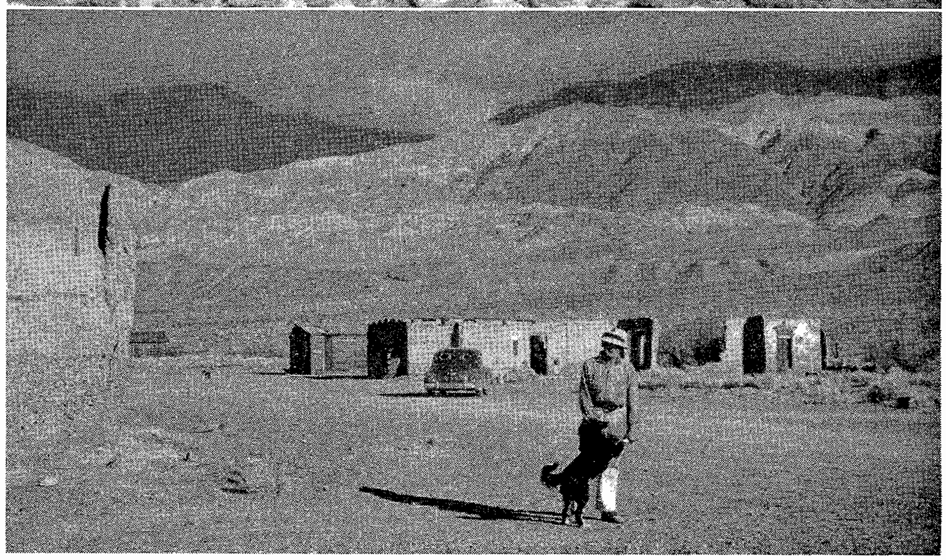
Remi Nadeau, an old time freighter, was responsible for constructing a road on the west side of the Panamint Valley serving the mines on that side and crossing the Slate Range at the south end of the valley. This road stills bears his name but fell into disuse when the mining activity ceased, and is now impassable to the ordinary car except from Water Canyon south, which portion has been used up to the present time. Much Chinese labor was used in its construction and the mammoth task is evidenced by the many hand placed rock slopes used in retaining the embankment on the steep side slopes, still standing and usable to date.

In later years when mining stopped and Death Valley was made a national monument the present road was constructed more nearly in the center of the Panamint Valley from the mouth of Wildrose Canyon to a connection with the Nadeau road at Water Canyon, making a new connection with the road leading to Ballarat, Panamint City and Indian Ranch.

Maintenance of the roads in this vicinity up to 1930 was spasmodic and consisted of light dragging supplemented by laborers hand picking rocks from the surface. A light coating of gravel was spread by the Civilian Conservation Corps but this improvement was nullified by the increased travel which badly corrugated the surface and increased the burden of maintenance.

The increasing travel through Trona into Death Valley from 1935 on made some improvement in the roads seem necessary. In 1937 efforts to obtain improvement were started but it was not until 1945 that funds became available through the FAS program. The project was completed late in 1949 in time for the Death Valley Centennial Celebration. With the addition of the proposed road-mixed surfacing this highway should serve increasing tourist traffic for many years.





UPPER—Panamint City, showing ruins of old smelter and brick furnaces, the foundations of which were hand-hewn rock. LOWER—Old ghost town of Ballarat. "Seldom Seen Slim," veteran prospector, is the only inhabitant

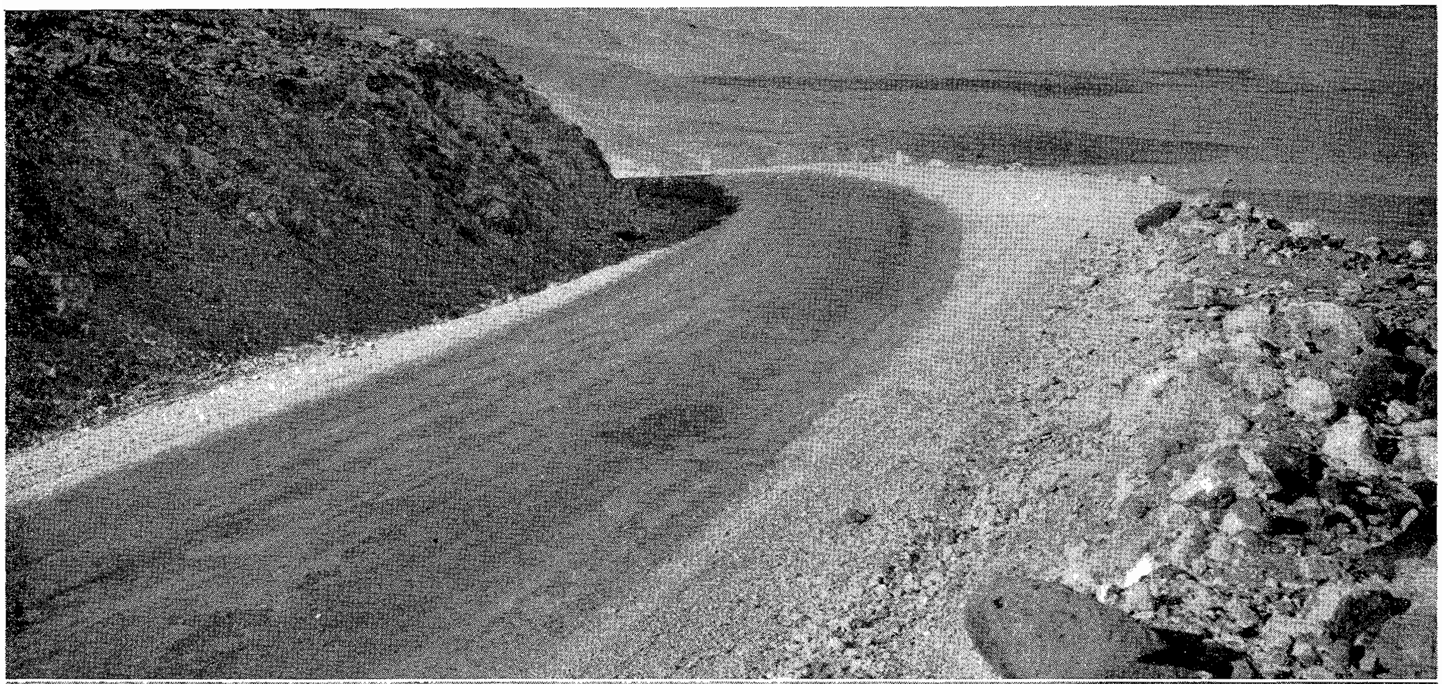
Old Fort Moore Hill

Continued from page 17 . . .

is coming under the direction of Paul O. Harding, present Assistant State Highway Engineer now in charge of District VII.

Practically all the resources of the State Division of Highways have been involved in the engineering features of this undertaking. Excavating and removal of the hill and the old Broadway Tunnel are but two of many problems that confronted the engineers when the decision was made for the routes of the freeway program. Drainage, bridges, entrances and exits to and from the freeway, traffic problems, right of way problems, everything has entered into this freeway program.

UPPER—New road at summit of Slate Range. Panamint Valley below. CENTER—New road winding down Slate Range into Panamint Valley. LOWER—New road through Panamint Valley



Colorado Freeway

Bridge Over Arroyo Seco Has Unusual Design Problems

By C. H. DARBY, Senior Bridge Engineer

MANY unusual conditions confronted the engineers planning and designing the Arroyo Seco Bridge on the Colorado Freeway in Pasadena. Problems seldom met in the design of larger bridges arose with the first preliminary studies and continued throughout the design. The highway engineer's modern thesis that bridge design should be subordinated to road design and the free flow of traffic should be the paramount concern of the latter had at last seriously involved a major structure.

Strict limitations of topography, a deep ravine within a few hundred feet of the main business section of a city of 100,000 population, necessitated placing ramps and curves on the deck of a structure whose size and location would ordinarily have dictated the design and planning of the entire project. Selection of type and architectural design was made more difficult than usual by the immediate proximity of the Colorado Street Bridge. Technical design calculations were complicated by curvature and superelevation, excessive width, variation in width, asymmetry of arch ribs and the magnitude of the structure.

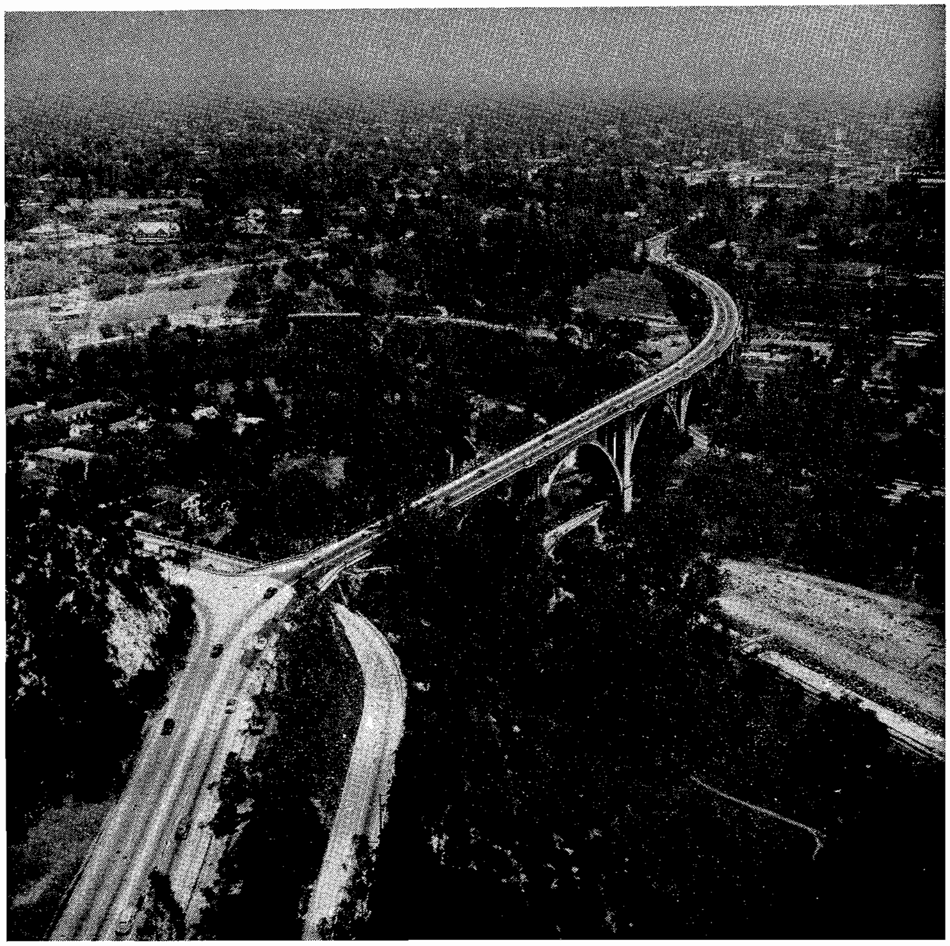


PHOTO 1—Old Colorado Bridge looking east toward Pasadena, showing main topographic features of the site of the new bridge

Topographic Features

Main topographic features of the site are shown in *Photo 2*. The Arroyo Seco is one-quarter to one-half mile wide, 150 to 300 feet deep, and about 15 miles long. The watershed extends from the southwesterly San Gabriel Mountains to the Los Angeles River about two miles north of the Los Angeles City Hall. There is water in the channel after heavy rains in the mountains, sometimes in such quantities as to be dangerous to structures on or near the floor of the arroyo. However, debris from the mountainous section of the watershed is controlled by the Devils Gate Dam and most of the channel below the dam has been lined with concrete by the Los Angeles County Flood Control District.

The channel at the bridge site is one of the few points not so improved. The arroyo is about 1,500 feet wide at this point and it is approximately 170 feet from the bottom of the canyon to the plateau on the east side and about 300 feet to the top of a low range of hills on the west side. The site is covered by a moderate growth of eucalyptus and oak trees with homes located throughout the wooded areas, except in the lower levels of the ravine.

Colorado Street Frontage Road

The major thoroughfare in this area is Colorado Street, extending from Glendale through Pasadena. It is one of the principal streets in the business section of the latter city. It is on the same level as the freeway and will remain in use as a service or frontage road along the freeway. A system of minor city streets and two through roads traverse the area below the proposed freeway. The roads, Linda Vista Avenue and Arroyo Boulevard, provide connections to the Pasadena Rose Bowl, which is only one mile from the bridge site.

The final road composition is shown in *Figure 1*. The six-lane freeway will be bordered by the frontage road on the south. Off-ramps from the freeway and frontage road to Linda Vista Avenue will connect about 1,000 feet from the west end of the bridge. One of these ramps will require a separation structure from the frontage road, and the combined ramps will cross under the westerly spans of the two Arroyo Seco bridges. The junction of the Linda Vista Avenue on-ramp to the freeway will be about 300 feet from the west end of the bridge. Traffic from Linda Vista, and adjacent areas north of the bridge, to Pasadena will use one of the alternative routes, such as El Circulo Drive, Arroyo Boulevard, or Holly Street. The Colorado Street "on" and "off" ramps connect the freeway with the business section of Pasadena.

Ramp Design Problems

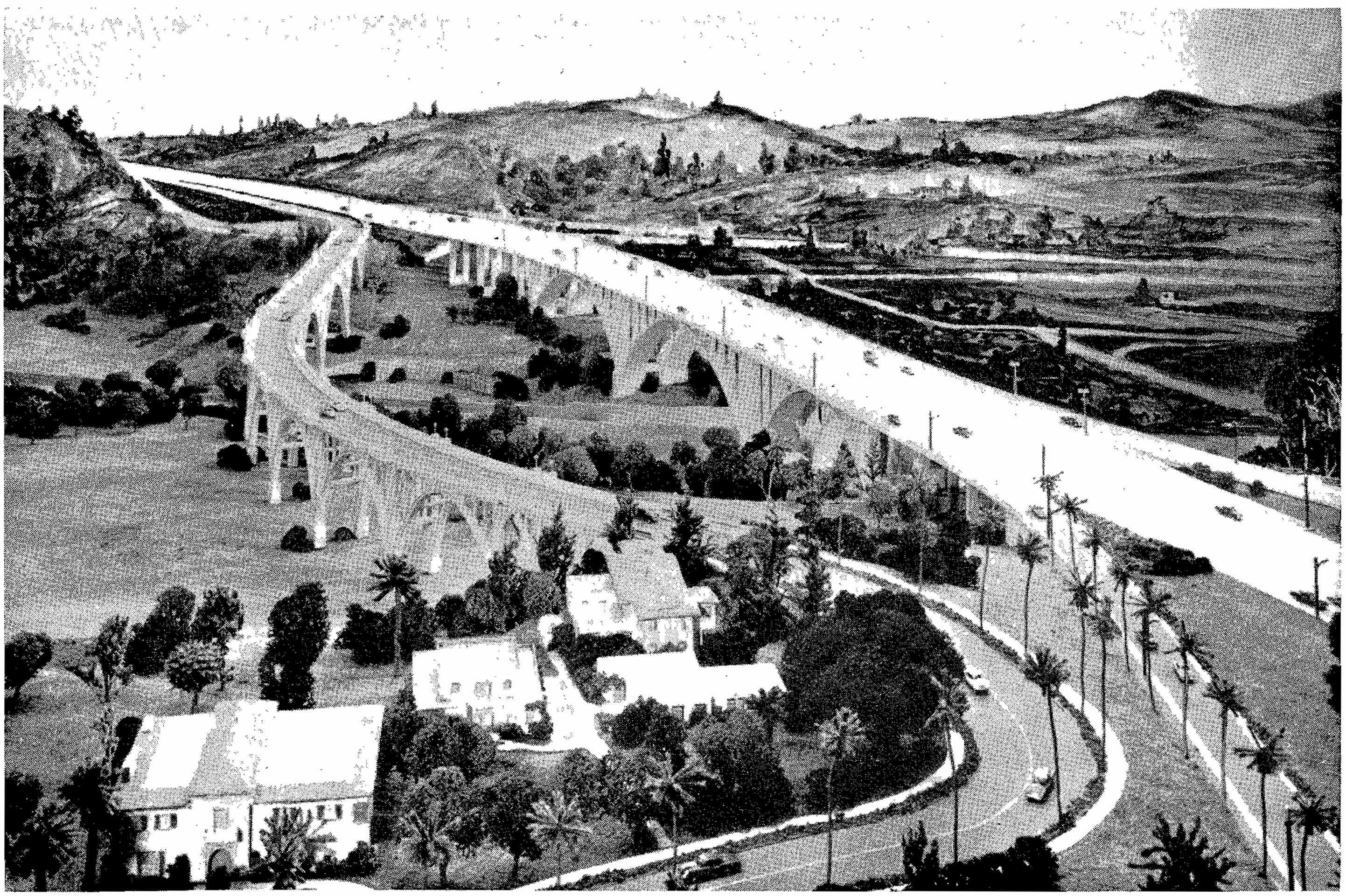
A separation will be required at the east end of the project to carry the Colorado Street on-ramp over the freeway. These ramps, which begin at about the middle of the bridge, cause much of the difficulty in architectural and structural design, as the width of the bridge must be varied from 93 feet 6 inches at Pier 7 to 171 feet 4 inches at Abutment 12 to accommodate them. Additional design complications are caused by the 2,000-foot radius curve on the westerly 650 feet of the bridge. This curve extends beyond the first 230-foot arch span. See *Photo 3*.

When studies for the bridge were resumed after World War II the freeway and road plans were being definitely established; the general road plan had been decided and the bridge planning had a definite basis upon which to proceed. The principal factors governing the preliminary studies were the retention in service of the existing Colorado Street Bridge, the alignment and geometric design of the freeway, and a steep rise in labor costs which had upset many of the prewar estimates on type comparison.

Built in 1913

The Colorado Street Bridge was built in 1913 by the City of Pasadena and Los Angeles County. It is composed of nine concrete arch spans and a concrete approach viaduct at each end. The total length is 1,460 feet and the deck is about 150 feet above the channel floor. It is an impressive, pleasing structure on a beautiful site and has become one of the famous landmarks of the locality. Its presence placed definite limitations on structural and architectural features of any structure proposed in this vicinity. It could not be duplicated for two reasons: economy and appearance. Increased labor costs had made structures with such complex detail uneconomical many years ago, and a repetition of some of the ornate details would detract from the appearance of both bridges.

PHOTO 2—This photograph shows the general relation of the existing and proposed Colorado Street bridges in Pasadena. This finished appearance has been accomplished by Van Der Goes, Bridge Department artist, who retouched a photograph of a model of the bridge. Bids will be opened on this project in Los Angeles March 8



The preliminary design problem, therefore, became not only one of selecting the most suitable structure for the terrain but also of providing a bridge type and style which did not conflict in appearance with the existing bridge.

Many Types and Styles

Studies were made for many types and styles of bridges. Some of the types given consideration were arch bridges of three, five, and seven spans, each with two, four, six, or eight ribs; Roman viaduct style bridges; long steel beam spans and deck trusses on high piers; and box girders on round, modernistic concrete pier shafts. The latter had many favorable aspects when considered for the natural site alone, but with the existing multi-span arch bridge the contrast in types made it seem out of place. Arch bridges of five and seven spans were too near the general arrangement of the existing bridge, and, due to a decided difference in profile of the two crossings, the short arch spans had too much height for their length which, with the wider roadway, made them extremely incongruous in appearance. Studies were made for double-decked bridges in an effort to overcome the difficulties of the single level deck by making the structure narrower. These, however, showed no improvement in appearance or economy.

As the studies progressed the three-arch span bridge with the single deck gained in favor. This structure is of the same general style as the existing structure but of sufficient difference in number and size of spans to afford a pleasing contrast. There is no harsh clashing between this style and the existing conventional style arch but rather a development from the smaller, more ornate architecture of the past generation to the larger and plainer architecture of the present giving a mute approval of the type selected by the original builders.

Detailed Studies

More detailed studies were made to determine proportions for piers and spans, the location of piers and abutments, length and type of approaches, architectural treatment and economy of design.

The first attempts to tie the two structures together architecturally were to use similar style arch ribs and piers, but due to the width of the proposed bridge six or eight ribs were required. This large number of ribs resulted in confusion of lines rather than grace and lightness. The type of structure selected maintains the same similarity between individual parts and over-all dimensions as that of the existing bridge. The two ribs and pier shafts are wide transversely and relatively thin in elevation. The spandrel columns are proportioned similarly to minimize the massive members required for the wide roadway and heavy loads. By decreasing the number of parts it was possible to maintain harmony between the appearance of the two structures. No further attempts for similarity of architectural design were made.

Design of Deck System

One of the first problems confronting the structural designers was the layout and design of the deck system. This was complicated by the excessive cantilever of deck slab from the exterior girder due to the curve on spans 6 and 7 and the variable spacing of longitudinal beams on spans 7 and 8 due to the flared east end.

The length of the cantilever arm varies from 9 feet to 14 feet 6 inches, with bending moments up to 50,000-foot pounds. Previous experience with similar but lighter contruction indicated that the usual working stresses would entail considerable cracking of the deck due to elongation of reinforcement. The resultant cracks are not only unsightly but as they progress the conditions upon which wheel load distribution formulas are based no longer prevail and progressive failure occurs.

Working Stresses

Two methods were adopted to alleviate the condition: allowable working stresses in the tensile reinforcement were reduced below the standard American Association of State Highway Officials specifications, and longitudinal distribution of wheel loads by steel reinforcement, as required by the specifications, was augmented by a girder type curb and rail secured to the edge of the slab with stirrups. Area of tensile reinforcement was computed on the basis of a balanced slab design with allowable stresses of 1,000 psi for concrete and 18,000 psi for steel reinforcing. The thickness of slab was then increased to reduce the maximum concrete and steel stresses to 750 psi or 13,500 psi, respectively. This method was used to maintain maximum spacing of reinforcement and for economy. It was estimated that under prevailing prices it was more economical to increase the quantity of concrete rather than the quantity of steel.

Interior Deck Panels

The interior deck panels were computed for the standard allowable working stresses. The only variation from customary design procedure on the interior deck panels was use of four-way reinforcing for the slab. Due to the variable widths many of the panels were nearly square, requiring reinforcement in four directions.

Another deviation from usual design practice was the elimination of the longitudinal expansion joint usually required to decrease transverse temperature stresses in extremely wide bridges. The majority of wide structures are on short rigid columns with little possibility of movement without developing critical temperature stresses. The columns of this bridge, however, are either long and relatively flexible or attached to elastic arch ribs which allow temperature movement without excessive stresses. As the structure is in an active earthquake zone, monolithic construction was considered of sufficient importance to forego the advantages of the expansion joint. Later, more accurate and detailed calculations indicated this choice to be desirable though temperature stresses in the spandrel columns were difficult to establish.

Design of Arch Ribs

The design of the arch ribs presented several unusual problems. Span 6 is a 230-foot span on the centerline of a 2,000-foot radius curve, with the left rib 5.5 feet longer than the right. Span 7 is a 319-foot span partially (45 feet) on the 2,000-foot radius curve, however, the major portion is on the flared roadway which requires a variation of

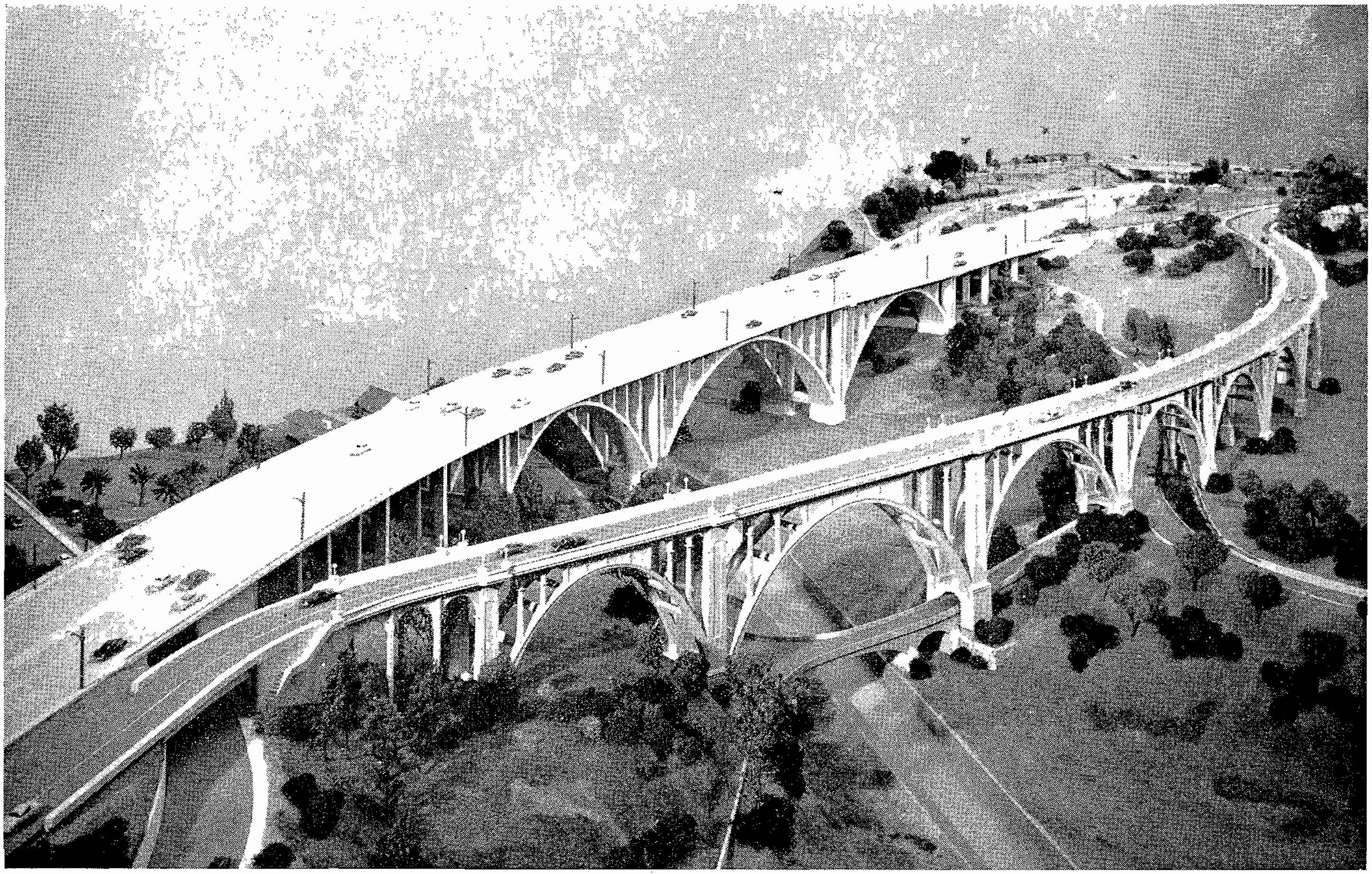


PHOTO 3—This is a photograph of a model of the new Colorado Street Bridge, showing the existing bridge on the right

seven feet in the distance between the ends of the arch ribs to compensate for the increased width. Span 8 is another 230-foot span, all of which is on the flared section.

The centers of the ribs are 55 feet and 70 feet apart at Piers 8 and 9, respectively, and the ribs are varied from 24 feet to 32 feet wide to secure adequate column spacing for the deck structure. No two points of springing are at the same elevation, making all arches unsymmetrical. Even the center arch, which had originally been planned as a symmetrical arch, required a 12-foot difference in elevation between the two ends. The entire bridge is on an ascending grade of 1.0 percent, giving unequal column loads at what would usually be corresponding points. This difference in loads is further aggravated by the increasing width and heaviness of superstructure and the widened rib in Span 8.

Trial Rib Selection

The trial rib was selected by a method based on the use of elliptical segments for the arch axis. After selecting the trial rib a dead load force polygon was drawn. This first polygon was disconcerting for there were more than the usual discrepancies between polygon and axis, and selection of the correct axis depended on adjusting the location of crown as well as changing the rise-span ratio of the unsymmetrical arch rib. The rib axes were determined by use of a grid system based on axes for two assumed positions of crown and rise ratio which would enclose the correct rib axis. By computing the elevation of the quarter point for the several positions of crown and different rise ratios, it was possible to select, by interpolation, an axis conforming to the dead load force polygon. The choice of these two trial axes for Span 6 was not sufficiently wide to enclose the true axis, but the location of the latter was accurately determined by extrapolation. Many days of design time were saved by these methods, especially when compared to the tedius "cut and dry" methods of establishing a multi-centered arch axis.

Curb Design

The curb design was influenced by safety considerations, distributing beam effect, mentioned above, and architecture. The junction of the "on and off" ramps near the center and over the highest point of the bridge will be an area of weaving traffic, and motorists maneuvering for position in traffic lanes will make this section more of a hazard than is ordinarily encountered on a bridge. A standard rail designed for 300 pounds horizontal load per foot of rail was not considered adequate for this location and a safety curb was provided with a heavy horizontal steel rail member above the double nine-inch curbs. However, when contemplating the architectural details of the bridge this curb appeared too narrow for its

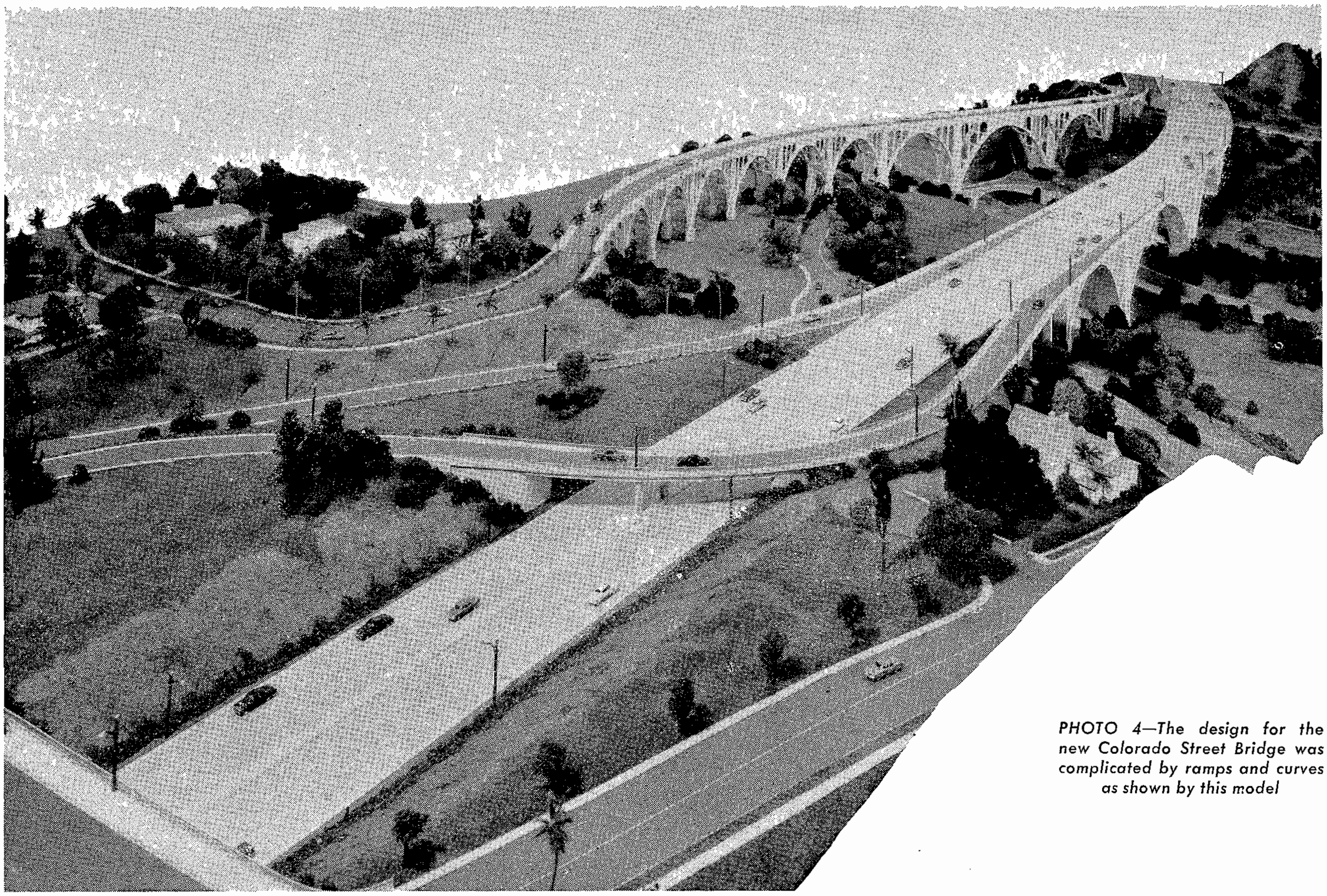


PHOTO 4—The design for the new Colorado Street Bridge was complicated by ramps and curves as shown by this model

length, being only two feet high on the outer face. The solid or safety curb portion of the rail was increased to 2 feet 3 inches high and the steel member reduced to a minor portion of the rail. This made the outer face three feet high, an increase of 50 percent for appearance; increased the rigidity of the curb so that it would be effective as a distribution beam; and, being higher, added to the safety feature of the double curb.

Box Girder Approach Spans

In the preliminary studies for arch span superstructure the longitudinal deck beams were assumed as T-beams. There had been some discussion about the use of a curtain slab or L-shaped beam for the exterior beams to give added weight to the appearance of the superstructure. Detailed stress analysis of deck slab and beam stresses disposed of this question in a short time. Due to the heavy cantilever slab stresses, large negative moments and dead load shear reactions were induced in the exterior beams as well as torsional stresses which could not be resisted by either the T- or L-beams. Box girders were designed to carry these stresses over the outer columns and, for uniformity, were also used over the interior columns. This design added to the visible dimensions of these beams and made the arch superstructure similar to the conventional box girder approach spans, thus greatly improving the appearance of the bridge.

One of the greatest difficulties in designing wider, modern bridges is to use a minimum number of columns. One of the more satisfactory methods is to increase the load-carrying capacity of the individual column by using a wide column with greater spacing and, consequently, heavier cap beams. The dimensions of the individual members are also in better proportion to the over-all dimension of the structure, and the decreased amount of form work per yard of concrete tends toward lower unit costs. This bridge, having a roadway much wider than the length of the average multiple span bridge, was particularly difficult in this respect, especially at the flared east end. Bent 11 is 132 feet wide and the adjacent spans are only 70 and 60 feet long, respectively.

Spacing of Columns

Spacing and widths of the arch ribs determined the paired spacing of spandrel columns and pier columns. This paired arrangement was used on the west approach to maintain the maximum consistency of design, but this arrangement was due to the ramps, an odd number of columns, and greater spacing.

Footing conditions and foundation materials are very good at most of the piers and bents. A bedrock formation of granodiorite underlies the entire area. This rock formation, at footing elevations, has bearing values up to 20 tons per square foot. The exceptional conditions are where the overburden over the rock is excessive. At Pier 8 the overburden is from 25 to 30 feet thick and is composed of sand with gravel and some large boulders. This material is also water-bearing as Pier 8 is in the middle of the stream bed. At Pier 9 the footing is over an old slide location in the wall of the canyon, the face of the underlying rock is quite steep, and the footing elevations were varied 27 feet between opposite corners of the block to obtain adequate foundation material. The mantle at Abutment 12 is a silty sand with a low bearing value, and abutment footings had to be carried from 30 to 36 feet below grade. Portions of Abutment 1 are in an old, poorly compacted fill which is not stable and has moved causing considerable cracking of wingwalls of the Colorado Street Bridge. It will be necessary to use steel piling for foundations in this area. While these conditions complicated the details of design they can hardly be classed as serious or difficult.

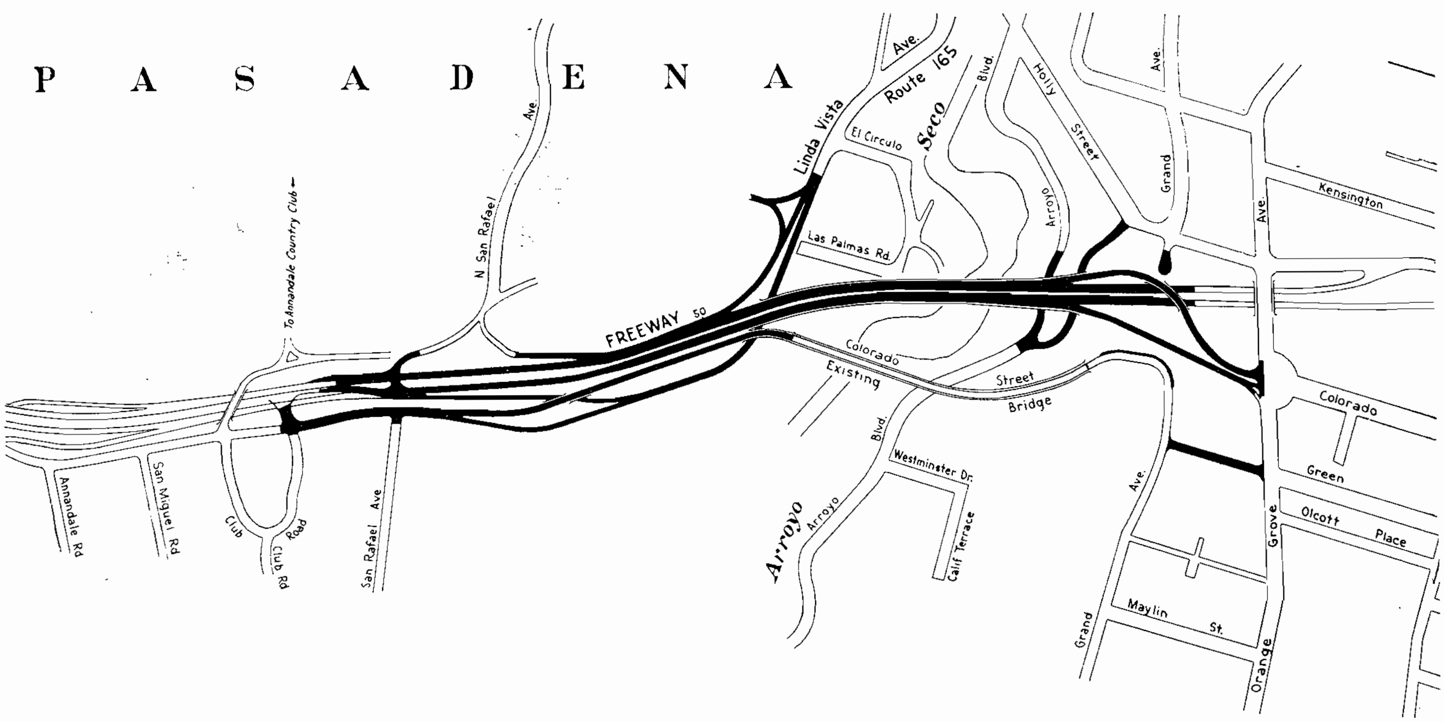
Pier 8 Impressive

Pier 8 is the most impressive portion of the structure. The twin pier blocks will be 60 feet high and 18 x 32 feet in cross-section. About 2,500 cubic yards of concrete will be required for the pier base and footing and 1,000 cubic yards for the columns. The 100-foot-high pier shafts were divided into four columns above the base. Structurally, these columns are sufficiently flexible to allow temperature movements without developing critical stresses or requiring use of expansion devices as needed on a solid shaft. Architecturally, a heavy solid shaft has no relationship with the narrow spandrel and approach columns, while the columns as designed do have similar proportions and less tendency to cut the bridge into five separate segments.

In concluding this description, a summary of dimensions and quantities is given for the statistically minded. The bridge is 1,364 feet long, 93 feet 6 inches wide at Abutment 1, and 171 feet 4 inches wide at Abutment 12. The deck is 130 feet above stream bed at Span 8. The clear spans of arch ribs are 214 feet, 302 feet, and 214 feet, respectively. Ribs for Spans 6 and 7 are 24 feet wide, and the rib for Span 8 varies from 24 to 32 feet in width. Crown thicknesses are 2 feet 6 inches and 3 feet for the 230- and 319-foot spans, respectively. Skewback thicknesses are 4 feet 3 inches and 4 feet 8 inches for the high and low ends, respectively, of Spans 6 and 8, and 5 feet 4 inches for Span 7. There are approximately 5,500 cubic yards of concrete in the arch ribs, 5,300 cubic yards of concrete in the arch piers and footings, and 32,000 cubic yards of concrete and 6,000,000 pounds of steel in the entire structure.

The architectural studies, sketches and drawings used in preliminary planning and designing were made by H. C. Van der Goes. H. E. Kuphal, Associate Bridge Engineer, made the original preliminary design studies and the arch rib design was based on his method of arch analysis, using elliptical segments for the axes. The writer has supervised the planning and design of the project since Mr. Kuphal's retirement in 1948. C. W. Jones, Senior Bridge Engineer, has had charge of the work done in the Los Angeles office of the bridge department and at the site. Messrs. R. S. Barker and P. H. Bowen, Associate Bridge Engineers, had charge of the structural design of arch spans and piers, and R. E. Fetter, Associate Bridge Engineer, had charge of the design of approaches and auxiliary structures.

This sketch shows the ultimate road system of the Colorado Freeway at Arroyo Seco Bridge



Flood Damage

Repairs on State Highways Hit By Storms Will Cost $3,400,000

By W. A. SMITH, Assistant Maintenance Engineer

DAMAGE to state highways in Northern California of more than $3,400,000 occurred from October 26th to the end of 1950. This is the most severe period that the State has experienced since the winter of 1937-38, when some $2,340,000 damage was done to highways in the north in December, 1937, and $5,660,000 damage to highways in the southern portion of the State in March, 1938. In the spring of 1941, storm damage totaling $2,500,000 occurred throughout the State.

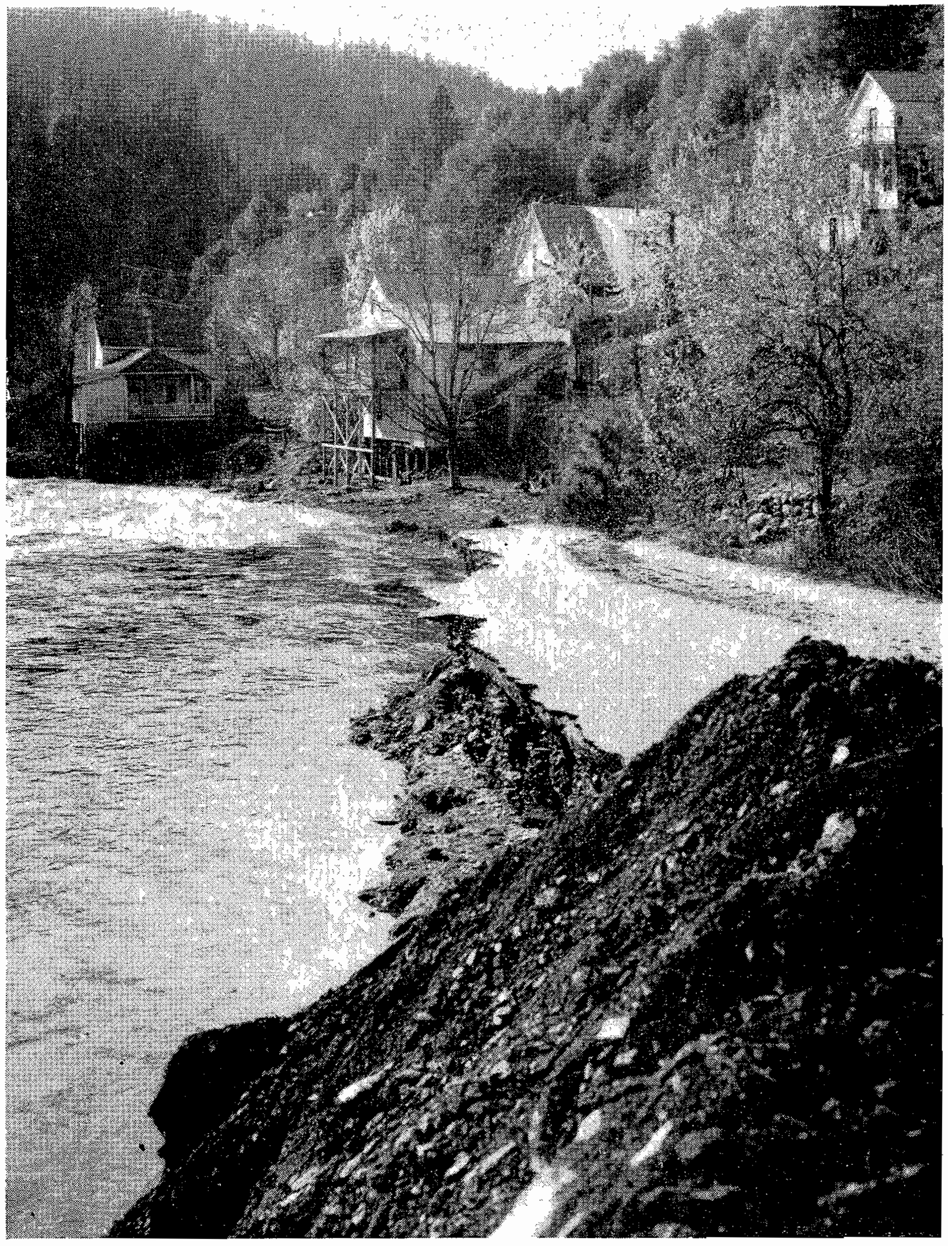
The October storm was mostly confined to the Smith River area east of Crescent City on U. S. 199. A total of 20 inches of rainfall was reported at Idlewild between October 26th and 28th. The damage consisted of undermining and washing out of protection work and fill slopes, although there was some damage to the roadway at two locations due to water over the pavement.

The damage which occurred during the November and December storm period was confined mainly to routes in the southern portion of the Sacramento Valley, the eastern portion of the San Joaquin Valley and the routes crossing the Sierra Nevada Mountains from Bakersfield north to Downieville.

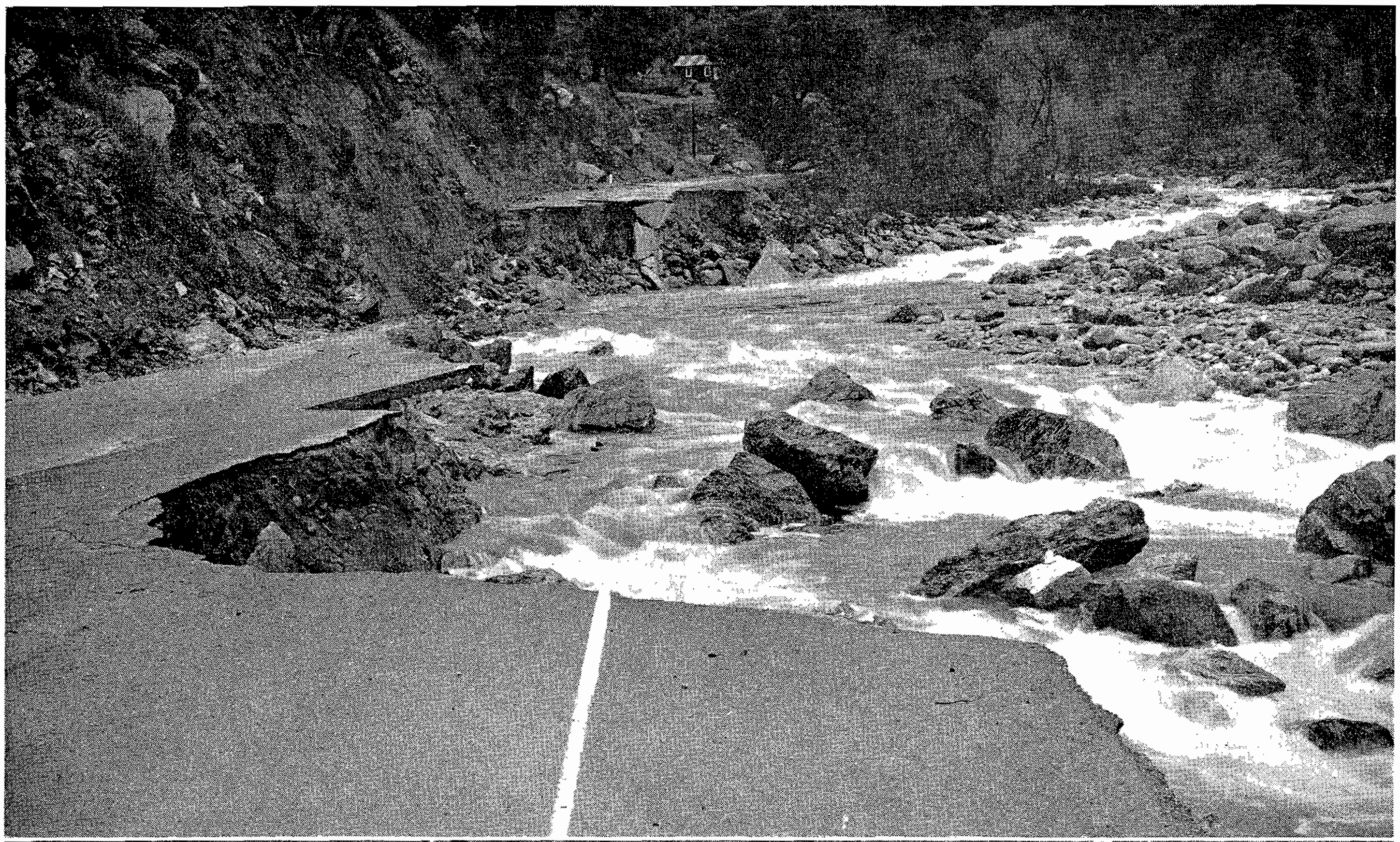
Rains Destroy Snow Pack

At the start of the November storm, the snow line was at the 3,000-foot elevation with a depth of eight inches at Donner Summit. Records at the Soda Springs weather station show that 18.85 inches of rain fell between November 16th and November 21st, and 12.33 inches fell from December 3d to December 9th. The November storm took off the entire snow pack to augment the run-off which, in some streams, exceeded all previous records.

The total damage to state highways was approximately 10 percent of the total estimated property damage caused by the floods throughout the area. In the vicinity of Marysville, Sacramento, Stockton, Coachella and similar locations, the damage to homes and furnishings and to farm lands, stream protection works, etc., reached the proportions of a major disaster. Damage to state highways in these areas, with two exceptions, was minor at any one location, consisting of washing of shoulders and cut and fill slopes at many locations. The major highway loss in the valley areas was the destruction of the Paradise Cut Overflow bridge on U. S. 50, west of Mossdale, and of the Goose Slough bridge on



This section of Sign Route 49 between Downieville and Sierra City was heavily damaged by floodwater



UPPER—Flood damage on Sign Route 140, the All-year Highway into Yosemite Valley, just east of El Portal. LOWER—Bulldozer equipped with Caterpillar diesel tractor at work on Sign Route 140. (Photo courtesy Caterpillar Tractor Company)

UPPER—Floodwaters destroyed the Paradise Cut overflow bridge on U. S. 50 west of Mossdale. LOWER—Aerial closeup of the bridge which was undermined and collapsed. Westbound traffic lanes are under water

state highway Route 139 in Kern County.

Maintenance Crews Work Hard

The principal problems of highway maintenance forces in these areas have been the measures required to warn and protect traffic and to protect highway facilities. As a general thing, the locations where trouble could be expected were well known from past experience. The most practical routes for detours could be decided quickly and signs and barricades were on hand in sufficient quantities in each area so that the local forces could act with the minimum of outside aid and instruction.

Every available man was pressed into service, of course, and each crew involved worked extra shifts to whatever extent was necessary. In the Truckee territory, for example, the normal time for the 40-man crew for the last half of November totaled 4,800 hours. This crew accumulated some 2,600 hours of overtime during the period. This represented the addition of the equivalent of 22 men, or an increase of over 50 percent in rate of expenditure of maintenance funds.

Debris Creates Problem

It was necessary also, in all areas where there was extensive damage, to rent power shovels, tractor units with bulldozer, heavy trucks, large scrapers, and other construction equipment. This type of equipment is not ordinarily required on maintenance work. It is rented fully manned and operated. The cost of operating this special

UPPER—Slide on Mt. Diablo Road, State Route 75, in Contra Costa County near Orinda. (Photo by San Francisco Examiner.)
LOWER—Heavy equipment clearing U. S. 50 at Camp Sacramento

equipment was an additional drain on maintenance funds.

In most watershed areas, the last flood of any consequence was in 1941. During the intervening period, a great deal of debris such as brush and fallen timber had accumulated. This debris was picked up by the flood water and washed into the main channels. The bridges with supports in the streams were endangered by this flow; in fact, the loss of the Goose Slough bridge in Kern County was due to this cause. A great deal of effort was required in clearing drift which lodged against major structures. It was necessary in some cases to secure dragline outfits and, in at least one case, a tug boat used. There was an almost constant patrol maintained of all highways in the areas affected in an effort to keep drainage channels and structures clear in order to minimize the damage.

Major Damage

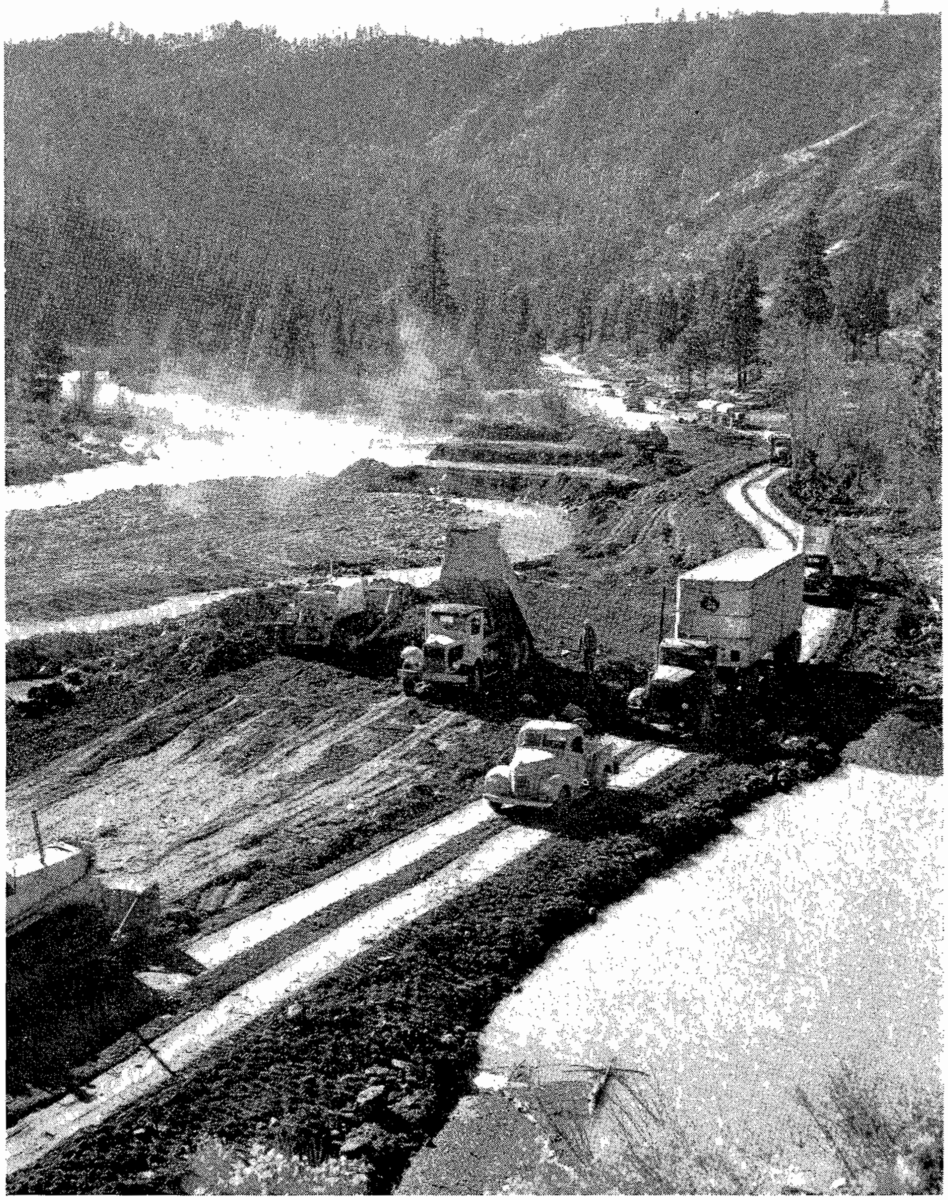
The major damage which occurred during the storm period was in the mountain areas, with the two exceptions noted above, and is summarized as follows:

Bridges	Number
Approaches washed out	22
Foundation or structural damage	12

Destroyed, or complete replacement required, as follows:

Deep Creek	Tul-10-C
Goose Slough	Ker-139-A
Silver Creek-Paradise Cut Overflow	Alp-24-C SJ-5-B

Roadway	
Completely washed out on various sections of eight major routes	5.2 mi.
Partially washed out on the same eight routes	2.1 mi.



U. S. 40 was closed by a washout at Mystic near the California-Nevada state line for nine days

The routes following were closed to all traffic for varying periods of a few days for some routes and up to nine days for U. S. 40, due to the washout at Mystic near the California-Nevada state line, and from November 20th to December 18th, for the section of U. S. 395 in the Walker River Canyon north of Coleville. The damaged section of U. S. 50 in the vicinity of Mossdale was closed from December 10, 1950, to January 5, 1951.

Road Closures

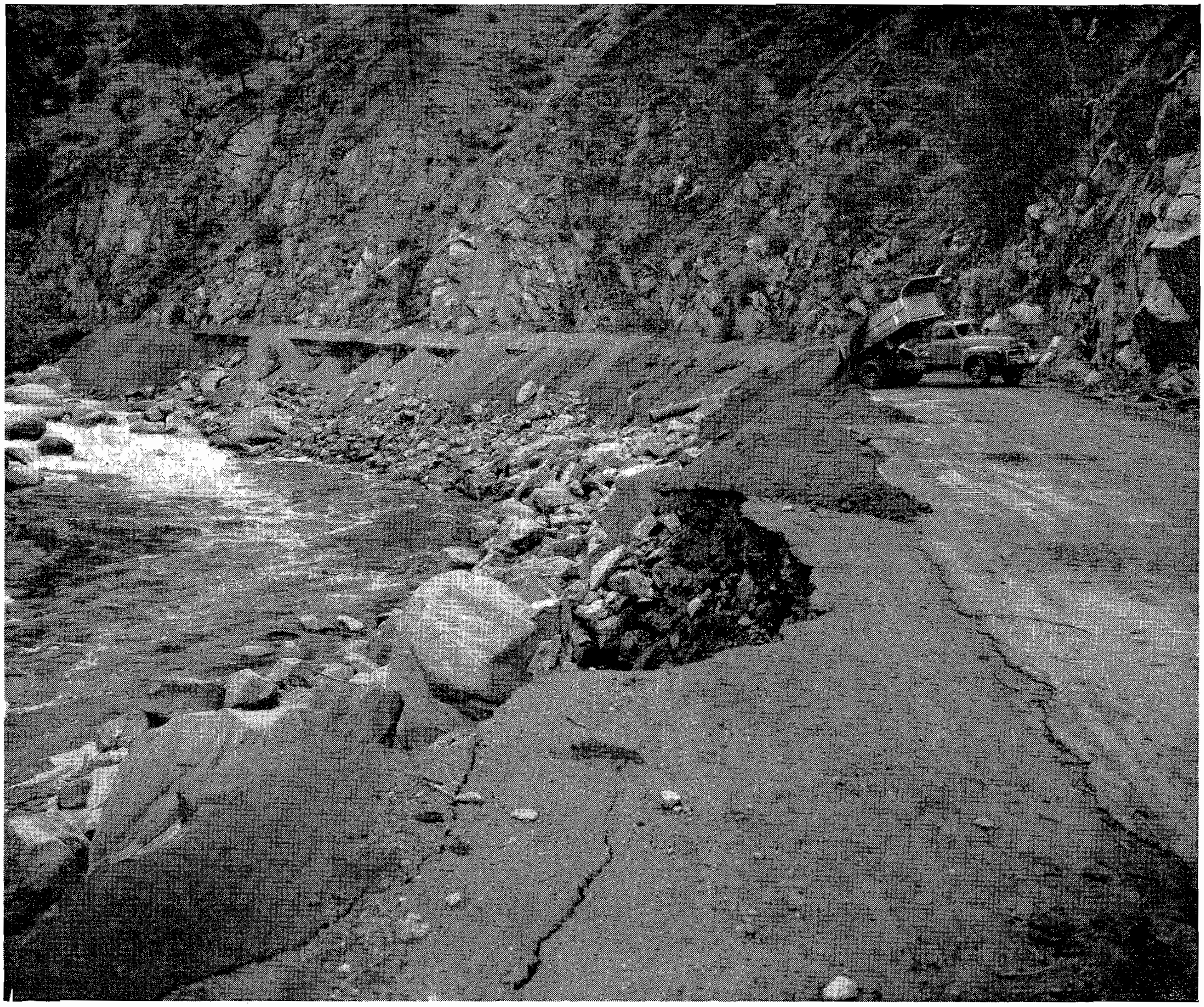
The main road closures in the mountain areas, as a result of major damage to roadway facilities, were at the following locations:

Number	Name	Location
Cal. 49	Yuba Pass	East and west of Downieville
U. S. 40	Donner Summit	Vicinity of Mystic near the Cal.-Nev. state line
U. S. 50	Echo Summit	At Camp Sacramento
Cal. 4	Along Carson River	East of Woodfords
U. S. 395	Walker River Canyon	North of Coleville
Cal. 140	All Year Highway	Merced River Canyon in the vicinity of Briceburg
Cal. 178	Kern River Canyon	Between the mouth of the Canyon and Bodfish

In addition to the above, highways were closed for various periods at many locations, including U. S. 99, south of Marysville, state highway Route 98 at Sacramento, and U. S. 50 at Mossdale, as previously mentioned.

Maintenance Budget Supplemented

The maintenance budget for the fiscal year, ending June 30, 1951, included an item of some $1,400,000, which was reserved to finance cost of slide removal and storm damage repairs. This reserve was based on estimates for a normal year. As of January 1, 1951, allocations from this reserve



The rampaging Kern River washed out this section of Sign Route 178 in Kern County

totaled about $1,484,000. This includes allocations for removal of the large slide on the Tunnel Road near Orinda in Contra Costa County, State Highway 75, and a number of similar emergency projects along the coast.

It has already been necessary to supplement maintenance funds by $800,000. The repair work which has been done on the main routes is only sufficient to provide for traffic during the rest of the winter season. More permanent repairs, including extensive protection work, must be deferred until more favorable weather. Where damage occurred on routes in the federal aid system, a portion of the cost of permanent repairs will be financed from federal funds that have been granted for the purpose. Further allocations of state funds will be required to complete the financing of these projects, as well as the major repair projects on the routes not on the federal system. It may be anticipated also that extensive pavement failures may develop on sections of highways not particularly damaged by floods. The subgrades are so thoroughly saturated that proper support may not be available to carry the volume and weight of traffic. The extent of such failures cannot be foreseen or provision made to protect against them. There is no doubt, however, that the cost of repairs will add considerably to the over-all cost of maintenance during the 1951 season.

GOLDEN RULE

Keep in mind the "Golden Rule" of motoring when you drive. Be as courteous to other drivers as you would have them be to you.

CHANGING SIGNAL

When you think a "Go" signal is about to change, reduce your speed. Speeding up to beat a changing signal is a common cause of traffic accidents at signal-controlled intersections.

Montgomery Freeway *Will Relieve Traffic In South San Diego*

By W. T. RHODES, Associate Highway Engineer, and A. K. GILBERT, Associate Bridge Engineer

In 1943, approximately 8.70 miles of four-lane divided highway was completed by the California Division of Highways to serve the industrial district adjacent to the San Diego Harbor area in the City of San Diego. It was built primarily as a defense road to provide ready access to naval and marine training stations, the 11th District Naval Storehouses, Lindbergh Field, airplane manufacturing plants, and innumerable other industrial plants engaged in the manufacture of war materials.

This project, known as Harbor Boulevard, extended from Seventh Street in National City to the junction of Hugo and Rosecrans Streets on Point Loma.

Freeway 11 Miles Long

On August 21, 1947, the California Highway Commission adopted and passed a resolution to construct a freeway from the international border to the existing terminus of Harbor Boulevard at Seventh Street in National City.

The Montgomery Freeway which runs from San Diego to Tia Juana was named by legislative resolution in 1949, after John J. Montgomery, a pioneer in the development of gliders. It is said that he made the first glider flight in history in 1883, on his farm along the route of the present freeway. He was killed in the crash of a glider in 1911.

The freeway will be approximately 11 miles in length, and it will accelerate the movement of traffic in the so-called South Bay area south of San Diego. The proposed program of development indicates that the 11 miles of highway will be completed during the 1952-53 Fiscal Year.

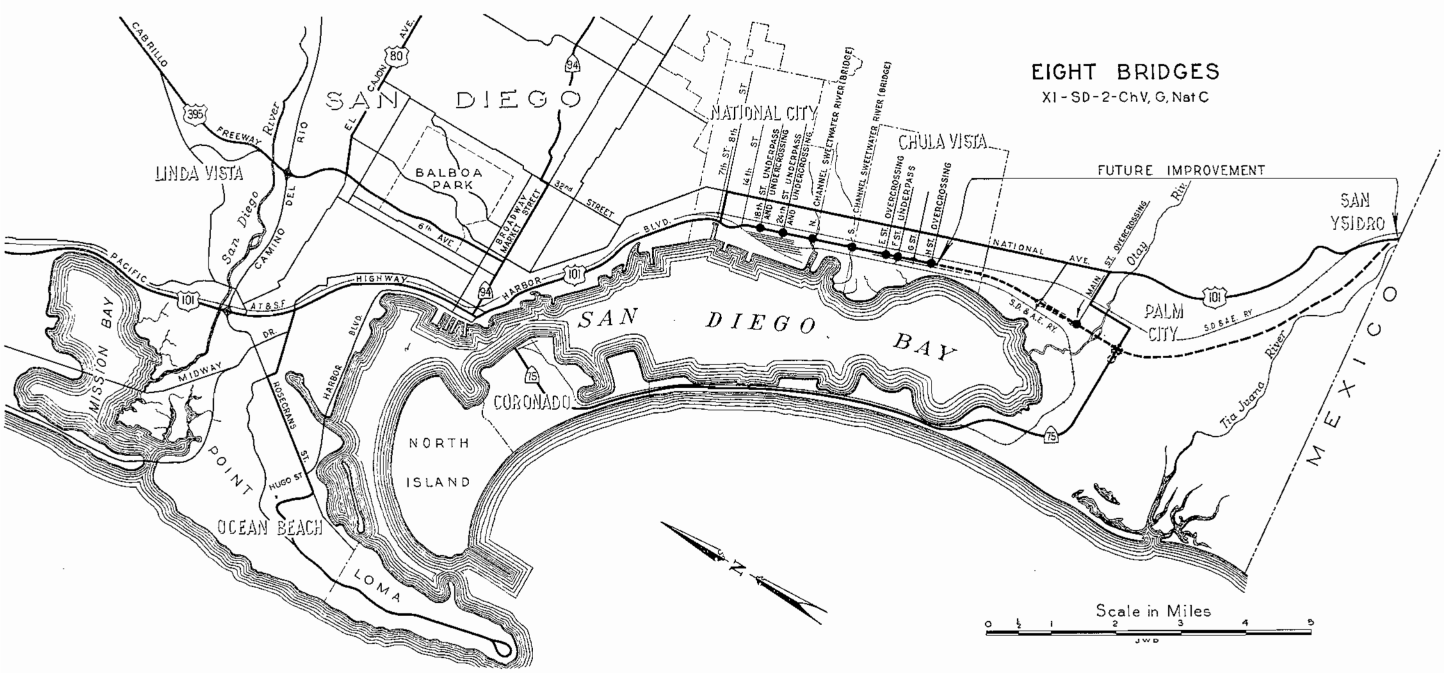
Rapid Progress

On November 4, 1949, a contract was awarded for the construction of 2.92 miles of highway and eight bridges on the first section of the Montgomery Freeway. This section begins at H Street in Chula Vista and ends at 14th Street in National City. A contract to widen and improve the section between Seventh and 14th Streets in National City has recently been awarded and is now under construction by the R. E. Hazard Construction Company. Still another contract, for the construction of overcrossings at H Street in Chula Vista and Main Street near Palm City, has been awarded to the Charles MacClosky Company and work thereon began on July 10, 1950.

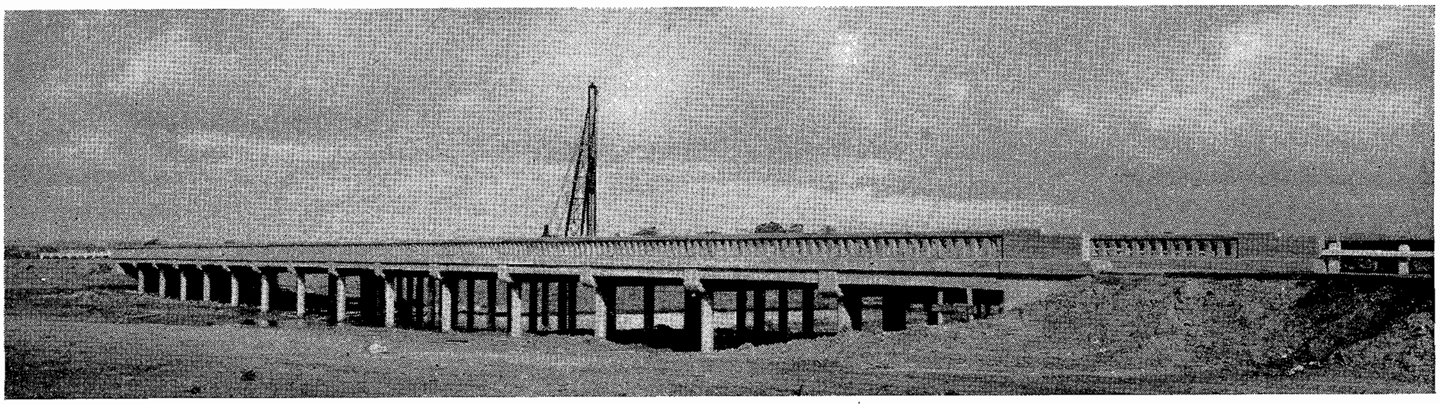
As of July 10, 1950, the joint venture contractors on the 2.92-mile section between Chula Vista and National City had completed 90 percent of the grading, and work on the eight bridges is 45 percent complete; March 1, 1951, is the tentative completion date.

Roadway Details

The construction consists of grading and paving two separate roadways with a variable width dividing strip. The

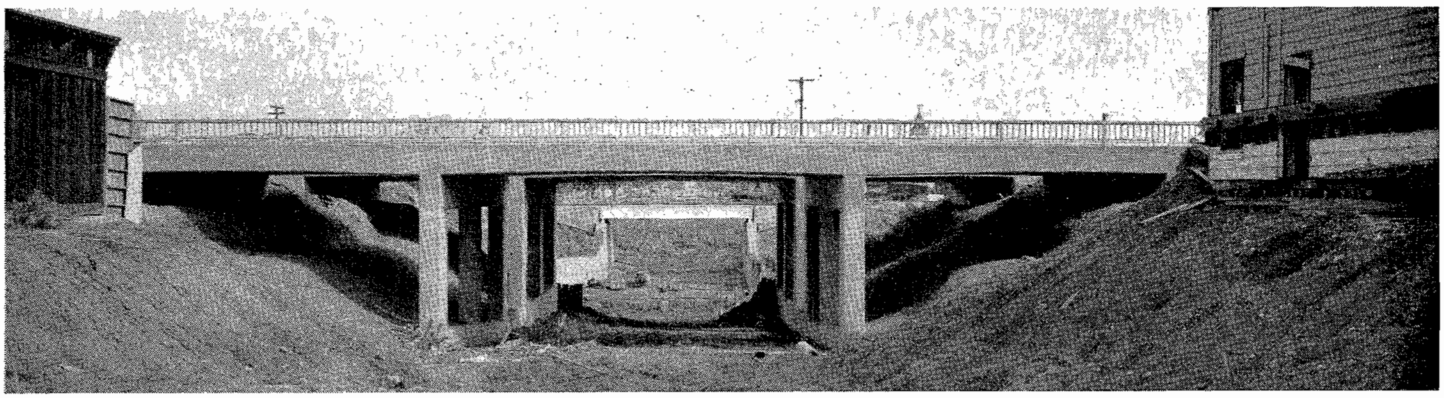


This map shows the general location of the project between San Ysidro and Seventh Street in National City on State Route 2 and the relationship to other state highways in the area.



This is the Sweetwater River channel bridge

plant-mix pavement, three inches in thickness, is to be placed on 13 inches of selected base material of which the top eight inches is to be stabilized by cement treatment. Each roadway will be 24 feet wide with a 3-foot shoulder on the outer side, and a 2-foot shoulder on the side adjacent to the median strip. Access to the northbound and southbound roadways is provided at E Street in Chula Vista and 18th Street in National City; and an outer highway is to be constructed on the west of the southbound roadway between G Street and D Street in Chula Vista.



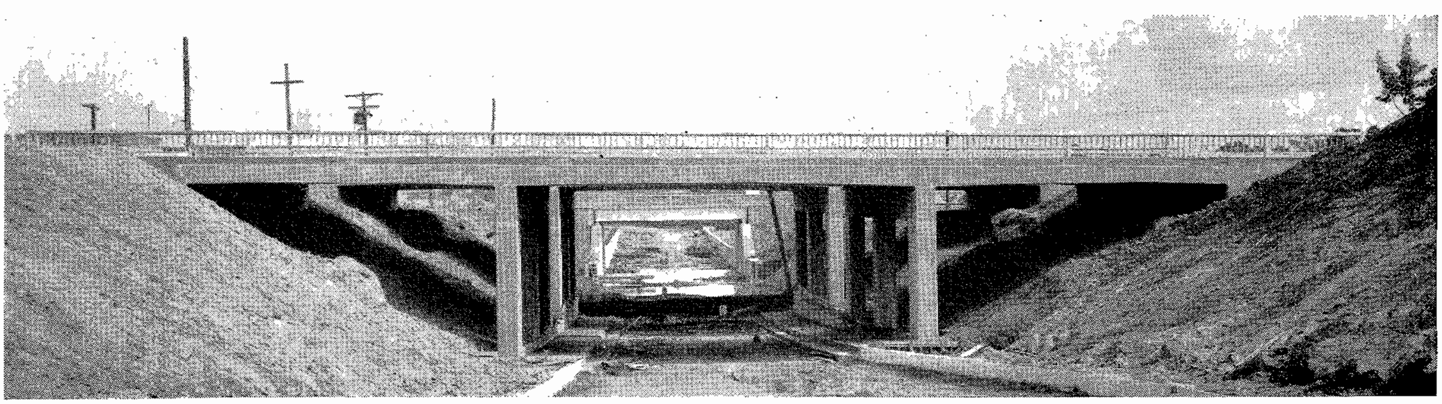
This is the 18th Street Union Pacific undercrossing in National City

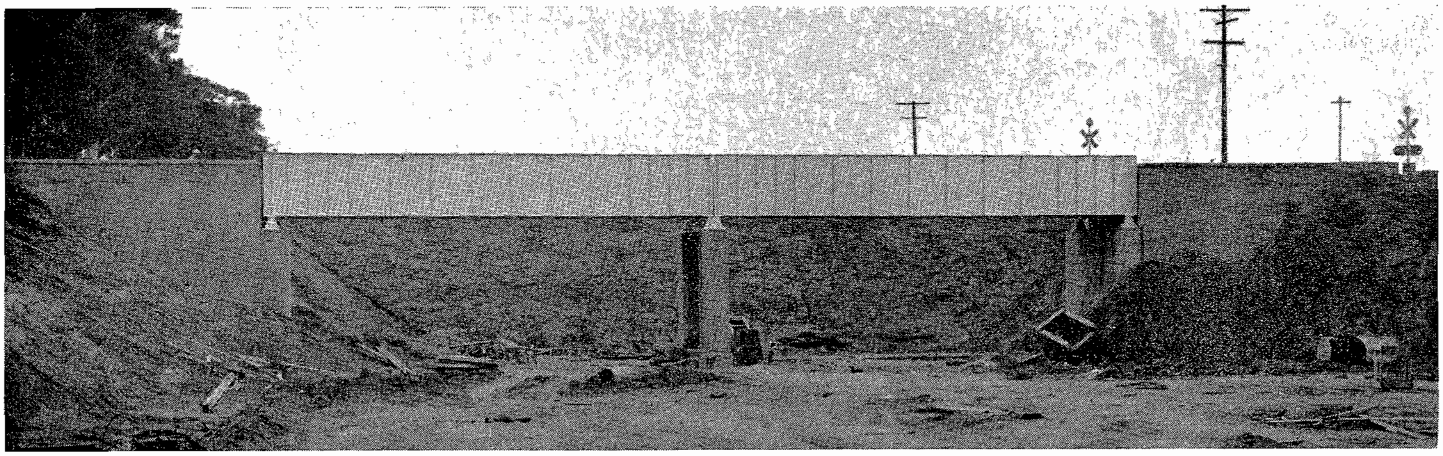
Southbound Roadway

In constructing the southbound roadway, for a distance of approximately one mile across Sweetwater Slough, it was found necessary to remove unsuitable material to a minimum depth of five feet prior to placement of the embankment, which consisted of coarse, sandy material from the cut section south of the slough.

In general the layout line of the Freeway is located approximately 125 feet west of Bay Boulevard. However, in order to utilize two existing bridges at North and South Sweetwater, plans were made to widen and raise the grade of Bay Boulevard for a distance of one mile across the slough and use it for northbound traffic.

This is the 24th Street Union Pacific undercrossing structure in National City





This is the F Street Union Pacific bridge in Chula Vista

Grade Separations

Eight bridges and grade separations were constructed as part of the project:

The F Street Underpass is a structural steel plate girder bridge consisting of two spans each 50 feet 10 inches long supported on reinforced concrete abutments and a center bent to carry a branch line of the San Diego and Arizona Eastern Railway over the freeway.

The E Street Overcrossing is a reinforced concrete slab bridge consisting of two spans each 52 feet 4 inches long supported on concrete abutments and a center pier. It provides a 26-foot roadway over the freeway for traffic entering the industrial and agricultural district from the vicinity of Chula Vista.

Sweetwater River Bridge

A new bridge across the south channel of Sweetwater River, consisting of 15 deck slab spans on concrete piles, was constructed to carry the southbound roadway; whereas the northbound roadway will utilize an existing bridge on Bay Boulevard, which was built in 1945. To provide adequate waterway area this bridge was lengthened approximately 231 feet by constructing 10 additional 23-foot spans.

The southbound roadway crosses the North Sweetwater channel on a new structure, consisting of eight deck slab spans on concrete piles. This crossing is approximately 171 feet in length. Here again an existing bridge on Bay Boulevard was utilized, after lengthening, for northbound traffic.

Access to the residential and industrial districts located west of Montgomery Freeway in National City was provided for by construction of undercrossings at 18th and 24th Streets. The two separations are identical, each consisting of a pair of reinforced concrete slab bridges carrying the freeway over the two streets. Each structure consists of one 40-foot span and two

. . . Continued on page 61

This is the E Street freeway overcrossing in Chula Vista

Certificate of Commendation Given Boorman

THE FIRST employee of the Department of Public Works to receive recognition by the State Merit Award Board was presented with a Certificate of Commendation by Director C. H. Purcell at a ceremony in Sacramento on January 26th.

Wetherby Boorman, a Division of Highways' employee at the Burlingame Maintenance Station, received the award for recommending an improvement in the catalog issued by the Service and Supply Department of the Division of Highways. The suggestion, now being put into effect, is to extend the present practice of showing the amounts or quantities of items according to standard factory packaging, thus enabling more efficient requisition and supply to various State field units.

G. T. McCoy, State Highway Engineer, G. F. Hellesoe, Maintenance Engineer, A. E. Cooper, Highway Superintendent at Burlingame, Frank B. Durkee, Department Chairman of the Merit Award Program, and Rodney C. Richardson, Assistant to Director, were present to witness the award, which was signed by Governor Earl Warren.

Milton Harris, Stores Engineer, states that the practice has been partially in effect, but that Boorman's suggestion has focused attention on the need and economy of expanding this catalog service. Possible state-wide adoption of the idea is being studied by the Division of Purchasing, Department of Finance.

This presentation is a part of the State Merit Award Program, enacted by the State Legislature in 1949. Fred W. Links, Assistant Director of Finance, is chairman of the five-man board, made up of State employees.

Boorman resides with his family at 132 San Benito Avenue, Lomita Park, and has been an employee of the Division of Highways for approximately 10 years.

State of California

Certificate of Commendation

This Certificate is awarded to

Wetherby Boorman

as official recognition and appreciation for individual initiative and resourcefulness while employed by the State of California in making a valuable contribution to the improvement of the operation of State government.

Dated at Sacramento, California this 16th day of January 1951

THE GREAT SEAL OF THE STATE OF CALIFORNIA

EUREKA

Governor

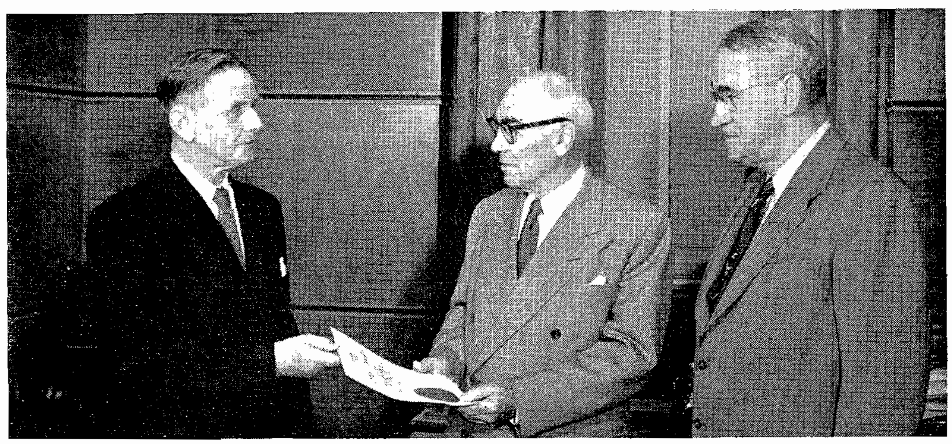
Attest:

Secretary of State

Countersigned:

Chairman, State Merit Award Board

Director of Public Works C. H. Purcell presents certificate of commendation to Wetherby Boorman. State Highway Engineer George T. McCoy on right



APPLICATION OF THE CALIFORNIA COORDINATE SYSTEM TO HIGHWAY SURVEYS AND RIGHT OF WAY ENGINEERING

By H. C. DARLING, District Locating Engineer and
L. M. PETERSEN, District Right of Way Engineer, District IV

SURVEYS play an indispensable part in providing highway service. They provide a portion of the basic data necessary for design; they provide information for acquisition of right of way; they direct the contractor's operations during construction; they determine final pay quantities and provide an "as built" record to be used for maintenance and future betterments or reconstruction.

While the cost of surveys is but a small percentage of the total cost of a modern highway, the total annual expenditure for surveys is considerable. In District IV alone, out of an annual total of approximately $2,000,000 in preliminary and construction engineering funds, about $300,000 is expended on surveys. These surveys are nearly all made with reasonable accuracy and are carefully adjusted, therefore would serve as a useful permanent record. Such surveys, if anchored to a state-wide and nation-wide network, become a part of that network, and therefore would be a permanent record continuing to serve far beyond their initial intended purpose.

Basic Network

To accomplish this objective there has been established by legislative action in California a basic network known as the "California Coordinate System." While the system has been in use but a short time, it is already true in some counties throughout the State that county, city and private surveys, which have been tied to the coordinate system, have been used by the Division of Highways at material savings in survey costs. Likewise surveys by the division have been used by others to their benefit. This cooperation is in its infancy; however, it now can be seen that the end result is going to be a material savings in survey costs to everyone concerned, including the division.

History of Systems

Before discussing the more technical details of having special purpose surveys tied to the California Coordinate System, the history of coordinate systems will be briefly reviewed.

An article on Plane Coordinates for Highway Maps was presented by J. C. Carpenter of the Division of Highway Transport before the Programing and Planning Engineers during March, 1948, and was distributed to the Division Engineers of the Public Roads Administration by H. S. Fairbank, Deputy Commissioner. Copies of this article were distributed to the various districts in the Division of Highways on July 22, 1948. Following is a short resume of this article.

In 1784, Thomas Jefferson was named chairman of a committee appointed by Congress to draft a plan for the survey and disposal of the western territory of the United States, and in Jefferson's own handwriting, the committee recommended a plan for the survey and sale of this most valuable area in the world. Under the scheme thus adopted, the standard parallels were projected westerly across the Country and principal meridians were located to cut this virgin area with squares 24 miles on a side. These were then divided into six-mile square townships and finally into the mile-square sections so familiar to all citizens. This rectangular plan of subdivisions and indexing is undoubtedly the most convenient ever devised by any nation. The first township was surveyed in 1785, and during the nineteenth century, the entire public domain was thus subdivided.

More Accurate Controls

As land values increased across the Country, the U. S. Coast and Geodetic Survey realized that more accurate controls would have to be established; and the coasts of this Country were tied together by extensive systems of triangulation arcs. This development allowed the true determination of any point within this area. This practice was then simplified when the U. S. Coast and Geodetic Survey promulgated the plane coordinate policy, and this system has been adopted by 24 states.

In 1933, Geo. F. Syme, Highway Engineer, North Carolina State Highway Department, made the first request to the Coast and Geodetic Survey that it suggest a plan for utilizing the geodetic data over an entire state which would involve only the formulae for plane surveying. This brought about the establishment of the North Carolina Coordinate System, by means of which the latitudes and longitudes of triangulation stations could be transformed into rectilinear coordinates on a single grid. Other states have since adopted similar systems using either the transverse Mercator or the Lambert projections.

States Divided Into Zones

Under these schemes, the various states are divided into different zones, and the type of projection used depends on the shape of the state in question. For one of limited east-and-west dimension, the transverse Mercator projection is used, while for California, the Lambert projection was selected as California's east and west dimension meets its requirements. This projection is more familiarly known as the "Lambert Grid."

The Lambert projection is named after Johann Heinrich Lambert, an Alsatian, who devised it in 1772. Essentially it employs a cone intersecting the spheroid at two parallels of latitude known as standard parallels for the area to be represented, as shown in *Figure 1.* The cone is centered on the polar axis of the earth. When the conical surface is split along an element, it can then be unrolled in a plane and the parallels of latitude become arcs of concentric circles. The meridians of longitude are straight lines on the rolled out cone converging at the peak of the cone. On this flat projection grid lines are drawn, equally spaced, and at right angles to each other. These lines represent the Lambert grid and the X and Y distances from the origin are the coordinates as in any system of rectangular coordinates. The right hand section of *Figure 1* represents a section of the cone unrolled in a plane.

The vertical lines are parallel to the central meridian which is a longitude line near the center of the zone. The origin of the X coordinate is moved to the left or west 2,000,000 feet from the central meridian. The origin of the Y coordinates is placed below the southern edge of the zone. In each zone the X and Y coordinates are always positive and the X coordinate is always larger than the Y coordinate.

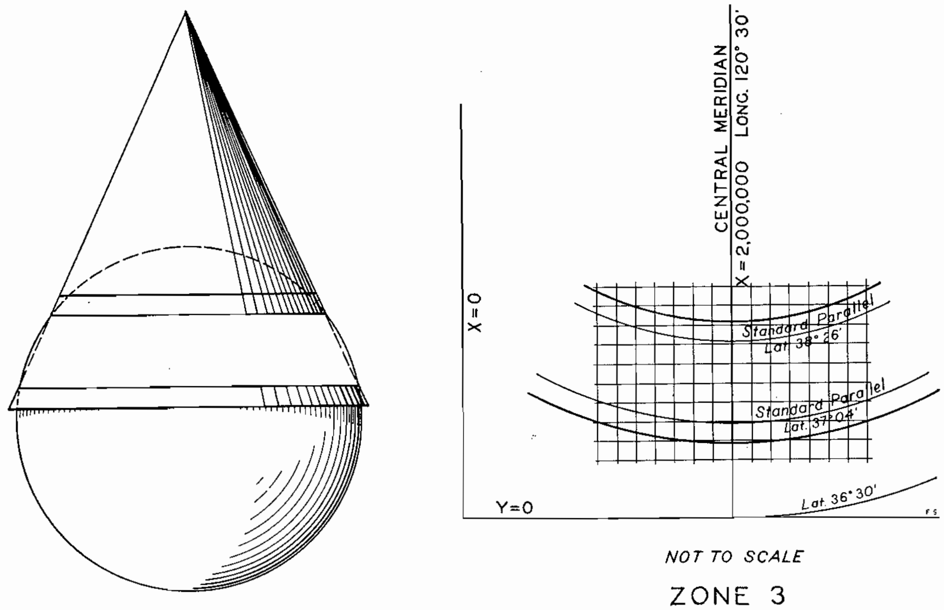


FIG. 1

Standard Parallels

The standard parallels are placed not more than 112 miles apart. For this spacing at our latitudes the relation of the length along the curved surface to the plane length along the conical projection will be such that the accuracy will be within 1:10,000. The projection may extend beyond the two standard parallels about 22 miles for the same accuracy, making the maximum width of zone in the north and south direction about 156 miles. Between the two standard parallels of latitude the earth bulges out above the surface of the cone. The geodetic length, the length along the earth at sea level, will be greater than the grid length between the parallels and a factor less than unity needs to be applied to obtain correct grid length. At the standard parallels, the factor is unity; and outside, it is greater than unity.

There are seven zones in California, all extending across the State from west to east, except Zone 7 which covers Los Angeles County only. (*See Figure 2.*) Zone lines follow county boundaries so that a survey in any county may be made in one zone only. The Coast and Geodetic Survey has calculated the coordinates of both zones for monuments that are near the edge of a zone. Many of our State Highway Districts have found that their district boundary includes more than one zone.

There is no convergence on the Lambert Grid as used in the California Coordinate System. A straight line run entirely across the State keeps the same bearing. The geodetic bearing would change several degrees.

State-wide System

The State-wide System of Plane Coordinates was enacted by the State Legislature under Chapter 1307, Statutes 1947. This is an act to define and officially adopt a state-wide system of plane coordinates, to provide for uniformity in the orientation of land surveys and maps within the State of California and is hereafter to be known and designated as the "California Coordinate System." It will become a part of the system of plane coordinates as established by the United States Coast and Geodetic Survey.

The State Highway Districts were officially notified by letter from Geo. T. McCoy, State Highway Engineer, on July 21, 1948, quoted in part as follows:

"In connection with development of surveys and preparation of plans, it is desired that our work be tied to the California Coordinate System." Further instructions were received from the then Deputy State Highway Engineer, Fred Grumm, on May 17, 1950, covering the use of plane coordinates in the preparation of deeds for property acquired as right of way.

Even before this act became effective, District IV had been using the plane coordinates as established by the United States Coast and Geodetic Survey in checking preliminary surveys to establish a more accurate preliminary line. The advantages obtained from use of these coordinates has more than offset the additional cost of tying in the surveys.

Best Method

The best method in the field is to occupy a monument for which Lambert Coordinates have been previously established, securing the proper orientation of bearings by sighting on another established monument, and then proceeding with the preliminary line to the end of project where another monument will be occupied and a check made on the bearings as recorded. If monuments are available along the route, ties should be made to them and azimuth closures made. If unable to occupy monuments at the beginning and end of the project, a triangulation should be made using as a base two established monuments. The triangulation should be so laid out that there are no small angles and all angles of the triangle should be turned by repetition and adjusted.

The same degree of accuracy should be used in chaining all courses of the preliminary line; and to eliminate all chances of one- to five-foot mistakes, the line should be "double chained." In general, the preliminary survey will not be a closed traverse in itself but becomes a part of the California Coordinate System. In order to accurately adjust the ground level distances to grid distances, no chaining errors should be prorated into the preliminary line. This was demonstrated in Santa Clara County along Routes 5 and 69 where monuments were occupied on both ends of the preliminary traverse, and a total error of 1.5 feet in 63,000 feet was found in the "Y" coordinate, the main direction of chaining. In this particular survey, angles were turned with a transit reading to one minute. Six measures were recorded for each angle, the telescope being reversed after three measures were made. In this case, the horizontal angle was measured between backsight and foresight in a clockwise order. The angular error in this particular survey amounted to 29 seconds.

Special Survey Party

In order to keep the field surveys well in advance of the priorities required by the Design Department, a special survey party was organized in District IV to carry the California Coordinate System to the preliminary line where this line can be readily adjusted; and when the final location is approved, it can be placed on the California Coordinate System entirely by office calculations with no further field work required. The advantages are evident at once; the plans for any portion can be made knowing that there will be no conflict in stationing and no equations on the layouts.

Precise instruments are used by this special survey party, tapes checked against a standard tape, allowances made for temperature, sag, and pull which require the use of a tension-handle and thermometer. This same accuracy should be used by the survey party engaged in the preliminary survey. The Chief of Party on this special work is responsible for all calculations; and in addition, it is planned that this party set bench marks along the location with a precise level.

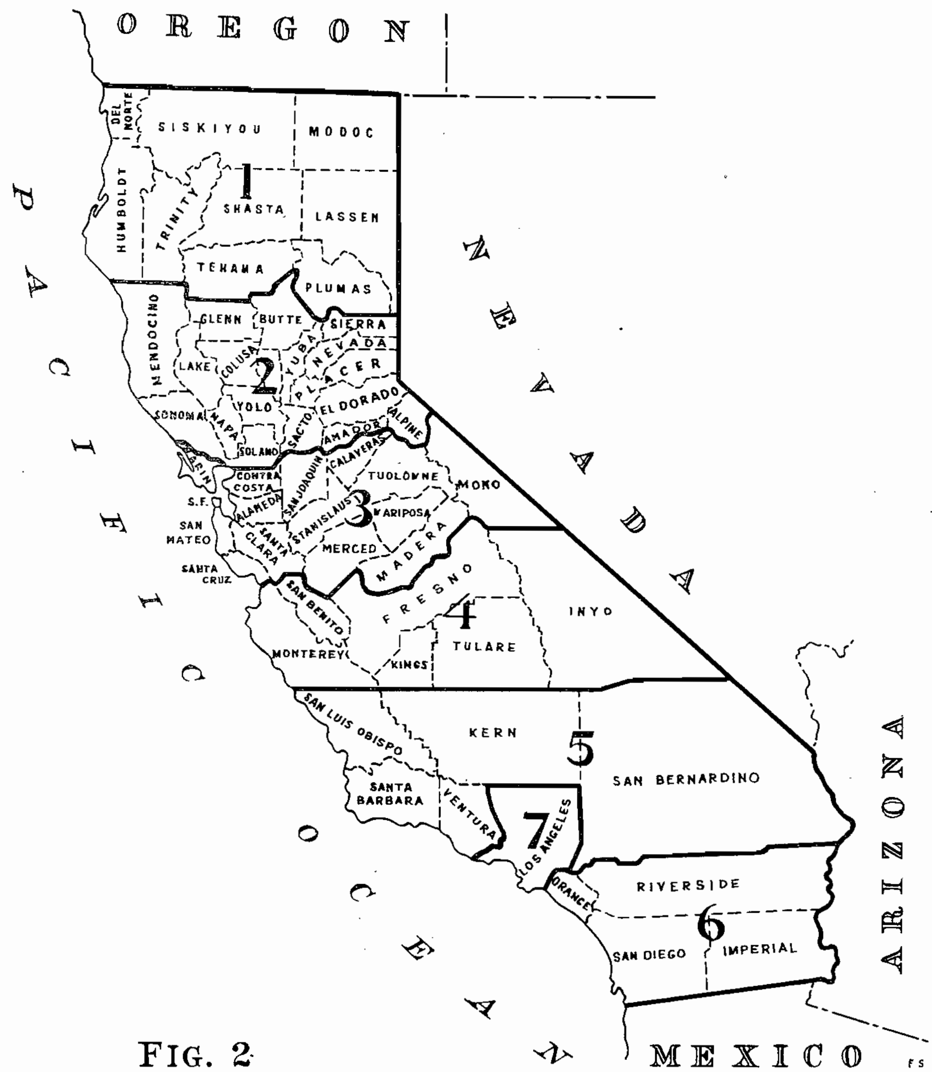


FIG. 2

Costs Decreased

For the present, the cost of the preliminary surveys will be increased, but advantages gained should outweigh this additional cost; and practically all errors will be eliminated. In a few years when many of the major surveys in the district have been anchored to the coordinate system, it is expected that the cost of additional surveys in these areas will be considerably decreased.

The adjustment of the triangulation and traverse lines based on the California Coordinate System is similar to any other traverse adjustment. There are two main differences. One is that scale factors should be applied to measured distances. Another is that adjustments can be made between known points instead of by a closed loop.

First the azimuth of lines should be adjusted. If a horizon closure has been made at any of the points, the error should be placed equally in all angles turned around the point. In any triangle in which all angles were turned the error should be placed equally in all three angles. If a quadrilateral was used, the adjustments should be made as explained in any modern surveying text, such as Davis and Foote. After azimuths of triangulation nets are adjusted, they are usually held and azimuths of traverse lines adjusted to them. An azimuth error in a traverse line is distributed by placing an equal amount in each angle. It is found easier to use azimuths in making corrections, rather than bearings, as corrections are the same direction in all four quadrants. No correction should be made larger than the expected accuracy of measuring, considering the instrument and the number of times the angle is turned. A field check should be made if corrections are too large.

Lambert Scale Factor

For most traverses of the extent embraced by the usual highway survey, say five or 10 miles, the Lambert scale factor can be considered constant. The scale factor is a function of the latitude and can be computed by the formula found on page 59 of Special Publication No. 235 or from projection tables for the State as in Special Publication No. 202. Both of these brochures are published by the U. S. Department of Commerce, Coast and Geodetic Survey. Since Lambert coordinates are based on sea level distances, sea level factors should also be applied to measured distances. This factor can also be considered a constant for most highway surveys. For instance, application of an average constant factor for a traverse where there is a 2,000 foot difference in elevation results in a maximum error of one part in 20,000 between the high and low length. The sea level factors are given on page 59 of the Coast and Geodetic Surveys Special Publication No. 235. The sea level factor and Lambert scale factor can be combined. Corrections for pull, sag, temperature, and slope, if any, should also be made. These corrections are usually made during surveys.

An Exception

In a traverse for which the scale factor and sea level factor can be considered a constant, it is not necessary to apply the factors in making adjustments between two known points. If chaining is consistent, proration of lengths results in correct adjustment. Courses could be measured in meters or any other unit of measure and prorated to get correct results. The factors may be applied to the resultant of the traverse to determine the error of closure, or they may be applied to each length before computing the traverse.

If errors are mostly systematic, making the azimuth adjustment as mentioned, and applying a constant length factor results in an error of closure so small it may be placed in two or three lengths or two or three angles, or both. The compass rule can be applied, but this refinement is often not warranted. In any event, no angle or distance (considering the scale factors) should be changed in an amount greater than the normal accuracy of the field work.

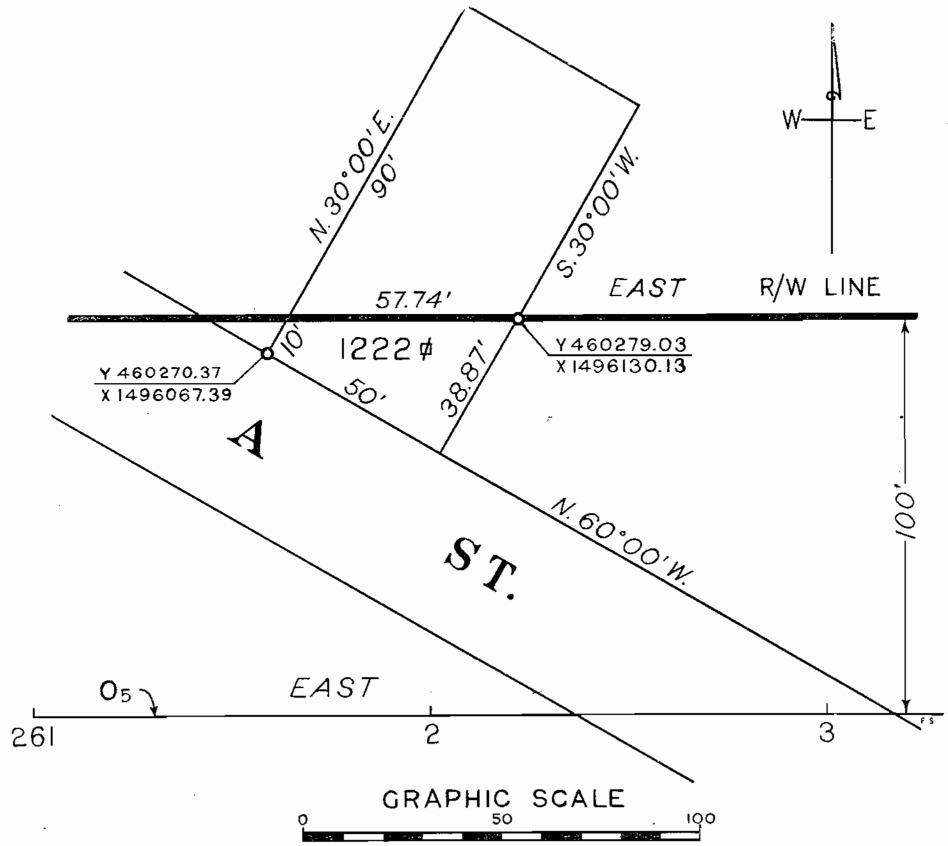


FIG. 3

Once the triangulations and traverses are adjusted, these should be held and all future office and field survey lines made to fit them. In order to keep on the Lambert grid, grid bearings and distances must always be used in calculations, maps and surveys after the preliminary lines are adjusted.

Right of Way Description

Nearly all highway improvements require acquisition of property for right of way. Before land can be acquired, it must be accurately described.

The description of a parcel of land for record purposes should positively identify the land for title purposes and should also provide the necessary information to locate the parcel on the ground. If the first condition is satisfied, it will continue to be satisfied as long as the records are kept. The second condition may be satisfied at the time of recording a deed, but in time physical monuments may decay and disappear. These stations may be restored by survey methods and these restored stations themselves become the bases from which other restorations are made. With each succeeding restoration, the accuracy is diminished as it is affected by the errors of the original survey combined with the errors of the restoration surveys. Eventually even a good survey may become little more than a paper record, beyond the power of a surveyor to establish the property lines with any degree of certainty.

The condition of providing information to locate the property on the ground can be considerably strengthened by including the coordinates on the state system of one or more of the corners of the land and by using bearings and distances based on the California Coordinate System. If the monuments which mark the land corners are destroyed, the coordinates become primary evidence of the location and the corners can be replaced by other monuments on the California Coordinate System.

In District IV, our present method of writing deeds on projects on which surveys are based on the California Coordinate System is illustrated by the following sample: *(See Figure 3.)*

Description

All that real property in the County of Alameda, State of California, described as:

A portion of that certain tract of land conveyed to John Jones by deed recorded May 17, 1945, in Volume 236, page 123, Official Records of Alameda County, said portion being described as follows:

Commencing at the most westerly corner of said tract at coordinates Y = 460,-270.37 feet and X = 1,496,067.39 feet; thence along the northwesterly line of said tract, N. 30°00′ E., 10.00 feet to a line parallel with and 100 feet northerly, at right angles, from the "05" line of the Department of Public Works' survey between Oakland and San Leandro, Road IV-Ala-69-C; thence along said parallel line, East 57.74 feet to the southeasterly line of said tract; thence along said southeasterly line S. 30°00′ W., 38.87 feet to the southwesterly line of said tract, being the northerly line of A Street, 40 feet wide; thence along last said line N. 60°00′ W., 50.00 feet to the point of commencement.

Containing 1,222 square feet, more or less.

Coordinates, bearings and distances in the above description are on the California Coordinate System, Zone 3.

Coordinates Secondary Call

The coordinates at the point of commencement are a secondary call as used above. That is, the tract corner is the point of commencement in case of a conflict with the location as established by the coordinates. This is also true if the coordinates are mentioned first, as the law specifically states that if there is a conflict between a record point and coordinates, the record point controls. However, if the corner monument is destroyed, the coordinates become primary evidence of where it stood. The coordinates may also be valuable information to surveyors, title companies, county offices, and others who plot property maps.

Before preparing deeds with descriptions as illustrated above, it is the practice in District IV to consult with officials of title companies involved and get their approval. To date, approval has always been given.

The description used above has the right of way line controlled by the survey line. The tie to the survey line controls regardless of the location of the tract. The question naturally arises: Why not use California Coordinates for control instead of the survey line which is not of record except in the offices of the State Division of Highways? This can be done by substituting the following description after the calls for the point of commencement:

. . . , N. 30°00′ E., 10.00 feet to a line with a bearing of East passing through coordinates Y = 460,279.03 feet and X = 1,496,130.13 feet; thence along last said line East, 57.74 feet to the southeasterly line. . .

This type of control should probably not be used until there is a common usage and knowledge of the California Coordinate System by surveyors and others using property descriptions.

Useless Descriptions

A large proportion of deeds now being recorded contain descriptions that are impossible to locate on the ground using the descriptions or references in the description alone. To physically locate the land with such a description it is necessary to first establish neighboring lands to establish the property lines. Some of these may have been written 50 or 75 years ago and used in each succeeding conveyance without change. As an example, the following is a description first used in a deed in 1871. It has been used in 18 deeds since, the last being in 1944. Names and dimensions have been altered without affecting its use as an example for the purposes of this article.

"All that lot of land situated in the Township of Mars, County of Venus, State of California, described as follows, to-wit:

"Beginning at a point on the northern line of the county road leading from Santa Rosa to Santa Cruz from which the southeasterly corner of a saloon once kept by John Jones bears South 88°15′ West 91 feet, 3 inches, distant; then North 0-½° East 257 feet to the center of Santa Clara Creek; thence up the center of said creek the three following courses and distances; South 38° West 138 feet; South 41½° West 100 feet South 19½° West 86 feet, 4 inches to a point from which the southeastern corner of Felix Brown's Shop bears North 20¼° West 62 feet distant; thence leaving said creek and along the northern line of said road, North 87°25′ East 180 feet, 10 inches to the place of beginning.

"Containing 58/100 (.58) of an acre and being the same land heretofore conveyed to John Jones by James Smith."

From this description, it would be practically impossible to reproduce the boundaries of this parcel as John Jones' saloon and Felix Brown's shop are long since gone and the other landmarks mentioned probably altered. A tie to the coordinate system would make reproduction much more certain.

This indicates clearly the need for better physical ties for land descriptions. The use of coordinates in deeds based on the California Coordinate System seems to satisfy this need.

Appreciation

The authors wish to express their appreciation for the guidance and assistance given them during preparation of this article by Mr. T. E. Ferneau, Assistant District Engineer. The work is being done under the direction of L. A. Weymouth, District Engineer, and Jno. H. Skeggs, Assistant State Highway Engineer.

To any interested person desiring to study the more technical aspects of coordinate systems, the following publications of the U. S. Department of Commerce, Coast and Geodetic Survey, are recommended:

Special Publication No. 193—Manual of Plane-Coordinate Computation.

Special Publication No. 194—Manual of Traverse Computation on the Lambert Grid.

Special Publication No. 195—Manual of Traverse Computation, Mercator Grid.

Special Publication No. 202—First and Second Order Triangulation in California.

Special Publication No. 235—The State Coordinate Systems.

FROM A HIGHWAY

At sunrise and at sunset
I see the world in silhouette;
The tangled branches of the trees
Are etched in mystic harmonies.

The fir trees and the placid palms
Enfold the shadows in their arms,
While rose and orange, blue and green
Are intermingled in the scene.

The mountains modify the line
That tells the earth of heaven-shine—
Both opening and closing day
With bugle notes of sunlight-play.

JOHN WARWICK DANIEL III
Delineator,
Design Department
Highway Division,
Los Angeles

Uniformity of Class "C" Cement-Treated Base Subject of Tests

By W. R. LOVERING, Senior Highway Engineer

THE ADDITION of small amounts of cement to imported base materials to reduce plasticity and increase the supporting power of the base is being more and more generally used on California highways. This type of construction, now designated as Class "C" cement-treated base, is particularly adaptable to roads with low traffic density but heavy axle loadings, which is characteristic of roads used for log hauling. Under this type of traffic, heavy construction is generally not warranted and yet the average crushed gravel base will not adequately support the heavy wheel loads without excessive thicknesses of surfacing.

This type of construction has been used extensively in other parts of the State. District I has several routes, however, which carry relatively light traffic volumes but on which approximately 15 percent of the traffic consists of heavy logging trucks. On these routes Class "C" cement-treated base provides an inexpensive but apparently satisfactory foundation.

Aggregate Unsatisfactory

Most of the aggregate used in this district comes from river bars and, even when crushed, is not satisfactory for heavy wheel loadings without the addition of Portland cement.

The Class "C" cement-treated bases have been constructed by mixing approximately 2 percent of cement with the crushed river gravel by road mixing methods, either with a blade or a road mixing machine. As the cement content is very low, there has been widespread doubt as to the uniformity with which the cement could be distributed.

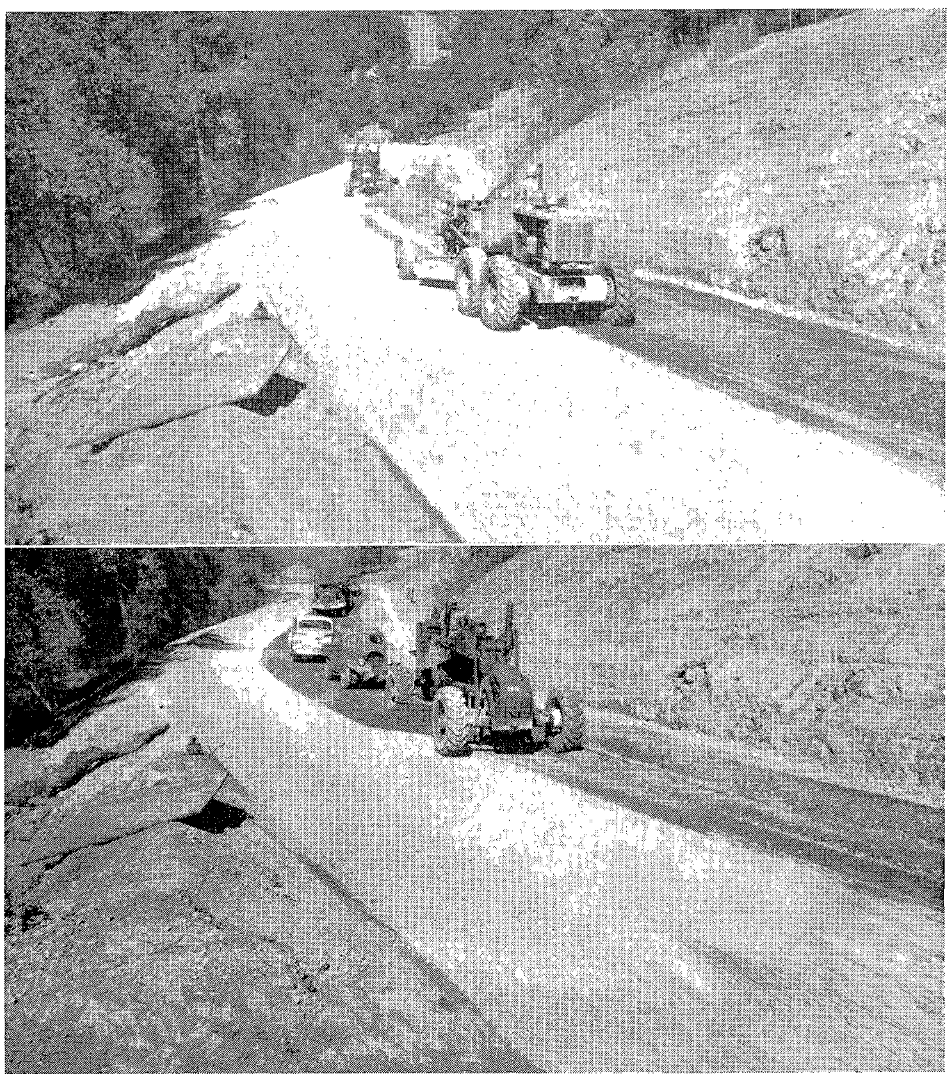
In order to secure information on the uniformity of mix obtained by blade mixing, a large number of compressive strength specimens were tested on the Maple Creek project in Mendocino County, road I-Men-48-A. The investigation was carried on as a part of the normal control testing with specimens being compacted in the field by Street Inspector R. J. Datel, and broken in the district laboratory by N. R. Price.

Construction Procedure

The imported base material, consisting of crushed gravel from Rancheria Creek, was placed on the roadbed in a windrow of sufficient size to provide a three-inch compacted course. This was as large a windrow as could be handled conveniently on the roadway without preventing the movement of traffic, and no attempt was made to mix the full six-inch depth at one time.

The Portland cement was spread on the windrow by hand-dumping the sacked cement. Each windrow was from 600 to 1,100 feet long. Mixing was accomplished with two motor patrols working in tandem. The windrow was turned four times for the dry mixing and four times after the water was added, but, because of the size of the windrow, several trips of the motor

This equipment is dry mixing cement and gravel during successful tests in Highway District I



patrols were required for one complete turning. Mixing was continued until a mix of uniform appearance was obtained. Approximately six hours were required for the complete mixing operation.

After a uniform mix was obtained, the material was spread on the roadbed and compacted in approximately one hour with two rollers. The material compacted nicely and made a satisfactory appearing base, with the exception of one day's mixing, November 2, 1949, in which the moisture content was somewhat high.

Testing Procedure

Standard cement-treated base compressive strength test specimens were compacted from the mix as soon as mixing was completed. Usually three specimens were obtained from each completed windrow. As approximately 15 minutes were required for the compaction of each test specimen, 45 minutes had usually elapsed before the third of these specimens could be compacted. A record was kept of each specimen showing the time interval to check on the possibility of this factor introducing an additional variable into the test data. However, there appears to be no consistent difference between specimens compacted within 15 minutes and those requiring 45 minutes. This may be because of the extremely long mixing time required for the blade mixing.

After the specimens were fabricated, they were shipped to Eureka and compressive strength tests were made at the end of 28 days. It was expected that the compressive strength test results would be quite low because of the low cement content, and it was felt that seven-day testing might lead to fracture of the specimen during the preparation for testing. The breaks were quite high, however, considering the low cement content and the long interval of time between adding the cement and completion of mixing.

Test Data

Twenty-eight day compressive strengths obtained on the 2 percent cement-treated base mix range from 442 psi to 845 psi with a mode, or most possible value, of 576 psi. It is interesting to note that the maximum and minimum results were both obtained on the same day, but not from the same windrow.

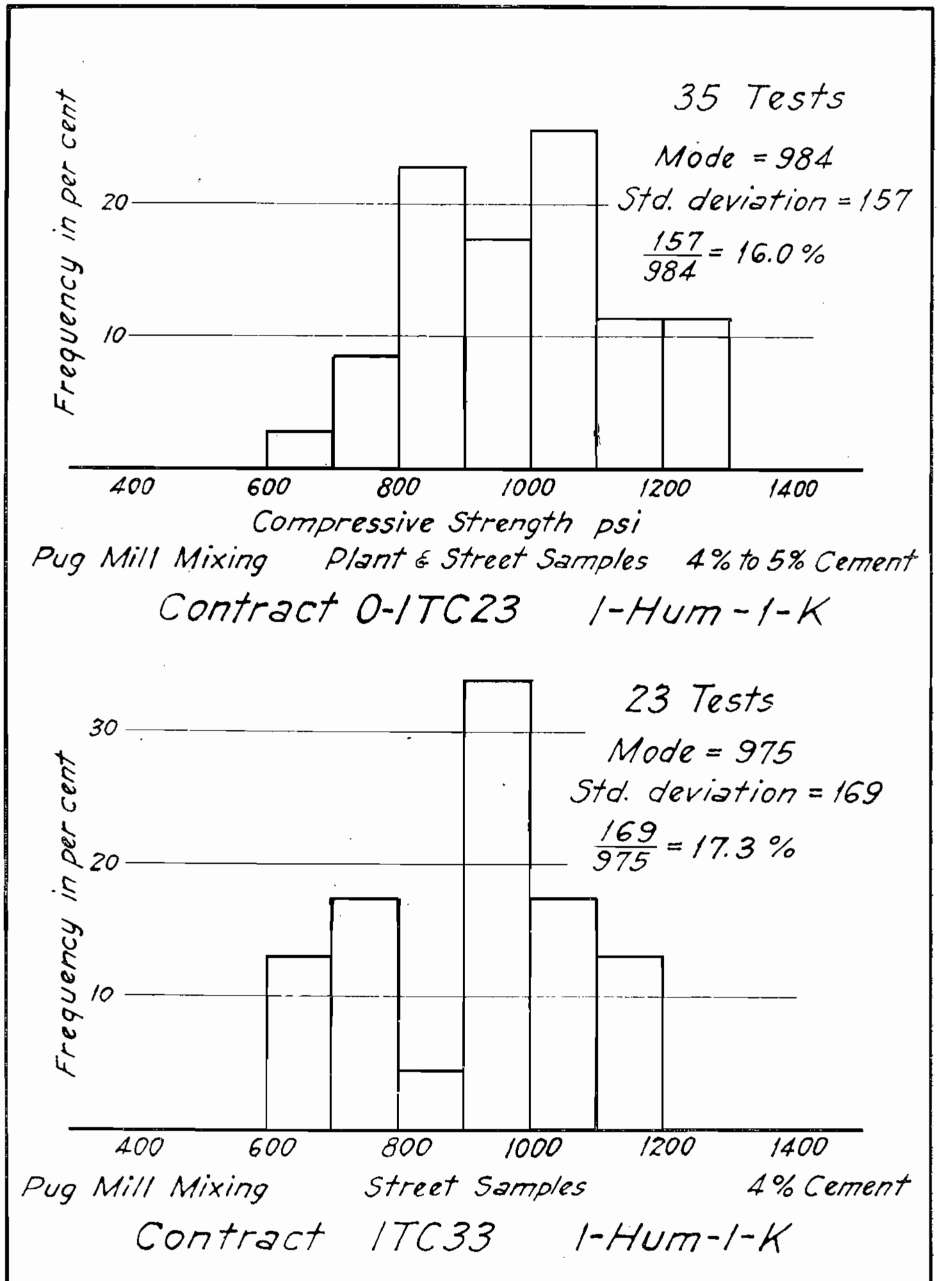


Fig. I

In order to provide a measure by which these results may be judged in relation to those obtained on our standard cement-treated base mixtures, frequency distribution of the test results are shown graphically on the prints, *Figure 1 and Figure 2,* both for this project and for three other typical plant-mixed cement-treated base jobs. Two of these projects, Contracts O-1TC23 and 1TC33, were constructed of gravel from Redwood Creek near Orick in Humboldt County. The other, Contract 1-1TC34, was built with gravel from the Klamath River at Klamath, in Del Norte County.

These graphs show that a better grouping of test values was obtained on the Class "C" mix than on the Class "A" mix; however, the breaks are considerably higher on the Class "A" mix and a greater spread of values is to be expected.

The data were subjected to statistical analysis and in order to get a more accurate measure of dispersion, the standard deviation was calculated for each project and the value obtained was divided by the mode. This value, the "coefficient of variation" which makes proper allowance for the higher breaks obtained on the Class "A" mix, should be a reliable indication of the uniformity of the test results.

The value of 18.9 percent obtained on the Class "C" cement-treated base is slightly higher than the values of 16.0 percent and 17.3 percent obtained on the two Redwood Creek projects, indicating slightly poorer uniformity, but is considerably better than the value of 23.5 percent obtained for the Klamath River project.

The extremely long mixing times used on the Class "C" mix are probably not typical of the average run of jobs, and either a reduction in the mixing time or an increase in the cost may be expected in future projects.

It should be noted that the aggregate used on this project was a crushed gravel with a relatively low dust content as shown by the attached grading chart. This study did not cover the use of finer materials and no implication is intended that similar results will be obtained with all types of aggregates.

Conclusions

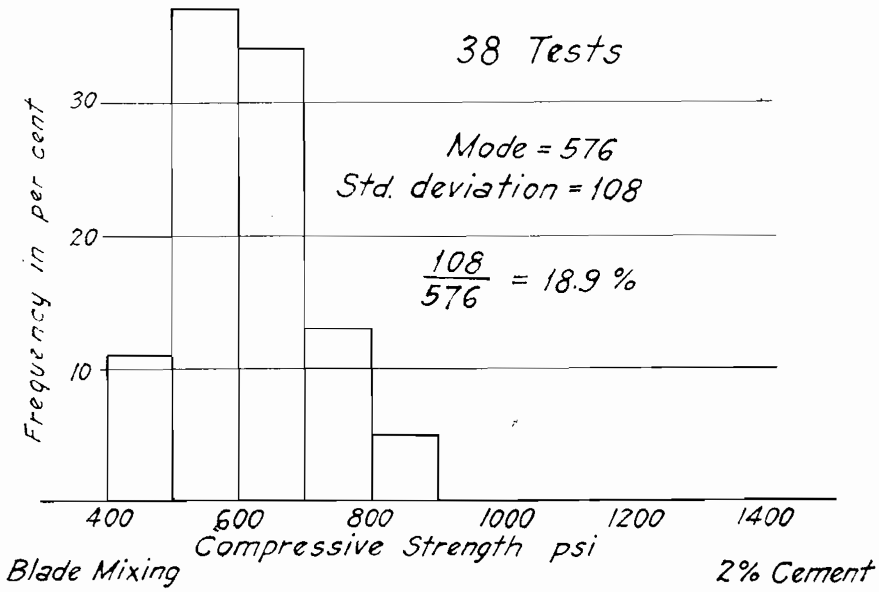
1. The uniformity of mix obtained on Class "C" cement-treated base using crushed stream gravel and mixed with blades on Contract 1-1TC37, road I-Men-48-A (Figure III), compares favorably with that obtained on our plant-mixed Class "A" cement-treated base.

2. Compressive strength values are sufficiently high to justify continued use of this class of base on roads of lower traffic density or as a subbase on the more heavily traveled routes.

3. Additional attention should be given to the improvement of the uniformity of the plant-mixed product.

PATIENCE PAYS OFF

Patience pays off when you are caught in congested traffic lanes. By waiting your turn to move ahead, you do other motorists a favor and avoid trouble yourself.



Contract 1-1TC37 1-Men-48-A

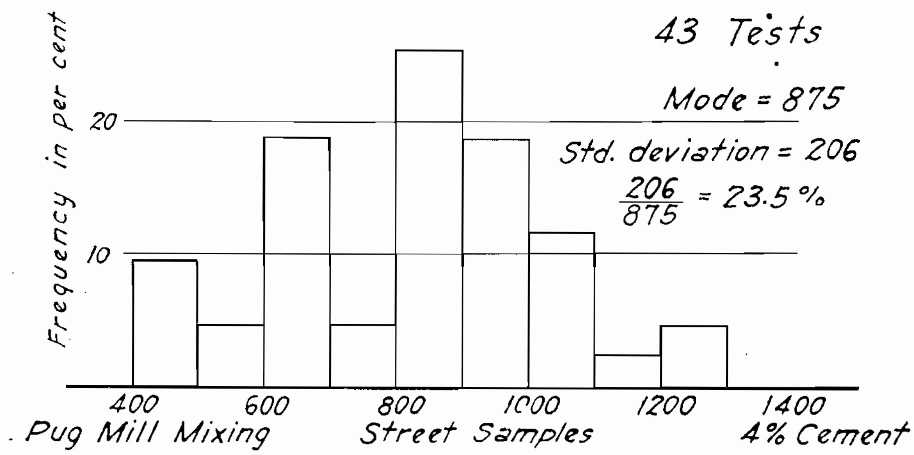


Fig. II Contract 1-1TC34 1-DN-1-AB

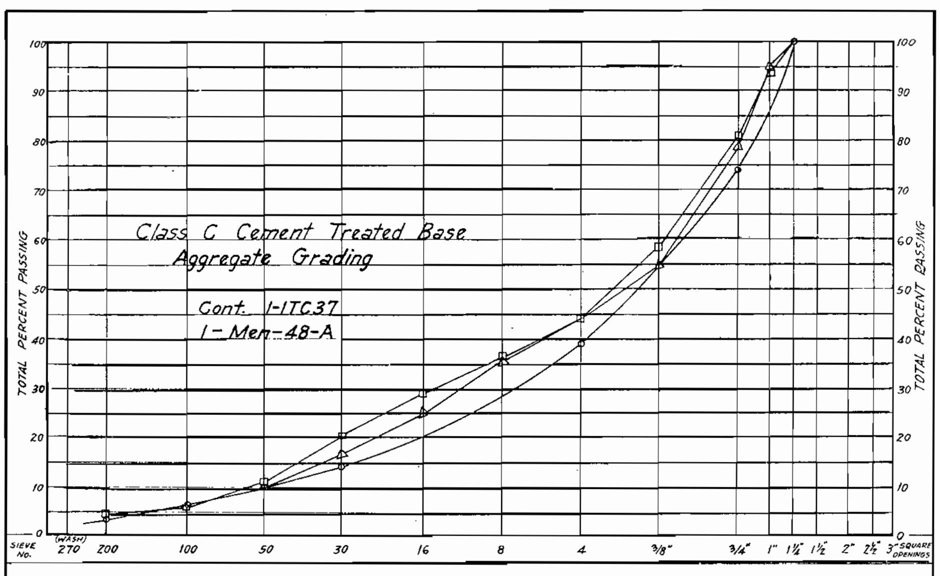


Fig. III

Modern Containers

Service & Supply Department Effects Saving of Highway Money

By G. G. McGINNESS, Assistant Engineer, Service & Supply

WHENEVER Portland cement concrete is poured in a pavement or fairly large structure on a state highway, samples of the concrete are taken at specified intervals. Samples are also taken from concrete buildings constructed for the State under the supervision of the Division of Architecture. These samples or specimens are carefully fabricated in tinned cans six inches in diameter and 12 inches high by a method simulating the placing in pavement or structure. They are allowed to cure for a short time and then they are shipped to the Materials and Research Laboratory in Sacramento where they are tested for strength.

G. G. McGINNESS

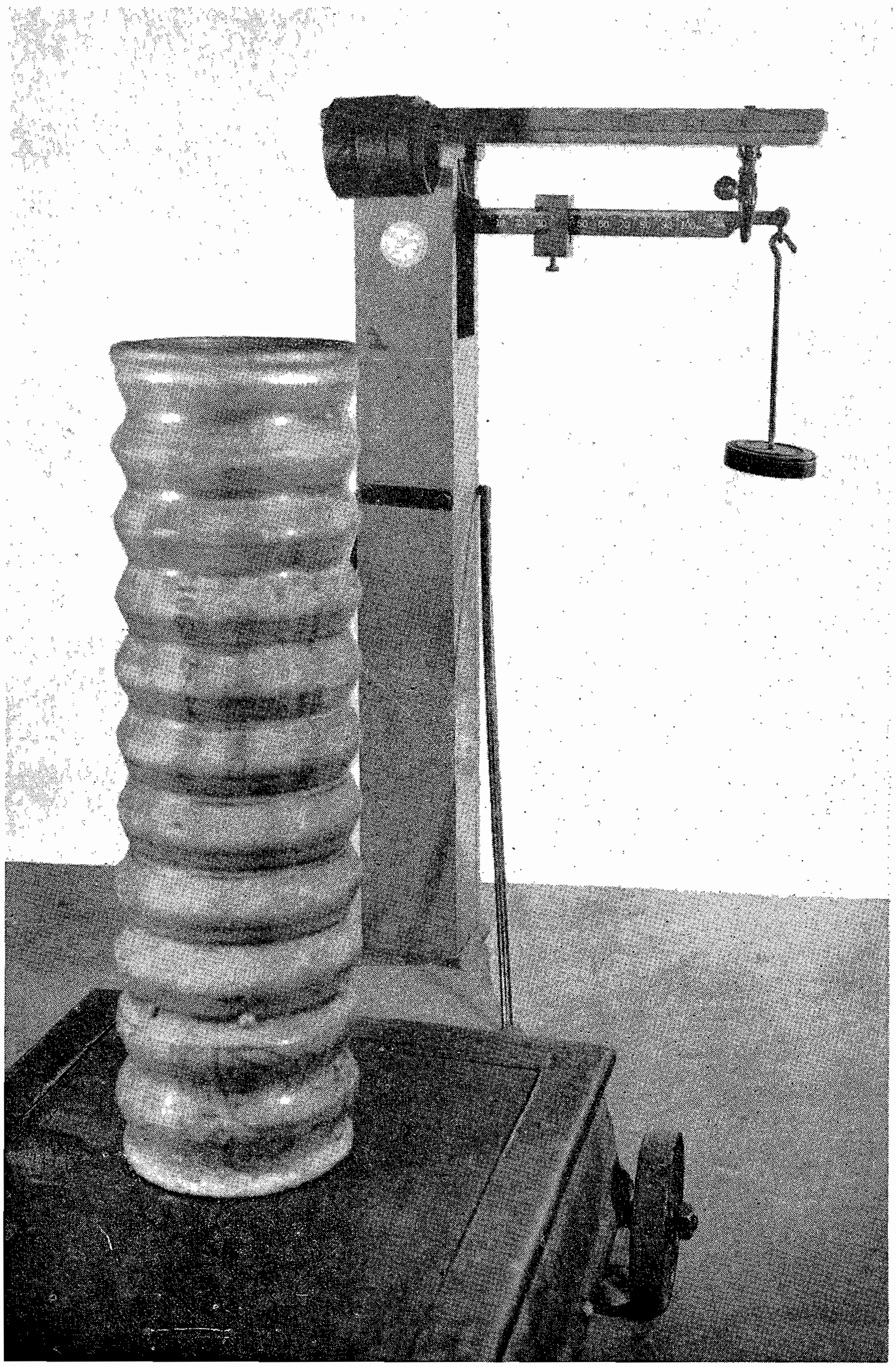
For many years these specimens were shipped from the job to the laboratory in containers made of 16 gauge eight inch corrugated metal pipe. Specimens were packed in wet excelsior, two to the container, making a gross shipping weight of 82 pounds. These were shipped by railway express as no other common carrier would guarantee the necessary prompt delivery. After the specimens were unpacked, the containers were returned to the job by express.

Shipment Costs Decreased

Analysis has shown that almost 1,800 concrete sample shipments were made by the Division of Highways during the year 1949 at a cost of approximately $6,500.

The Service & Supply Department of the Division of Highways in its role of investigators of service became aware of the high cost of these metal shipping containers and the added shipping charges due to their weight and decided to see if there was not a lighter

Empty metal shipping container on scale. Note weight is almost 30 pounds



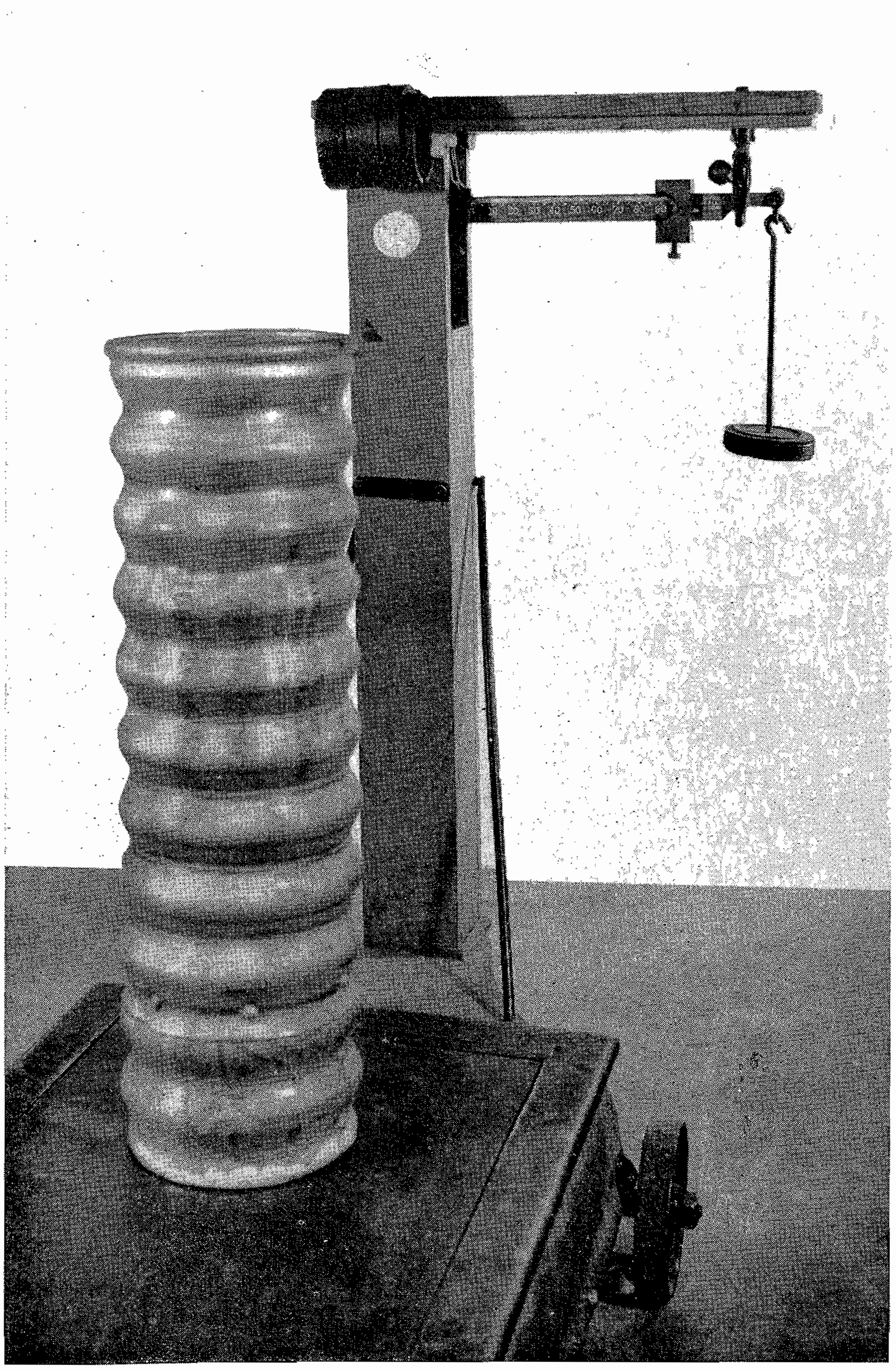
shipping container which would serve the purpose.

In cooperation with the Materials and Research Department, and a carton manufacturer, the Service & Supply Department distributed several corrugated paper containers designed for two concrete specimen cylinders. The cylinders shipped from the field in these cartons, which have a gross weight of less than 60 pounds, were received at the laboratory in Sacramento in excellent condition.

Considerable Saving

An analysis of comparable express shipping costs on the shipments made during the year of 1949 by the Division of Highways, indicates that a saving of over $1,700 per year may be expected by using the lightweight cartons in lieu of the metal shipping containers. Savings on individual shipments will range from $0.48 to $1.68 with an average saving of a little less than $1 per shipment. The saving of the difference in the first cost of the containers is in addition.

Metal shipping container with two concrete specimens. Weight over 80 pounds



Further savings in transportation costs are also being made by shipping by means of truck freight whenever facilities insure prompt delivery. This applies not only to the concrete samples but many other samples of construction materials which must be sent to the laboratory by the engineer in the field. For example, 12 sacks of sample aggregate weighing 435 pounds can be shipped from Bakersfield to Sacramento in one day by common carrier truck, door to door delivery, for $4.87. The same shipment by express would cost $16.53. Care in the selection of transportation agencies in such cases throughout the State will result in a saving of approximately $10,000 yearly.

Although the metal shipping containers were used many times and the carton only for one shipment of concrete specimens, the saving in shipping charges more than pays for the carton on the shortest shipments.

Besides being used to ship the concrete specimens from the field to the laboratory, these cartons are used to ship the empty tinned cans from the Service & Supply Department warehouses to the engineers in the field. When the engineer in the field receives the carton, it contains not only the empty cans but complete instructions for use, illustrated instructions for proper packing, the necessary pieces of gummed tape to seal the carton securely and also two labels addressed to the Materials and Research Department Laboratory in Sacramento.

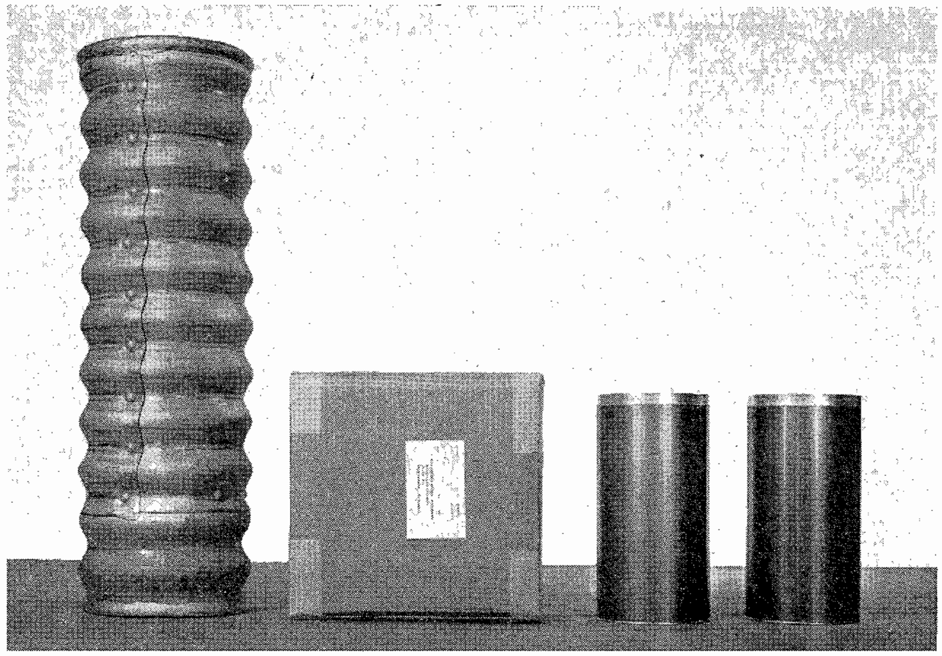
In addition to carrying the empty cans to the field and the specimens to the laboratory, many of the used cartons are being salvaged and reused for packaging miscellaneous materials.

By asking "*why*" the metal shipping containers were necessary, the Service & Supply Department has been able to save on the first cost of the containers, on shipping charges, in time and convenience to the engineers in the field, in time of clerks consigning empty containers back to the job, and the salvage of the used cartons for other purposes.

The specifications used for procurement of these cartons are printed below.

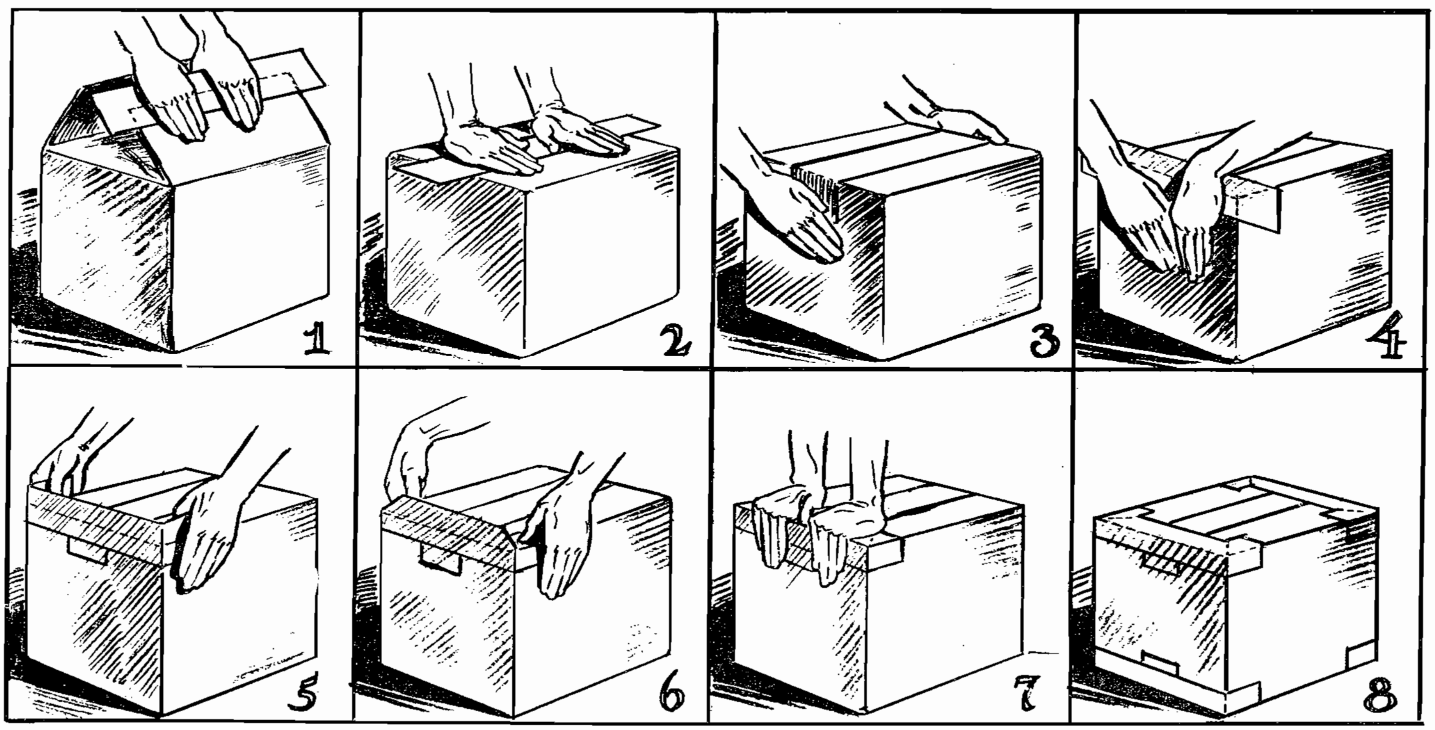
California Division of Highways Specifications for Corrugated Paper Containers for Shipping Concrete Specimens

(a) Size of Container. The inside dimensions of the container shall be such that it will snugly hold two metal concrete specimen cans six inches in diameter by 12 inches high, separated by a quarter-inch thick pad. The height shall be sufficient to fold the top down without bursting a two inch strip of 60 pound gummed kraft paper tape in shipment. The approximate inside dimensions shall be 12¼ inches wide, six inches thick and 12¼ inches deep.



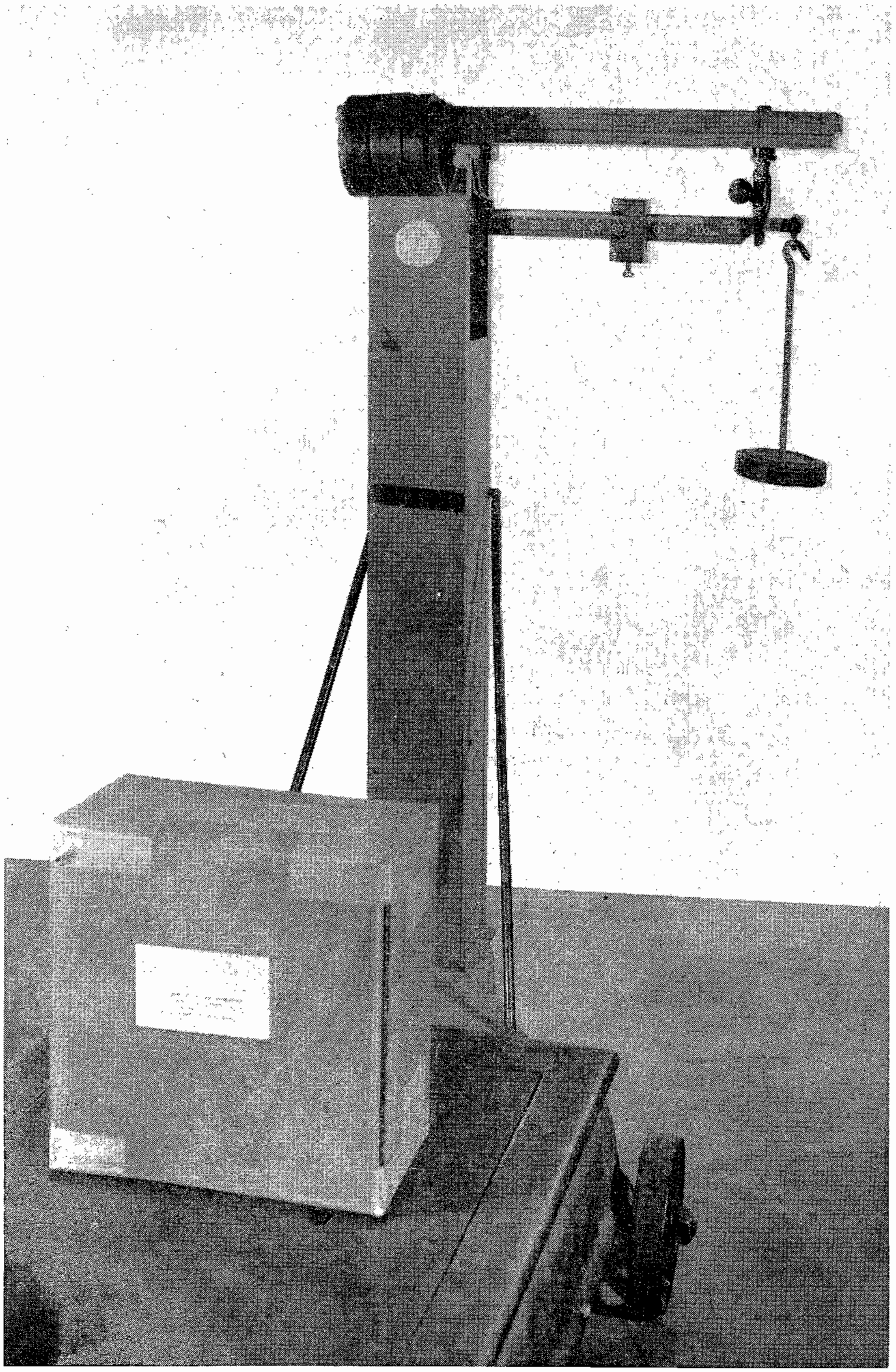
This illustration compares metal and corrugated paper containers and shows sample cans which they are designed to carry

How to Apply Gummed Sealing Tape Properly



1- Apply strip of tape to one flap. Allow at least a 3-inch overlap.
2- Close flaps and seal center seam. Press firmly with heel of hand.
3- Fold down end overlap. Press downward firmly with palms.
4- Seal edge seams with at least a 3-inch overlap at each corner.
5- Bend around sides and pull tightly around carton, pressing inward.
6- Fold corners over top and press firmly with thumbs.
7- Fold and press top to complete sealing of the edge seams.
8- The finished job, securely sealed on all seams, top and bottom.

Always use the correct basis weight and width for your particular job. Remember, to double-strip your carton -- is waste.



The new corrugated paper container with two concrete specimens. Note that weight is less than 60 pounds

(b) Size of Pad. The pad shall be twelve inches (12″) by six inches (6″).

(c) Material. The material of both pad and container shall be double wall corrugated kraft or jute paper to conform to the following requirements:

350 pounds per square inch bursting strength.

100 square inch size limit.

120 pound gross weight limit.

(d) Construction. Jointing of one side only will be accomplished by the use of at least a one and one-quarter inch (1¼″) overlap on one panel and flat wire stitching to the adjacent panel.

The container shall conform to all construction requirements of Consolidated Freight Classification Rule 41.

In Memoriam

WILLIAM HARTMAN PETERSEN

William Hartman Petersen, Principal Structural Engineer, Division of Architecture, died suddenly on November 11, 1950. He was a native of Watsonville, Santa Cruz County, California. He was born September 28, 1897. His early life was spent in this area and he attended grammar school at Castroville. His parents, Peter and Agaptha Petersen, were natives of Denmark who moved to California where they took up farming and eventually purchased a large ranch on U. S. Highway 101 about five miles south of Salinas, California.

Like many farm boys, Mr. Petersen decided he would rather be a civil engineer than an agriculturist, so he enrolled in the Polytechnic College of Engineering in Oakland and completed his training about 1917.

His first engineering position was with the Pacific Gas and Electric Company. However, the work on this project was terminated suddenly by World War I. His employment record shows that the next few years were spent working for the California Highway Department and the Nevada Highway Commission. On February 4, 1926, he accepted a position as Junior Structural Engineer with the Division of Architecture and his employment has been continuous since that date except for a short period during World War II.

During his service he was always active and interested in the welfare of his fellow employees. At the time of his death he was president of the Central California Structural Engineers' Association as well as a delegate to the State Employees Association.

Mr. Petersen was well thought of by his fellow workers and his sudden death due to a heart attack on the afternoon of November 11, 1950, came as a shock to his family and his many friends. He is survived by his wife, Mrs. Beryl Wilson Petersen, and two children, Marcia Ann, and Andrew Hartman Petersen, and also by two brothers and a sister.

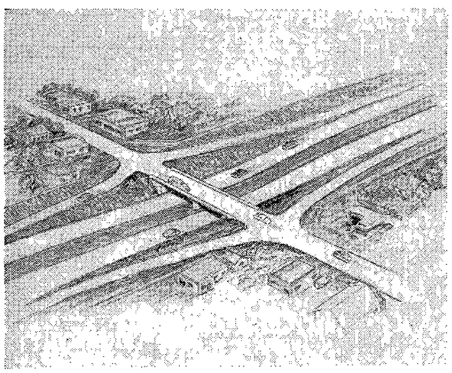
Traffic Interchange Design

By SAM HELWER, Assistant Engineer of Design

This is the second of three articles by Mr. Helwer—Editor.

DIAMOND TYPE

Another type of design which has been used extensively is the diamond type. This rather simple looking design has a great deal in its favor, due principally to this simplicity. It requires a minimum number of connections, is direct in alignment and can be compressed into an area that would not accommodate any other design type. Consequently, it is well suited to heavily developed area. It is easily signed and requires a minimum of circuity of travel.



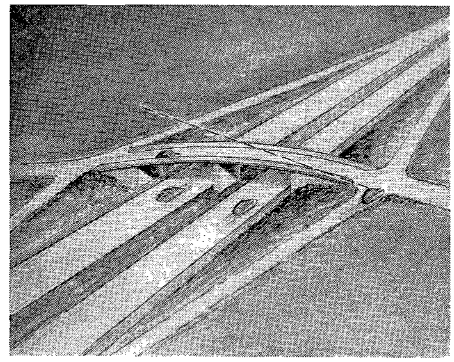
Diamond type design

There are some disadvantages, however, which must be considered. While all four of the right-turn movements can turn right and merge without crossing conflicts, all four of the left-turn movements are required to turn left across traffic on the cross street. Another disadvantage, under certain arrangements of grade lines, is an inadequacy of sight distance at the ramp connections to the cross street.

Diamond Type Grade Line Systems

The most desirable grade line arrangement for a diamond type interchange is one in which the freeway is completely in cut section at the intersection. This arrangement requires a minimum amount of disturbance to the existing street system and provides better sight distance conditions at the ramp intersections with the cross street. The advantage of not requiring revision of the grade lines of the existing street system is very desirable in highly developed areas where a change in grade would necessitate outright acquisition of many affected properties.

Another grade line system which requires no change in grades of the existing street system is one in which the freeway is on a structure over the cross street. While this design also leaves intact the properties fronting on the local street, it has the disadvantage of reduced sight distance at the ramp intersections with the cross street. In this arrangement, the horizontal sight distance on the ramps is impaired by the freeway fill. While this condition can be helped by moving the connections laterally to a position farther removed from the separation structure, some of the inherent advantage of the

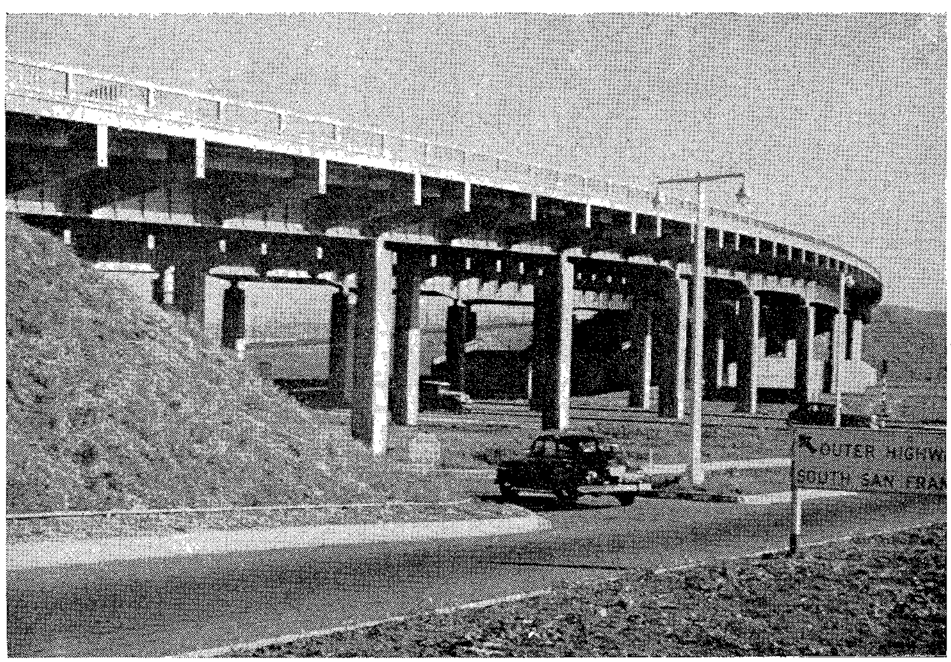


Better sight distance

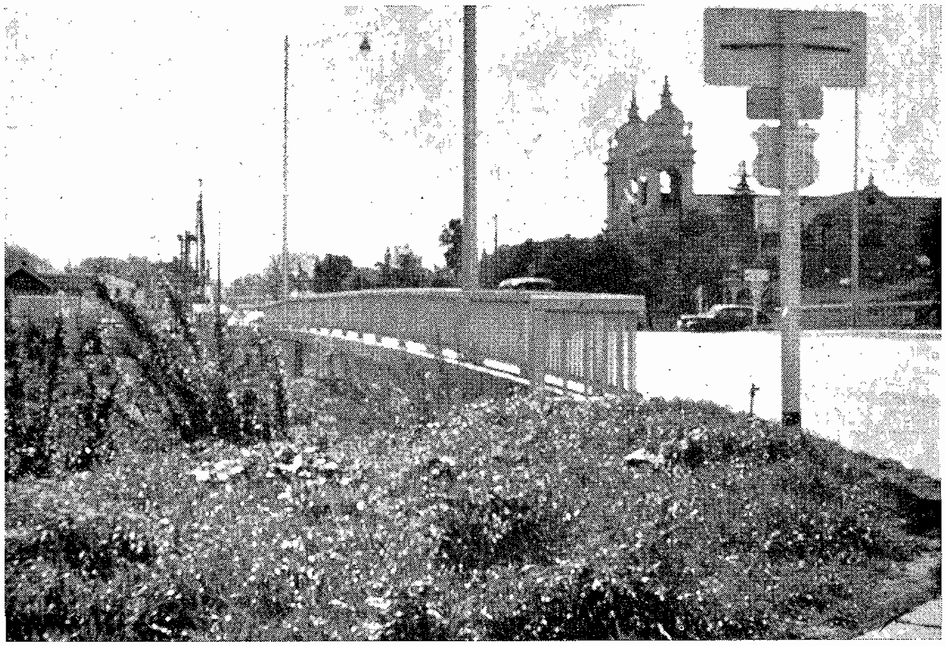
diamond type is lost by increasing the right of way required.

The least desirable grade system for a diamond type interchange is one which requires a complete raising or lowering of the local cross street. This system not only may require acquisition of the properties fronting on the cross street for a distance of about 600 feet on each side of the freeway, but also creates undesirable sight distance restrictions at the ramp connections to the cross street.

Diamond type off-ramp with freeway on fill



The vertical sight distance provided on the cross facility is usually not in excess of 35 miles per hour nonpassing sight distance. On a crest vertical curve, this lower sight distance, combined with the additional sight restrictions imposed by the bridge railing on the separation structure, creates an unfavorable ramp intersection which may be hazardous under certain traffic conditions. Although modern bridge railings are open and well designed for a maximum of sight distance, there are always conditions where any railing has the same effect as a solid obstruction to a driver stopped on a ramp just opposite the end of the structure. For these reasons, great care must be exercised to obtain the best sight distance possible under the design controls imposed on the interchange designer.



End view of bridge railing which obstructs view of vehicle approaching on crest vertical, top of which shows just above bridge railing

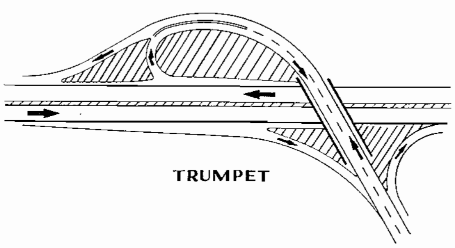
BRIDGED ROTARY

The bridged rotary type interchange, although capable of moving large volumes of traffic, has not been used extensively in California. This design requires two separation structures and large right of way areas to provide for the design of a traffic circle which will permit adequate turning radii and weaving lane sections. The need for large areas makes this design unsuitable in highly developed areas which is a usual condition in California.

The two separation structures permit uninterrupted flow of the through movements on the freeway, but the through traffic on the cross facility and all the left and right turning movements must weave or merge on the traffic circle at grade.

TRUMPET TYPE

The trumpet type interchange is used at "T" intersections, which require provision for only six traffic movements instead of the customary 12 movements of a full intersection. Of these six movements, two are straight through, two are right turns, and two are left turns. Turning movements at "T" intersections are usually heavier on one side of the trumpet than the other, which permits a design that subordinates the minor movements to the major flows of traffic. The trumpet is inclined to provide direct high standard alignment for the major movement, while the minor movement is required to go through an indirect cloverleaf movement on a lower standard of design.



At "T" locations where the interchange movements are all relatively heavy and of equal importance, a multiple structure interchange may be warranted to provide more direct alignment for all movements. The "San Francisco Airport Overcrossing Interchange" on the Bayshore Freeway is an example of this type of "T" intersection interchange.

COMPARISON OF INTERCHANGE TYPES

In addition to the preceding interchange types, there are hybrid combinations, too numerous for individual discussion. They usually represent difficult physical controls and unusual traffic patterns and for these reasons are the most difficult to design.

It would again be convenient to have definite design and traffic warrants which would enable the designer immediately to select a diamond type, for example, in preference to a cloverleaf type. Unfortunately, this cannot yet be done; each interchange location must be individually analyzed on the basis of traffic service and cost.

Right of way and construction costs can be determined with a relatively high degree of accuracy, but much research remains to be done before traffic service can be evaluated to the same degree of accuracy.

The following comparison of right of way areas that have been acquired for the interchange connections for several interchanges on completed projects is of interest. The areas indicated are for ramps and loops only, and are exclusive of the normal right of way for the freeway proper.

Interchange	Type	Loop radius	Additional ramp area, acres
San Bruno Ave.	4-quadrant cloverleaf	130′	14.4
Pierce Road	Bridged rotary	130′	8.9
Swanston Road	2-quadrant cloverleaf	55′	4.1
Santa Clara Ave.	Diamond		4.0

If the required interchange areas are highly developed with correspondingly high land values, the advantages or disadvantages of a particular design type from the standpoint of initial cost are readily apparent. Large areas not only increase initial cost, but also increase perpetual maintenance cost. The removal of large areas of productive land or valuable developed properties from the tax rolls should be avoided if alternative designs giving comparable traffic service are possible. Where right of way costs will be a major factor in a cost comparison analysis, the Right of Way Department should be requested to make the cost estimate of the affected parcels.

INTERCHANGE STRUCTURES

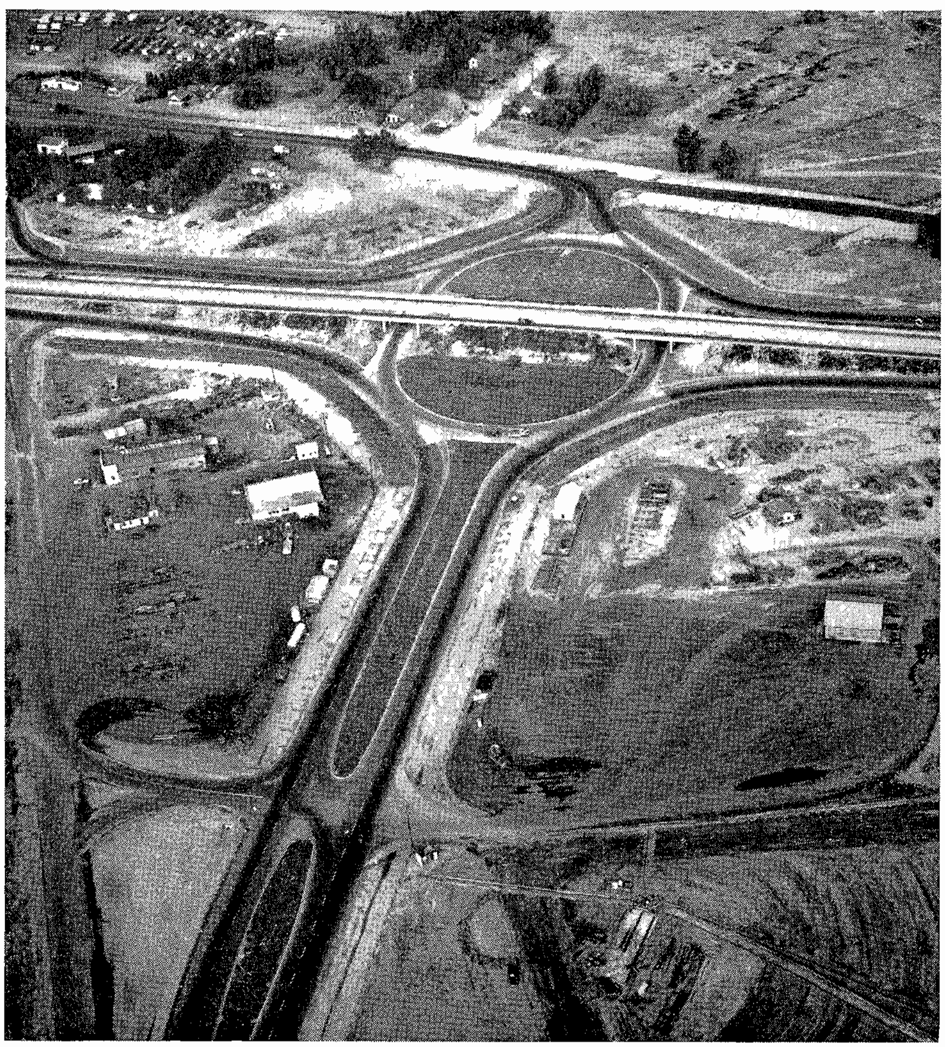
Up to this point, this discussion has treated the interchange structures as an item to be taken for granted because obviously if an interchange is to be constructed, it is necessary to have a bridge. The interchange designer, however, cannot take structures for granted; he must always give structure requirements a top priority in his thinking from the standpoint of both economy and operating characteristics. Frequently the interchange structure is the most important single item in the project.

The interchange designer must be thoroughly familiar with the effect that horizontal and vertical curvature, superelevation, skew angle and span length have on the over-all cost and appearance of the structure. While the bridge engineer will make the ultimate decisions on the structure, there are several broad rules which will expedite design if they are recognized at the beginning of preliminary interchange studies.

1. Span Lengths

The economic relation between materials of construction, methods of fabrication, type of structure and span length follows definite patterns. Of course, there are variations and overlapping, but it can be assumed for the average job that the material and type of construction for given span lengths will be as described below.

Pierce Road rotary separation structure north of Bakersfield in Kern County



A. For short low spans from 16 to 40 feet long, reinforced concrete slab spans have been proving more economical. This type bridge has the further advantage of being less than 2½ feet thick, cutting cost of approach fills and increasing vertical sight distance.

B. When spans are from 35 to 75 feet long and bents are of medium height, the choice usually lies between rolled steel beams and concrete "T" beams. Comparative availability of materials and labor and foundation conditions will effect the economy of this group. The steel beam spans require only four feet of depth; the longer concrete beams will exceed this.

C. When spans range from 60 to 125 feet long, the economical choice lies between reinforced concrete boxed girders and riveted steel plate girders. Foundation material, loads, curvature, superelevation and skew are factors affecting economy of these two types. Steel structures are preferable for poor foundation conditions due to their lighter weight and adaptability for articulation, and also for heavier railroad loadings. Concrete structures are more adaptable to curved, skewed and warped alignment and present the best appearance for one, two or three span highway separation structures.

In rural areas where pedestrian travel is light and appearance is not a major factor, an open-end, multiple-span structure bridge is usually more economical than a high abutment type. The open-end structures, however, should be avoided in congested areas especially if accessible to pedestrians.

2. Horizontal and Vertical Curvature

The interchange layout should avoid variable superelevation on the structure wherever possible. The structure should either be completely on curved alignment, or on tangent alignment a sufficient distance from the beginning or end of a horizontal curve to be beyond the influence of superelevation.

From an appearance standpoint, the structure is usually the center of interest in the layout. Roller coaster grade lines are not pleasing in appearance, particularly on the bridge rails. From the standpoint of economy, roller coaster grade lines are difficult and expensive to design and construct. It is realized that the structure is usually the point of critical clearance, but unless some natural topographical feature governs the grade line, reverses of grade on the structure should be avoided.

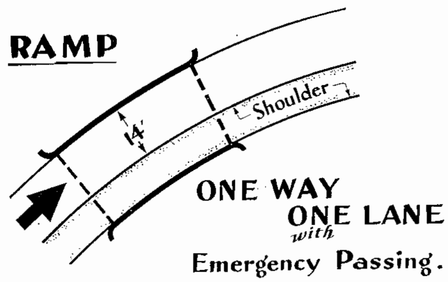
In the preliminary interchange studies, adequate vertical clearance should be provided for the required span lengths. If the structure thickness is less than contemplated in the preliminary design, it will be noted on the preliminary bridge studies, and the grade lines can be revised if economy or increased sight distance warrants the change.

3. Structure Widths

From the standpoint of traffic service and safety, the most important design feature of the structure probably is its width. Due to the high speed of traffic and large size of commercial vehicles, it is extremely important to provide full unobstructed shoulder widths across the structure wherever possible. Structures narrower than this width not only introduce taffic hazards but also reduce traffic capacity. A vehicle stalled in a traffic lane, because of the lack of an emergency parking shoulder, reduces the capacity of the facility by more than one lane of traffic due to the hazard and conflict introduced into the other lanes.

In California freeway practice, all bridges having a length less than 100 feet are built with full shoulder width. Although it would be desirable to provide emergency parking shoulders for the full length of all structures, economy forces a reduction of width on the longer structures. Structures over 100 feet in length are designed to a width four feet wider than the traveled way. This extra four feet provides a two-foot offset to the bridge curbs on each side of the traveled way.

One exception to this rule is for structures on one-way, one-lane ramps. For these ramps, the minimum structure width provides room for emergency passing of a stalled vehicle in all cases. Failure to provide this width could result in complete blocking of a ramp by a single stalled vehicle.



4. Horizontal and Vertical Clearance

Horizontal clearances to a bridge abutment or pier depend on whether the obstruction is to the right or left of traffic. On the driver's left, the *minimum* clearance is 4½ feet from the pavement edge. The recently adopted 16-foot minimum freeway median results in 4½-foot clearance from the curb line or 6½ feet from the edge of pavement. On the right side the minimum clearance is increased to six feet, but preferably eight feet, based on the belief that a driver will shy farther away from an obstruction on his far side.

Vertical clearance to a structure over a traffic lane is 15 feet, which is 1½ feet in excess of the legal load height limit. Vertical clearance over a railroad track is 23½ feet.

RAMP CONNECTIONS AND SPEED CHANGE LANES

The safe and efficient functioning of any traffic interchange is directly dependent on the auxiliary lanes and ramp connections which transfer the interchange traffic from one facility to the cross facility. Ususally this transfer is between a high-speed, free-flowing freeway and a lower design standard local street or road. In order to maintain the free-flowing characteristics of the freeway, the ramps and auxiliary lanes at their junctions with the freeway must be designed to comparable high design standards. However, at the junction to the local facility, it is frequently necessary to reduce ramp design standards to conform to local street design standards, local traffic regulations and for consideration of pedestrians.

Speed Change Lanes

The speed change lanes on a freeway provide auxiliary areas for the deceleration of leaving traffic and the acceleration of entering traffic. The length of a deceleration lane is based on leaving the freeway at 0.7 of its design speed and decelerating to the safe speed of the ramp alignment. The length of an acceleration lane is based on the distance required to accelerate to 0.7 of the design speed of the freeway from the safe speed of the ramp. The use of the 0.7 design factor is an American Association of State Highway Officials recommendation, based on observations of average speeds on freeway lanes. Similar observations in California indicate this figure may be somewhat low for drivers on California freeways.

In the design of speed change lengths, a word of caution appears desirable. It must be understood that present design standards do not include a safety factor for speeds higher than 0.7 of the freeway design speed. They assume that decelerating traffic can always get off the freeway, that accelerating traffic can always enter, and that the driver will drive at the assumed design speed of the ramp alignment. These assumptions may cause operating difficulties when the traffic volumes on our newly constructed facilities exceed the practical capacities for which they were designed.

(To be continued)

In Memoriam

SAMUEL J. SMITH

Samuel J. Smith, resident engineer for District VIII of the State Division of Highways, died Monday in Sawtelle Veterans Hospital after a brief illness, it was learned yesterday.

Mr. Smith, 32, who resided at 1259 Genevieve Street, San Bernardino, had been an engineer in the Division of Highways in San Bernardino since 1941. He served with the 956th Engineers Topographical Company during World War II.

He is survived by his parents, Mr. and Mrs. Harry C. Smith, and two sisters, Mrs. Leah Smith and Mrs. Mary Morgan, all of Los Angeles.

Successful Test

Road Mixing Machine Proves Satisfactory in District I

By R. L. MYERS, Resident Engineer

THE P and H "Single-Pass" Soil Stabilizer was used for the first time on a state highway project during the summer of 1950 near Orick, Humboldt County, in District I. It was used for road mixing into cement-treated base a graded aggregate which had been placed on the roadway to the required depth and section. The over-all results were considered very satisfactory.

It appears that this machine is particularly adapted to mixing base material that has been recently placed and sufficiently compacted to provide a good riding surface for traffic. This base should be constructed closely to section as it is our opinion that the final riding qualities, lack of sags and uniform crown or super elevation in the completed base is controlled largely by this prior preparation of the base to be mixed.

Controls Material Volume

The construction of this machine is such that all the material to be mixed is lifted cleanly off the roadway and no material below the lower plane of the proposed mixture is disturbed. This prevents areas of loose or uncompacted material below the cement treated base and provides an excellent control of the volume of material to be mixed. The depth control for the thickness of base appears positive.

The machine may be operated at any of several speeds ranging from 6.2 to 32.9 feet per minute while mixing. The mixing action is apparently as thorough at the maximum rate of speed as at the minimum. However, one criticism of the machine was made by the operator who felt that it was difficult to steer the machine to a true line at maximum mixing speed. It would be well to note that this operator had never operated a machine of this type before and the alignment of the road in this case presented numerous sharp curves with radii as short as 400 feet and no longer than 500 feet.

P & H Stabilizer processing cement stabilized base on U. S. 101 near Orick

Operation of Machine

The machine is steered much in the same manner as a caterpillar tractor. The mixing chamber is supported on a transverse member immediately behind the rear end of the tracks on which the machine travels and protrudes about 10 feet to the rear. Any small change in the direction of the machine is greatly amplified in the sidewise movement of the mixing chamber. This, of course, can be controlled by careful operation of the machine and anticipation of turning movements by the operator.

The arrangement of this machine is such that a water truck is pushed ahead and water is pumped through tanks within the machine to the mixing chamber. One good point is that the machine can operate for some time on the water in its own tanks while water trucks are being changed or filled.

Driver Must Be Skilled

One disadvantage is that the water truck obscures the operator's view when moving around a curve to the right. The operator sits over the left track sighting over a butterfly sight mounted immediately in front at a vertical needle mounted on the left side of the radiator. He aligns these sights with line rods from three to six feet long set one foot inside the edge of the area to be mixed and for 200 feet ahead. Obviously, a water truck would interrupt the view on sharp curves. The application of water is precisely controlled through a registering meter and is applied through one or two spray bars of the type used on distributor trucks. These are mounted on

This photo shows the uniform spread of thoroughly mixed cement stabilized base material as the P & H Stabilizer processes 1,275 square yards per hour

top of the box spraying water through slots in the top just ahead of the first row of mixing paddles. It was noted that the nozzles immediately adjacent to the sides of the mixing chamber frequently became clogged with cement, dust and sand. However, they were readily cleaned without stopping the machine. The water is turned on and off very positively with no dribbles. Any nozzle may be turned off without disturbing the others.

Little Hand Work Required

A distinct advantage of this machine is that it can be backed into position at a bridge end or transverse joint and the box lowered into position with the shafts in motion, mixing to full depth almost against the structure or joint.

A distinct disadvantage is that the mixing chamber is either 8 or 10 feet in width and no practical mechanical means of varying this width has been developed. Therefore at present the areas to be mixed should preferably be an even multiple of 8 or 10 feet. Either the 8- or 10-foot mixing chamber may be installed on the same machine. Mixing a 6-foot strip with the 8-foot box was accomplished by applying a strip of cement six feet wide and leaving two feet of shoulder area uncovered. Then the entire 8-foot strip was mixed, the assumption being that none of the cement would migrate into the 2-foot strip.

Suggested Improvement

Since the pugmill paddles are set at different angles to deflect the material transversely, some cement was undoubtedly thrown into the 2-foot strip. This amount could not be determined. This could possibly be avoided by installing a vertical "cut-off" plate longitudinally in the box and straddling the shafts of the pugmill paddles. Such plates are *not* manufactured for the machine.

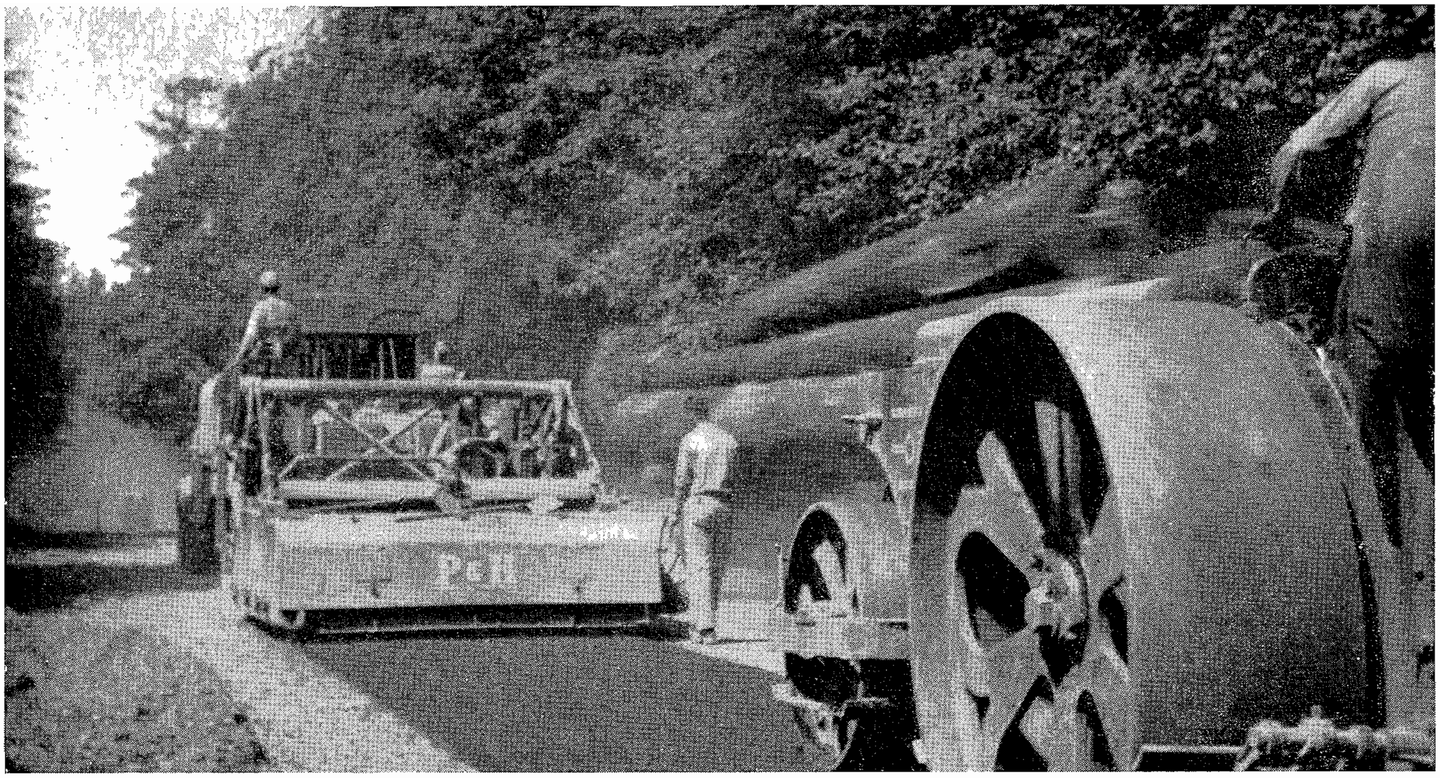
In mixing material on a steeply superelevated curve the mixed material tends to move to the lower side of the superelevation leaving an area of variable width along the upper edge of the strip with little or no material in it. This requires redistribution of the mixed material with the motor patrol. As a motor patrol is required for finish cutting of the rolled base this disadvantage of the machine is not of great consequence.

Adjustments

As the cutting, blending, and mixing paddles are mounted on four transverse shafts, not articulated, the bottom of the excavation is always a plane surface and cannot be crowned. When required to mix a strip down the center of the road it became necessary to find a means of obtaining the desired crown. On the rear of the mixing chamber is a controllable screed or "tail-gate." This was raised and two cutting edges from a motor grader blade were installed with the holes near centerline slotted vertically for adjustment. For a 2 percent slope for four feet (½ box width) the ends of the blades at centerline were raised 0.08 foot above the outer ends. This afforded the necessary crown on the surface but of course left the mix .58 feet thick at the center instead of the designated 0.50 foot. The cement content was not increased to provide for the increased depth; consequently the strength of the base at centerline should theoretically be less than at the edges of the strip.

Operations

On the projects in the vicinity of Orick the efficiency of the cement spreading device was found to be questionable. After considerable changing of sprockets and base plates the proper spread of cement per station for the mixing width was obtained but the cement was not uniformly spread transversely. Representatives of the P and H Company felt that during mixing the soil stabilizing machine would distribute the cement uniformly



The thoroughly mixed cement, water and road material was compacted immediately behind the stabilizer by a heavy steel wheel roller. Traffic used the new base as soon as a lane was completed

over the 8-foot width. Rather than risk uneven distribution the contractor was required to furnish a man with a push broom to spread the cement in a blanket of uniform depth ahead of mixing. After mixing specimens were taken across the strip and adjacent strips.

The digging and mixing speeds of the machine are 6.2, 10.8, 18.5, 26.7, and 32.9 feet per minute with a forward maneuvering speed of 46.7 feet per minute. Reverse speeds are 26.0, 45.5, 78.0, 139.0, and 196.0 feet per minute.

On this particular project 69,000 square yards of cement treated base six inches deep were road mixed in an operating time of 52¾ hours and an elapsed time of 83¾ hours.

Maintenance Not Difficult

Lost time was six hours due to weather, 10 hours due to maintenance, 14 hours due to maintenance on the cement spreader and waiting for cement, and one hour due to delay in resetting stolen centerline offset stakes.

The maintenance consisted entirely of replacing the cutting teeth. No blending blades or pugmill blades were replaced during this project although at the conclusion of the work replacement of some of the latter was necessary. There were no breakdowns and as indicated above the greatest delay was experienced with the cement spreader and in waiting for cement which was hauled from Eureka to Orick, 49 miles, in 10-yard dump trucks.

This machine was found to be capable of doing a large amount of work very rapidly with a minimum of inconvenience to passing traffic. The surface of the finished cement treated base was left smooth and few pot holes developed under traffic. The strength of the mixture was good as is shown by the test results.

Tests Results Satisfactory

It was the opinion of the district that mixing with this machine produced as thorough and uniform a product as could be produced by road mix methods. On the basis of test results the latter part of the work was done with the cement content reduced from 5 percent to 4.5 percent and compressive strength still remained well above the required minimum.

The contractor believes the machine has some distinct advantages. It is quite maneuverable which makes it easy to move into position for the beginning of a day's work and to move about on the job. The only maintenance item is the replacement of teeth and paddles and this is done very rapidly by merely tapping them out of tapered sockets with a hammer. New ones are placed in the sockets and secured by a few taps of a hammer. The cutting teeth are rather expensive, being made of a special material, and when mixing a tightly compacted gravel wear is fairly rapid.

The machine can be loaded quickly on a low bed trailer under its own power but an over-width permit is required for its movement over highways. It is equipped with twin G. M. C. diesel engines and though its initial cost new is about $42,000 the contractor believes the investment was worthwhile for the type of work for which it was purchased. Next spring he proposes to use the machine to mix

. . . Continued on page 57

New Booklet on State Government

CALIFORNIA STATE GOVERNMENT: A GUIDE TO ITS ORGANIZATION AND FUNCTIONS, 1951, is a new 112-page publication prepared in response to a widespread demand from students, teachers, and the general public for a concise, nontechnical description of State Government as it exists and operates.

The agencies of the State of California, and the functions they perform, are described in clear, understandable language under 10 group headings: General Control Agencies, Correctional Agencies, Educational Agencies, Mental Hygiene Agencies, Natural Resources Agencies, Public Health Agencies, Public Safety Agencies, Public Works Agencies, Regulative Agencies, and Security and Welfare Agencies. Their organization and interrelationship are illustrated by means of simple, legible charts.

In his foreword to this booklet, Governor Earl Warren states: "Our State Government is an enterprise in which every California citizen has a stake. Yet relatively few of us have the opportunity to know first-hand the diversity of our state governmental services, or know how our State Government is organized to do its job."

The publication is priced at 50 cents, plus sales tax for California addresses, and may be obtained from the Documents Section, Printing Division, 11th and O Streets, Sacramento 14, California. Orders should be accompanied by remittance, since purchase orders can only be accepted from public agencies.

Successful Test

Continued from page 56 . . .

road mixed surfacing on his Contract 1-1DC12, FAS-975. Grades on this project include a section of 10 percent and operation of the machine on this grade and for this type of mixing is being looked forward to with interest by the district.

DISTRICT SHOP 8 RECEIVES "CERTIFCATE OF MERIT"

By RUSSELL J. STANDING, District Safety Supervisor

District Highway Engineer Spencer W. Lowden, left, presents certificate to Albert A. Hilton, right. In center, C. P. Coote and Ray S. Milnor

WHEN a group of people work 174,734 hours without a lost time accident it is a record that merits consideration and honor.

District Highway Shop 8 in San Bernardino piled up a record of two years and seven months without time lost due to accidents, and has now been duly honored for that record.

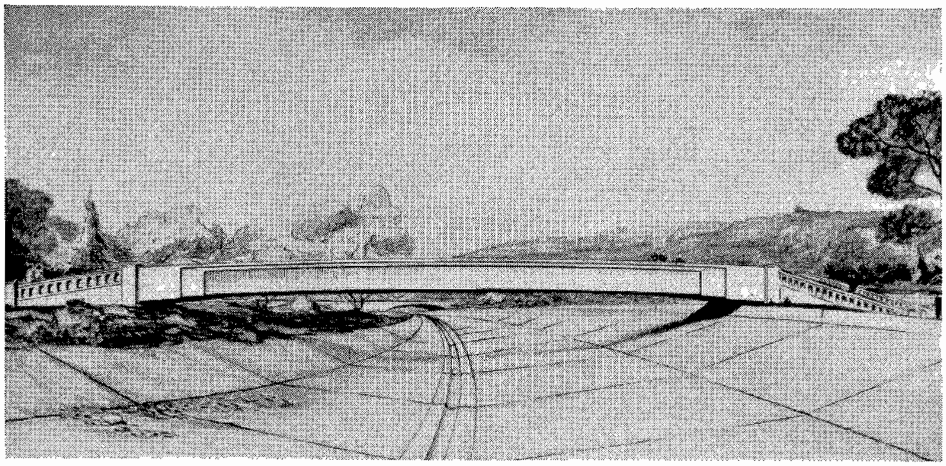
The District Shop has 35 employees, most of whom work with heavy equipment and machinery used in highway maintenance and construction. This work is under the direction of Albert A. Hilton, equipment superintendent, who has supervised shop work in District VIII for the past nine years. Prior to this time, Hilton was shop foreman at Shop 7, North Hollywood for 21 years.

In a ceremony at Shop 8 Monday, January 8, 1951, a "Certificate of Merit" was presented to Hilton, C. P. Coote, shop foreman, and Ray S. Milnor, assistant shop foreman, by Spencer W. Lowden, District Engineer, District VIII, for the shop employees. The certificate is signed by C. H. Purcell, Director of Public Works, and G. T. McCoy, State Highway Engineer.

Mr. Lowden gave an inspirational talk to the employees, commending them for their record, and encouraging them to continue their loyalty and efforts.

Members of the District Safety Committee on hand to witness the presentation and offer their congratulations were: L. R. McNeely, Assistant District Engineer, Chairman of the Committee; Almon Coonrod, District Office Engineer; G. E. Malkson, District Maintenance Engineer; Loren S. Moore, District Traffic Engineer, and Russell J. Standing, Secretary.

California Builds A Prestressed Bridge



Arroyo Seco pedestrian bridge

THE ACCOMPANYING photo of a sketch by the Bridge Department artist is a view looking upstream on the Arroyo Seco channel showing a reinforced concrete pedestrian bridge now under construction. The channel roughly parallels the Arroyo Seco Parkway at this point in the vicinity of Avenue 58, Los Angeles. The contractor is Walter Kaucher of Los Angeles, who is presently more than half-way through his work.

This structure, 110-foot span and 8-inch width, is unique in the fact that it is the first of its type to be built in California and employs wires rather than bars for reinforcing. These wires are so located and stressed in advance of their being subjected to passing loads as to counteract the bending stresses. The resultant reduction in the amount of concrete and reinforcing steel in the superstructure provides lightness and good appearance. The economy in weight carries through to the foundations which are obviously lighter than orthodox construction.

The beams are being constructed on the ground at the site where they will be prestressed. Upon the completion of these operations and a seasoning period the beams will be lifted into final position by two cranes. This method speeds the contract, saves the expense of supporting timber work required when the deck is built in final position and avoids the hazard of loss which might result if the channel were occupied by falsework timber during flood. Subsequent articles in this magazine will cover later developments.

R. H. BALDOCK RECEIVES BARTLETT AWARD FOR 1950

R. H. (Sam to his friends) Baldock, chief engineer of the Oregon State Highway System and former director of ARBA, is the winner of the 1950 George Bartlett award. Presentation was made at the annual meeting of the American Association of State Highway Officials in Miami. The AASHO, the American Road Builders' Association and the Highway Research Board of the National Research Council cooperate in selecting the winner of the award for outstanding highway service each year.

SIGNS AND SIGNALS

Two-thirds of all traffic deaths happen at night, according to the California State Automobile Association. Your best defense against after-dark hazards is common sense obedience to warning signs and signals.

In Memoriam

MARSHALL H. HUBBS

Marshall H. Hubbs, Supervising Highway Engineer, Headquarters Office, passed away suddenly November 26, 1950, while on a hunting trip in Yolo County.

Marshall, or "Tex" as he was known to some of his more intimate friends, was born in San Marcos, Texas, July 26, 1888. His early schooling was obtained in the Hays County public schools and the Lone Star College in San Marcos. He came to California in 1910 where for a short time he worked in the Imperial Valley and soon after went to work for the Southern Pacific Company on a survey party.

He first entered state service September 29, 1914, on survey work for the Highway Commission in Division IV, and subsequently was assigned to construction as an Assistant Resident Engineer. During one of the intervals in state service he worked for a time for the City and County of San Francisco as an engineer on the Hetch-Hetchy water development, both on surveys and construction, where he made a host of friends among the early administrators of that great project. He also worked during 1919-20 as Resident Engineer on highway construction for Contra Costa County.

Re-entering state service in August, 1921, he served continuously until his death, rising from Assistant Resident Engineer and Resident Engineer in District I to Senior Highway Engineer in District V, and later to Supervising Highway Engineer at Headquarters Office.

Due to his wealth of construction experience Marshall Hubbs was selected by the late Charles Stockton Pope, then Construction Engineer, to write the Fourth Edition of the Construction Manual in 1938, which edition prevailed as the guiding authority on construction practice until 1950.

His many friends and associates are greatly saddened by Marshall's passing and extend to his widow, Ruth, their heartfelt sympathy.

HIGHWAY BIDS AND AWARDS

November, 1950

ALAMEDA COUNTY—In the City of Oakland, between 38th Avenue and Fallon Street, about 2.8 miles of roadside areas to be prepared and planted. District IV, Route 69. J. Henry Harris, Berkeley, $89,503; Watkin and Sibbald, San Anselmo, $97,700; Huettig, Schromm and Bennett, Palo Alto, $98,574; Leonard Coates Nurseries, Inc., San Jose, $2,441,093. Contract awarded to Justice-Dunn Co., Oakland, $89,-079.55.

BUTTE COUNTY—Across Tule Canal and Biggs Extension Canal, about 1.7 miles west of junction Route 3, two existing bridges to be widened with reinforced concrete construction. District III, Route 45, Section A. Eugene G. Alves, Pittsburg, $20,977; O'Connor Bros., Red Bluff, $21,977; Transocean Engineering Corp., San Lorenzo, $22,989; C. C. Gildersleeve, Nevada City, $27,316. Contract awarded to B. S. McElderry, Berkeley, $19,928.

HUMBOLDT COUNTY — Between Robinson Ferry Bridge and Alton Grade Crossing, about 4.4 miles to be graded and surfaced with plant-mixed surfacing on cement treated base and bridge to be constructed. District I, Route 1, 35, Sections E, F, A. Clyde W. Wood and Sons, Inc., North Hollywood, $983,528; Fred J. Early Jr. Co., Inc., Mercer Fraser Co., Inc., Mercer Fraser Gas Co., Inc., San Francisco, $1,093,655; N. M. Ball Sons, Berkeley, $1,012,471; Piombo Construction Co., M. K. Corporation, and Clements and Co., San Francisco, $1,139,426; Harms Brothers and C. M. Syar, Sacramento, $1,165,394; United Concrete Pipe Corporation and Ralph A. Bell, Baldwin Park, $1,373,249; Parish Brothers and Healy Tibbitts Construction Co., Benicia, $1,430,790. Contract awarded to Fredrickson Brothers, Emeryville, $946,610.29.

INYO COUNTY—At District IX Yard in Bishop, furnishing and erecting a prefabricated metal building. District IX, Route 23, Section D. Kyle Steel Construction Co., Vernon, $8,935; Valley Steel Construction, Bakersfield, $11,947. Contract awarded to Pascoe Steel and Construction Co., Pomona, $8,-844.00.

LOS ANGELES COUNTY—On Hollywood Freeway at Van Ness Avenue, in the City of Los Angeles, two reinforced concrete box girder bridges to be constructed and road connections to be graded and paved. District VII, Route 2. Webb and White, Los Angeles, $318,768; MacDonald and Kruse, Sun Valley, $321,-082; Charles T. Brown Co., San Fernando, $330,023; Fredericksen and Kasler, Sacramento, $330,139; George W. Peterson and Jack W. Baker, Los Angeles, $33,046; Carlo Bongiovanni, Los Angeles, $354,745; Charles MacClosky Co., San Francisco, $358,479. Contract awarded to J. E. Haddock, Ltd., Pasadena, $308,813.70.

LOS ANGELES COUNTY—On Santa Ana Freeway, between Eastman Avenue and 0.1 mile westerly of Atlantic Boulevard, portions, about 1.1 mile to be graded and portions surfaced with Portland cement concrete pavement on cement treated surface, interchange roadways, acceleration and deceleration lanes and outer highways to be surfaced with plant-mixed surfacing on untreated rock base; two grade separation structures and one pedestrian overcross structure to be constructed to provide a freeway with a six-lane divided roadbed. District VII, Routes 2 and 166, Sections D, A. J. E. Haddock, Ltd., Pasadena $1,162,527; United Concrete Pipe Corp. and Ralph A. Bell, Baldwin Park, $1,185,732; Webb and White, Los Angeles, $1,188,122; Griffith Co., Los Angeles, $1,202,518; Guy F. Atkinson Co., Long Beach, $1,208,500; Peter Kiewit Sons' Co., Arcadia, $1,234,-450; N. M. Ball Sons and Ericksen Philips and Weisberg, Berkeley, $1,245,779. Contract awarded to Winston Brothers Co., Monrovia, $1,112,920.20.

LOS ANGELES COUNTY—In the Cities of Monterey Park and Montebello at the intersections of Atlantic Boulevard with El Portal Place, Harding Avenue, and Newmark Avenue, and Garvey Avenue with Hitchcock Drive, and Pomona Boulevard with Findley Avenue, semi-traffic actuated signal systems at five intersections and highway lighting at one intersection to be furnished and installed. District VII, Routes 26, 167, 172. Fishbach and Moore of California, Inc., Los Angeles, $21,955; Ets-Hokin and Galvan Inc., Wilmington, $22,560; Electric and Machinery Service, Inc., South Gate, $22,714; Clinton Electric Corporation, Burbank, $22,856; C. D. Draucker Inc., Los Angeles, $23,685. Contract awarded to Westates Electrical Construction Co., Los Angeles, $18,929.

LOS ANGELES COUNTY—Between La Verne Avenue and Eastland Avenue, about 0.6 mile, roadside development to be performed. District VII, Route 166, Section A. Moulder Bros., Glendale, $20,915; Stephen L. Vistica, San Mateo, $24,495; Jannoch Nurseries, Altadena, $26,502. Contract awarded to Henry C. Soto Corp., Los Angeles, $19,812.

ORANGE COUNTY—Between Heim Avenue and Peralta School, about 4.6 miles, the central dividing strip, the tops of fill slopes and other areas to be planted with Mesembryanthemum edule (ice plant) cuttings. District VII, Route 43, Section B. Justice-Dunn Co., Oakland, $12,736; Huettig, Schromm and Bennett, Palo Alto, $13,942; Henry C. Soto Corp., Los Angeles, $15,428; Jannoch Nurseries, Altadena, $17,606. Contract awarded to D. and M. Sprinkler Co., Long Beach, $11,816.93.

ORANGE COUNTY—At the intersection of Grand Avenue with Orangethorpe Avenue, traffic signal and highway lighting system to be furnished and installed. District VII, Route 171, Section B. Westates Electrical Construction Co., Los Angeles, $9,680; Clinton Electric Corp., Burbank, $9,966; E. D. Johnson, Anaheim, $10,740; Fischbach and Moore, Los Angeles, $11,367. Contract awarded to Electric and Machinery Service Inc., South Gate, $9,090.

RIVERSIDE COUNTY—Between 1 mile north of Temecula and Antelope Road, about 7.0 miles, to be graded and surfaced with plant-mixed surfacing on cement treated base and three reinforced concrete slab bridges to be constructed. District VIII, Routes 77, 78, Sections A, C. Basich Brothers Construction Co., R. L. Basich-N. L. Basich, San Gabriel, $627,-201; E. L. Yeager Co., Riverside, $634,772; N. M. Ball Sons, Berkeley, $638,444; McKinley and Kirk Construction Co., Paramount, $639,329; Peter Kiewit Sons Co., Arcadia, $642,713; Claude Fisher Co., Ltd., Los Angeles, $647,373; Foster and McHarg, Riverside, $651,152; R. P. Shea Construction Co., Indio, $654,843; Westbrook and Pope and Clements and Co., Sacramento, $658,239; Ralph B. Slaughter and Anderson Co., Julian, $667,893; George Herz and Co., San Bernardino, $674,395; Winston Brothers Co., Monrovia, $674,659; Clyde W. Wood and Sons, Inc., North Hollywood, $674,919; Dimmitt and Taylor and T. M. Page, Monrovia, $724,293; United Concrete Pipe Corp., and Ralph A. Bell, Baldwin Park, $728,308; Griffith Co., Los Angeles, $740,026; A. Teichert and Son, Inc., Sacramento, $742,149; Cox Brothers Construction Co., Stanton, $764,764. Contract awarded to L. A. and R. S. Crow, El Monte, $617,930.50.

RIVERSIDE COUNTY—Between Imperial County line and three miles southeast of Mecca, about 14.8 miles to be graded and surfaced with road-mixed surfacing on imported base material. District XI, Route 187, Section A. B. Westbrook and Pope, W. C. Lefever and D. G. Bing, Sacramento, $544,447; Basich Brothers Construction Co., R. L. Basich and N. L. Basich, San Gabriel, $554,982; Hensler Construction Corp., Sun Valley, $559,704; Rice Brothers Inc., Marysville, $573,525; R. P. Shea Const. Co., Indio, $593,739; Dimmitt and Taylor and T. M. Page, Monrovia, $601,727; McKinley and Kirk Construction Co., Paramount, $613,481; R. A. Erwin, Colton, $621,527; Webb and White, Los Angeles, $626,109; Clyde W. Wood and Sons, Inc., North Hollywood, $626,175; Claude Fisher Co. Ltd., Los Angeles, $628,-291; E. L. Yeager Co., Riverside, $630,239; Cox Brothers Construction Co. and J. E. Haddock, Ltd., Pasadena, $639,930; Arthur H. Famularo and Roland T. Reynalds, Anaheim, $690,811; Ralph A. Bell, Monrovia, $737,847. Contract awarded to Griffith Co., Los Angeles, $533,704.40.

RIVERSIDE COUNTY—Between 7.8 and 8.2 miles north of Route 26 in Dry Morongo Canyon, about 0.4 mile to be graded, imported base material to be furnished and placed, and bituminous surface treatment to be applied thereto. District VIII, Route 187, Section E. Fred McKinley, Paramount, $31,989; Ken Lowe, San Bernardino, $33,734; Anderson Co., Visalia, $34,623; E. L. Yeager Co., Riverside, $35,-212; E. S. and N. S. Johnson, Fullerton, $35,997; Paul E. Woof, Fresno, $36,683; Foster and McHarg, Riverside, $46,996; Frank Day, Big Bear Lake, $47,-858; M. S. Mecham and Sons, South Gate, $49,850. Contract awarded to R. P. Shea Co., Indio, $28,-416.75.

SACRAMENTO COUNTY—On 12th Street and 16th Street between Sacramento city limits and American River Bridge. The existing pavement to be surfaced with plant-mixed surfacing and widening strips to be graded and surfaced with plant-mixed surfacing on crushed rock base. District III, Route 3, Section B. Harms Brothers, Sacramento, $14,780; A. Teichert & Son, Inc., Sacramento, $15,786; Brighton Sand & Gravel Co., Sacramento, $16,093; McGillivray Construction Co., Sacramento, $18,491. Contract awarded to J. R. Reeves, Sacramento, $13,-541.20.

SAN BERNARDINO COUNTY—In the City of San Bernardino, at Fifth and I Streets, a structural steel railroad overhead to be constructed, about 0.3 mile to be graded and surfaced with plant-mixed surfacing on crusher run base, and a lighting system to be installed. District VIII, Route 9. Fepco, Los Angeles, $410,425; J. E. Haddock, Ltd., Pasadena, $411,680; Webb and White, Los Angeles, $419,471; Ralph A. Bell, Monrovia, $428,069; Griffith Co., Los Angeles, $429,423; George Herz and Co., San Bernardino, $446,987. Contract awarded to K. B. Nicholas, Ontario, $385,574.

SAN DIEGO COUNTY—Between Wildwood Glen and Descanso Junction, about 0.8 mile to be graded and surfaced with road-mixed surfacing on base material and a structural steel girder bridge to be constructed across Sweetwater River. District XI, Route 12, Section D. Winston Brothers Co., Monrovia, $395,916; McKinley and Kirk Construction Co., Paramount, $397,194; Walter H. Barber and H. R. Breeden, La Mesa, $438,045; Webb and White, Los Angeles, $446,941; Ralph A. Bell, Monrovia, $467,-457; Cox Brothers Construction Co., Stanton, $468,-337; C. B. Tuttle Co., Long Beach, $479,725; Guy F. Atkinson Co., Long Beach, $498,400. Contract awarded to Clyde W. Wood and Sons, Inc., North Hollywood, $369,668.10.

SAN JOAQUIN COUNTY—Across Old River and Middle River, about 17 miles and 12 miles west of Stockton, the fenders of two existing bridges to be repaired. District X, Route 75, Section A. Ben C. Gerwick, Inc., San Francisco, $21,986; The Duncan-son-Harrelson Co., Richmond, $25,630; H. F. Lauritzen, Pittsburg, $26,755; Pomeroy Sinnock, Stockton, $33,668. Contract awarded to Healy Tibbitts Construction Co., San Francisco, $20,829.

SANTA CLARA COUNTY—On Bayshore Highway at Fourth Street Extension, a full traffic actuated signal system and highway lighting to be furnished and installed, and channelization to be constructed. District IV, Route 68, Section B. A. J. Raisch Paving Co., San Jose, $19,878; Granite Construction Co., Watsonville, $20,850; Leo F. Piazza Paving Co., San Jose, $21,926; J. Henry Harris, Berkeley, $23,795. Contract awarded to Edward Keeble, San Jose, $18,-485.75.

TULARE COUNTY—At the intersection of Mineral King Avenue with Conyer Street, in the City of Visalia, a traffic signal system and highway lighting. District VI, Route 10. L. H. Leonardi Electric Construction Co., San Rafael, $4,100; R. O. Ferguson Co., Visalia, $4,121; Westates Electrical Construction Co., Los Angeles, $4,142. Contract awarded to Clinton Electric Corp., Burbank, $3,966.

TULARE COUNTY—At the east city limits of Tulare, at the proposed Route 134 overcrossing, highway lighting system to be installed. District VI, Route 134, Section B. R. O. Ferguson Co., Visalia, $8,859; Robinson Electric, Fresno, $13,125. Contract awarded to L. H. Leonardi Electric Construction Co., San Rafael, $8,543.

VENTURA COUNTY—At various locations between Route 79 and Los Angeles County line, six bridges to be widened and a bridge to be constructed, including approaches thereto. District VII, Route 9, Section A, B, C. Barringer and Botke, Santa Paula, $95,452; E. G. Perham, Los Angeles, $96,827; Ralph A. Bell, Monrovia, $103,061; J. E. Haddock, Ltd., Pasadena, $105,261. Contract awarded to Norman I. Fadel, North Hollywood, $89,747.50.

YOLO AND SACRAMENTO COUNTIES—On bridge across the Sacramento River at Sacramento, the existing Portland cement concrete curbs to be removed and new Portland cement concrete curbs and raised traffic bars to be constructed. District III, Route 6, Section C, Sacramento. D. M. Sandling, San Pablo, $8,675; Brighton Sand and Gravel Co., Sacramento, $8,725; B. S. McElderry, Berkeley, $11,880. Contract awarded to A. Teichert & Son, Inc., Sacramento, $7,767.

YOLO COUNTY—On West Sacramento Freeway, over Jefferson Boulevard, about one mile west of the city limits of Sacramento, a reinforced concrete slab bridge to be constructed, and about 0.2 mile to be graded and surfaced with plant-mixed surfacing on crushed rock base. District III, Route 6, Section C. Chittenden and Chittenden and B. S. McElderry, Auburn, $81,699; Holdener Construction Co., Sacramento, $85,183; The Utah Construction Co., Richmond, $97,007. Contract awarded to Charles MacClosky Co., and Harms Brothers, San Francisco, $76,346.

F. A. S. County Roads

MADERA COUNTY—Across Kaiser Fork and North Fork of San Joaquin River, near North Fork, two reinforced concrete girder bridges to be constructed. District VI, Route 962. Transocean Engineering Corp., San Lorenzo, $42,550; Trewhitt-Shields and Fisher, Fresno, $45,695; Chittenden and Chittenden and B. S. McElderry, Auburn, $46,565; Granite Construction Co., Watsonville, $50,230. Contract awarded to C. C. Gildersleeve, Nevada City, $39,915.

KERN COUNTY—Across Kern River at Gordon's Ferry on China Grade Loop, about 4.5 miles north of Bakersfield, a reinforced concrete slab bridge to be constructed. District VI, Route 886. Chittenden and Chittenden and B. S. McElderry, Auburn, $80,591; Concrete Construction Service, Inc., Gardena, $84,338; G. M. Carr and Bati Rocca, Santa Rosa, $84,658; Erickson, Phillips and Weisberg, Oakland, $88,105; Tumblin Co., Bakersfield, $88,662; Griffith Co., Los Angeles, $89,368; J. E. Haddock Ltd., Pasadena, $89,527; Trewhitt-Shields, and Fisher, Fresno, $90,458; Dan Caputo, San Jose, $93,475; Granite Construction Co., Watsonville, $94,924; E. G. Perham, Los Angeles, $96,961; Norman I. Fadel, North Hollywood, $101,098. Contract awarded to Madonna Construction Co., San Luis Obispo, $75,980.

KERN COUNTY—Across Beardsley Canal and at Beardsley School, about 0.6 and 0.4 mile north of Junction Route 4, a reinforced concrete slab bridge and a reinforced concrete box pedestrian undercrossing to be constructed. District VI, Route 881. Trewhitt-Shields and Fisher, Fresno, $40,294; G. M. Carr, Santa Rosa, $41,909; Chittenden and Chittenden and B. S. McElderry, Auburn, $43,361; Norman I. Fadel, North Hollywood, $46,230; Granite Construction Co., Watsonville, $46,822. Contract awarded to Griffith Co., Los Angeles, $39,567.40.

FRESNO COUNTY—Across Kings River, about one mile west of Reedley, a reinforced concrete bridge to be widened. District VI, Route 817. E. G. Perham, Los Angeles, $98,505; Granite Construction Co., Watsonville, $101,827; Chittenden and Chittenden and B. S. McElderry, Auburn, $103,130; Bent Construction Co., Los Angeles, $113,540; Dan Caputo, San Jose, $120,930; Trewhitt-Shields and Fisher, Fresno, $134,737. Contract awarded to Thomas Construction Co., Fresno, $95,610.

FRESNO COUNTY—On Shaw Avenue between State Highway Route 4 and Fruit Avenue, about 3.3 miles to be graded and surfaced with plant-mixed surfacing on cement treated base and a reinforced concrete slab bridge to be constructed. District VI, Route 561. P. J. Moore and Son, North Sacramento, $119,266; Rice Brothers, Inc., Marysville, $121,448; Volpa Brothers, Fresno, $128,381; Ted F. Baun, Fresno, $131,037; Roland T. Reynolds and Thomas Construction Co., Fresno, $137,315; Harms Brothers, Sacramento, $138,380; Louis Biasotti and Son, Stockton, $139,802; Granite Construction Co., Watsonville, $142,861. Contract awarded to Gene Richards, Fresno, $110,479.60.

RIVERSIDE COUNTY—On Lakeview Avenue, between Nueva and Lakeview, about 2.9 miles to be graded and surfaced with road-mixed surfacing on cement treated base. District VIII, Route 718. E. S. and N. S. Johnson, Fullerton, $77,957; Clyde W. Wood and Sons, Inc., North Hollywood, $78,722; E. L. Yeager Co., Riverside, $78,991; George Herz and Co., San Bernardino, $82,435; Ken Lowe, San Bernardino, $85,499; Cox Brothers Construction Co., Stanton, $87,660; Ralph B. Slaughter, Julian, $88,507; R. A. Erwin, Colton, $100,502. Contract awarded to Foster and McHarg, Riverside, $73,466.

December, 1950

ALAMEDA COUNTY—At San Miguel Avenue in Castro Valley about 0.2 mile, the existing pavement to be widened with crusher run base on imported subbase material and the existing pavement and newly constructed crusher run base surface with plant-mixed surface and a seal coat applied and a full traffic actuated signal system to be furnished and installed. District IV, Route 5, Section B. Transocean Engineering Corp., San Lorenzo, $25,203; Clements and Co., Hayward, $25,491; Eugene G. Alves, Pittsburg, $26,116; J. Henry Harris, Berkeley, $26,833. Contract awarded to Gallagher and Burk, Inc., Oakland, $23,495.25.

CONTRA COSTA COUNTY—At Walnut Creek near south city limits of Walnut Creek, existing bridge to be widened and about 0.2 mile of approaches to be widened and surfaced with plant-mixed surfacing on crusher run base. District IV, Route 107, Section A. Transocean Engineering Corp., San Lorenzo, $38,179; Lee J. Immel, San Pablo, $40,761; O. C. Jones and Sons, Berkeley, $43,734; Eugene G. Alves, Pittsburg, $48,999; J. Henry Harris, Berkeley, $49,699. Contract awarded to H. H. Anderson, San Leandro, $36,958.25.

KERN COUNTY—On Brundage Lane at Central Branch Canal and Kern Island Canal, two existing culverts to be extended. District VI, Route 141, Section A. Contract awarded to E. G. Perham, Los Angeles, $27,145.

LOS ANGELES COUNTY—In the Cities of Los Angeles, South Pasadena and Pasadena, on Figueroa Street-Arroyo Seco Freeway between College Street and Glenarm Street, highway lighting and illuminated sign systems to be furnished and installed. District VII, Routes 165, 205. Fischbach and Moore of California, Inc., Los Angeles, $48,877; Ets-Hokin and Galvan, Inc., Wilmington, $50,586; Newberry Electric Corp., Los Angeles, $53,595. Contract awarded to Electric and Machinery Service, Inc., South Gate, $45,871.

LOS ANGELES COUNTY—City of Los Angeles, on Hollywood Freeway, between Western Avenue and Virgil Avenue, highway lighting and illuminated sign systems to be furnished and installed. District VII, Route 2. Newberry Electric Corp., Los Angeles, $54,435; R. E. Ziebarth, Torrance, $54,855; Electric and Machinery Service, Inc., South Gate, $58,161; Ets-Hokin and Galvan, Inc., Wilmington, $59,345; State Construction Co., Los Angeles, $64,895; Westates Electrical Construction Co., Los Angeles, $65,970. Contract awarded to Fischbach and Moore of California, Inc., Los Angeles, $52,494.

LOS ANGELES COUNTY—On Harbor Freeway at Fifth and Sixth Streets in the City of Los Angeles, five reinforced concrete bridges for overcrossings and two pedestrian undercrossings to be constructed, and various adjacent roadways and streets to be graded and surfaced with asphalt concrete pavement and plant-mixed surfacing. District VII, Route 165. Webb and White, Los Angeles, $999,940; Granite Construction Co., Watsonville, $1,003,838; Charles MacClosky Co., and C. G. Willis and Sons, San Francisco, $1,038,350; J. E. Haddock, Ltd., Pasadena, $1,051,065; MacDonald and Kruse, Sun Valley, $1,070,459; Guy F. Atkinson Co., Long Beach, $1,086,821; W. J. Disteli and R. J. Daum Construction Co., Los Angeles, $1,097,168; United Concrete Pipe Corp. and Ralph A. Bell, Baldwin Park, $1,105,030; Carlo Bongiovanni, Hollywood, $1,133,425. Contract awarded to Winston Brothers Co., Monrovia, $956,067.45.

LOS ANGELES COUNTY—In the City of Los Angeles, between Beaudry Avenue and Grand Avenue, about 0.4 mile of roadside areas to be prepared and planted. District VII, Route 2. Huettig and Schromm and Bennett, Palo Alto, $39,012; Henry C. Soto Corp., Los Angeles, $39,716; Moulder Brothers, Glendale, $43,573; Stephen L. Vistica, San Mateo, $46,473. Contract awarded to Jannoch Nurseries, Altadena, $34,409.75.

LOS ANGELES COUNTY—At the intersection of Firestone Boulevard with Church Street, traffic signal system to be furnished and installed, at intersections of Firestone Boulevard with Paramount Boulevard, La Reina Avenue, and Downey Avenue, traffic signal systems to be modified. District VII, Route 174, Section B. Westates Electrical Construction Co., Los Angeles, $9,375; C. D. Draucker, Inc., Los Angeles, $10,987; Electric and Machinery Service, South Gate, $11,049. Contract awarded to Fischbach and Moore of California, Inc., Los Angeles, $8,730.

MONTEREY COUNTY—At Sanborn Road intersection, about one-half mile south of Salinas, about 0.1 mile, acceleration and deceleration lanes to be graded and surfaced with plant-mixed surfacing on crusher run base. District V, Route 2, Section B. Contract awarded to Granite Construction Co., Watsonville, $9,983.45.

SAN DIEGO COUNTY—In the City of Oceanside at the intersection of Cassidy Street with Hill Street, traffic signal system and highway lighting to be furnished. District XI, Route 2. Ets-Hokin and Galvan, San Diego, $10,100. Contract awarded to California Electric Works, San Diego, $9,884.

SAN MATEO COUNTY—On Bayshore Highway between south city limits of San Francisco, and north city limits of South San Francisco, about 3.2 miles to be widened and paved with plant-mixed surfacing on cement-treated base. District IV, Route 68, Section A, SSF. Morrison-Knudsen Co., Inc., Los Angeles, $369,180; Eaton and Smith, San Francisco, $405,163; Guy F. Atkinson, South San Francisco, $419,112. Contract awarded to Charles L. Harney, Inc., San Francisco, $348,037.70.

SAN JOAQUIN COUNTY—Across Paradise Cut Overflow, about six miles east of Tracy, a timber trestle bridge on timber pile bents to be constructed. District X, Route 5, Section B. Lew Jones Construction Co., San Jose, $17,284; Dan Caputo, San Jose, $21,508; The Duncanson-Harrelson Co., Richmond, $23,856; Nomellini Construction Co., Stockton, $25,966; Al. Erickson and Co., Napa, $30,768; Healy Tibbitts Construction Co., San Francisco, $35,900; Johnson, Drake and Piper, Inc., Oakland, $35,940; Ben C. Gerwick, Inc., San Francisco, $45,080. Contract awarded to Lord and Bishop, Sacramento, $12,480.

SANTA CRUZ COUNTY—In the City of Santa Cruz at Ocean and Water Streets, construction of channelization and alteration of traffic signals. District IV, Routes 5, 56. Granite Construction Co., Watsonville, $9,960; Caputo and Keeble, San Jose, $11,220; Guerin and Morgan, Los Gatos, $12,801. Contract awarded to Leo F. Piazza Paving Co., San Jose, $9,699.50

SHASTA COUNTY — Office building to be painted. District II, Redding. E. W. Peterson, Yreka, $2,250. Contract awarded to H. L. Barnes, Redding, $2,057.

SOLANO COUNTY—Between Alamo Creek and Ulatis Creek, about 1.7 miles to be graded and surfaced with Portland cement concrete and plant-mixed surfacing and two parallel grade separation structures and two parallel bridges to be constructed. District X, Route 7, Section C, Vac, D. Fredrickson and Watson Construction Co., Oakland, $869,514; Parish Bros., Benicia, $874,077; Harms Brothers and Charles MacClosky Co., Sacramento, $941,296; Lord and Bishop and M. J. B. Construction Co., Sacramento, $1,004,346. Contract awarded to Fredrickson Brothers, Emeryville, $782,675.55.

. . . Continued on page 64

U. S. SUPREME COURT UPHOLDS CALIFORNIA

In the July-August, 1950, issue of *California Highways and Public Works,* Deputy Director of Public Works Frank B. Durkee discussed in detail the opinion of the California Supreme Court in the important case of Holloway vs. Purcell, arising out of the proposed relocation as a freeway of the state highway (U. S. 40) between North Sacramento and Roseville in Sacramento and Placer Counties.

Subsequent to the time the above article was written, the plaintiffs petitioned the United States Supreme Court for a writ of certiorari to review the decision of the State Supreme Court. On November 13, 1950, the Supreme Court of the United States unanimously denied the petition for a writ of certiorari. This had the effect of affirming the decision of the State Supreme Court in its holding that the California Highway Commission has authority to approve the relocation of state highways, including highways constructed or acquired under the State Highway Act of 1909 (the original State Highway Bond Issue) and also in upholding the California Freeway Law as valid and constitutional.

Montgomery Freeway

Continued from page 36 . . .

31-foot 6-inch spans supported on concrete bents and abutments resting on timber foundation piles.

Grade Separations

The 18th and 24th Street separations also provide a structure to carry the San Diego & Arizona Eastern Railway tracks over the two streets. The railroad parallels the freeway and crosses 18th and 24th Streets on 40-foot structural steel plate girder bridges, on reinforced concrete abutments.

Since the grade of the depressed portion of the subways is below ground water level, it became necessary to design for uplift and construct a "boat" section. This involved thickening the base slab, applying membrane waterproofing and installing rubber waterstops at the expansion and construction joints.

This highway was financed by gas tax and federal-aid funds, and was administered by District XI of the Division of Highways. The contractors were the Charles MacClosky Company, R. E. Hazard Construction Company, and C. G. Willis & Sons. W. T. Rhodes was the Resident Engineer for District XI and A. K. Gilbert was the Bridge Department Representative.

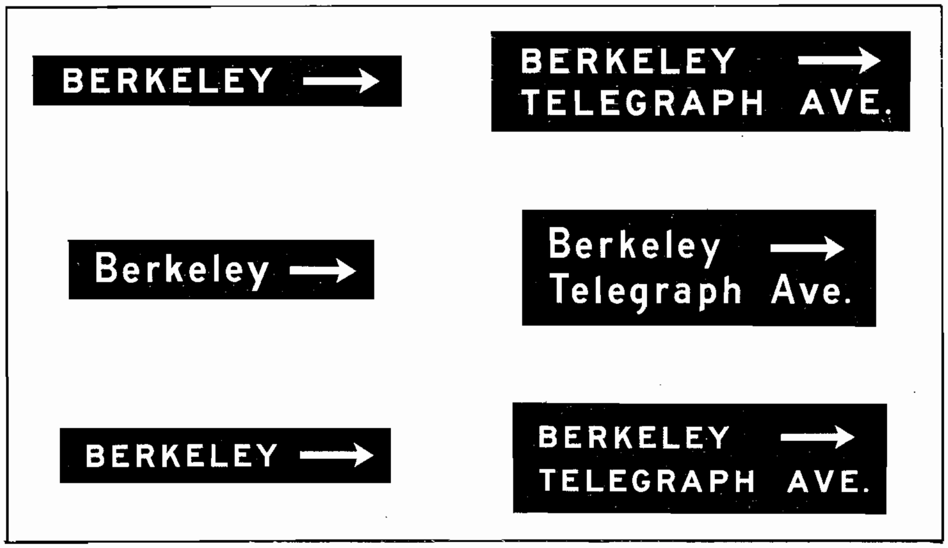


PHOTO 8—Signs of Equal Area—Top, 2 letter-heights per line; middle, 3 loop-heights per line; lower, 2½ letter-heights per line (visibility varies as shown in Figure 8)

Sign Legibility

Continued from page 11 . . .

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Estimates of Distances

For rule-of-thumb estimates of distance at which place name signs can be read, the following generalizations of *Figures 3, 4, 5, and 6* are given:

Distances in feet

	Lower case per inch of loop height: average observer	Lower case per inch of loop height: near-sighted observers*	Capitals per inch of height: average observer	Capitals per inch of height: near-sighted observers*
Bright daylight	131	102	114	90
Illuminated, night	95	74	87	69

* Whose reading distance was exceeded by 85 percent of observers.

Acknowledgments

The work was done by members of the Traffic Department, the Materials and Research Department, and the Photographic Laboratory of the Division of Highways as a joint research project with the University of California Institute of Transportation and Traffic Engineering. The Division of Highways activities were under the direction of J. C. Young, Traffic Engineer, and the institute provided the technical guidance of Dr. T. W. Forbes, Visiting Associate Professor of Engineering and Psychology. Individuals making substantial contributions to the progress of the investigation were Carroll Dunham, Robert Monroe, and F. E. Houghton.

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Messrs. Martin O'Brien, F. M. Carter, A. L. Hutchison and Roy Smith of the division, working with the sign company, have all contributed to the letter designs used in California signs.

DEEP FREEZE

Winter weather can make a "deep freeze" of your car, unless it is conditioned for cold-season driving. The lubrication, fuel and electrical systems need special treatment obtainable at reliable service stations.

INDEX TO CALIFORNIA HIGHWAYS AND PUBLIC WORKS

January to December 1950

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Montgomery Freeway

Continued from page 36 . . .

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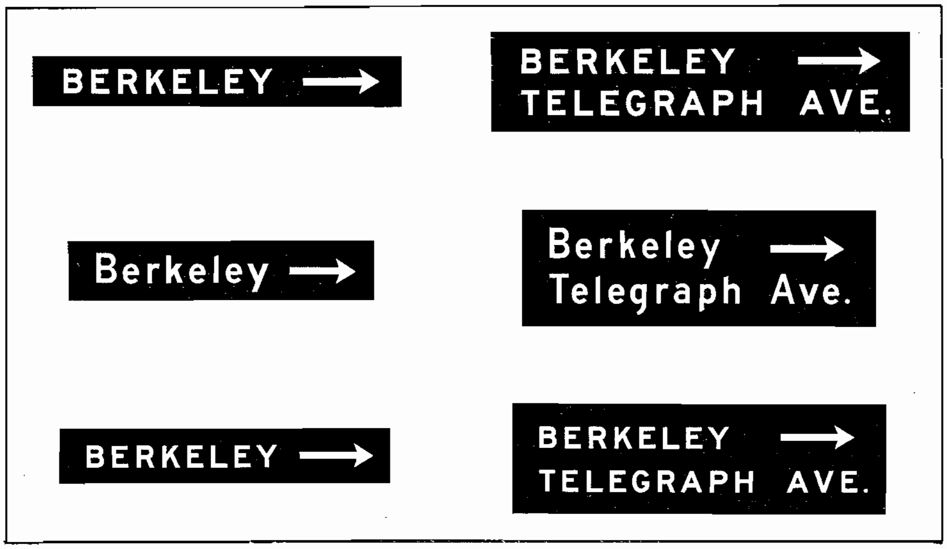

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	average observer	near-sighted observers*	average observer	near-sighted observers*
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* Whose reading distance was exceeded by 85 percent of observers.

Acknowledgments

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DEEP FREEZE

Winter weather can make a "deep freeze" of your car, unless it is conditioned for cold-season driving. The lubrication, fuel and electrical systems need special treatment obtainable at reliable service stations.

INDEX TO CALIFORNIA HIGHWAYS AND PUBLIC WORKS

January to December 1950

INDEX OF AUTHORS

Index to Authors—Continued

Bids and Awards

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YOLO COUNTY—West Sacramento Freeway, near Sacramento, at Davis Highway Ramp Overcrossing, West Sacramento Underpass, Third Street Underpass, and State Box Overcrossing, four bridges to be constructed and about 0.8 mile of ramps and a detour to be constructed and surfaced with plant-mixed surfacing on crusher run base. District III, Route 6, Section C. Dan Caputo and Edward Keeble, San Jose, $397,208; Granite Construction Co., Watsonville, $414,899; Brighton Sand and Gravel Co., Sacramento, $419,737; Lord and Bishop, Sacramento, $425,016; Charles MacClosky Co. and Harms Brothers, San Francisco, $442,678. Contract awarded to A. Teichert and Son., Inc., Sacramento, $387,780.80.

F. A. S. County Projects

KINGS COUNTY—Across Kings River (Dutch John Cut), about eight miles north of Hanford, a reinforced concrete bridge to be constructed. District VI, Route 568. Thomas Construction Co., Fresno, $68,191; Tumblin Co., Bakersfield, $69,893; Anderson Co., Visalia, $71,125; E. G. Perham, Los Angeles, $72,524; E. H. Peterson and Son, Richmond, $77,222; J. E. Haddock, Ltd., Pasadena, $77,532; Trewhitt-Shields and Fisher, Fresno, $79,524; G. M. Carr and Bati Rocca, Santa Rosa, $83,201. Contract awarded to Charles S. Moore and Robert R. Murdoch, Oakland, $67,255.

KINGS COUNTY—On 10th Avenue between Seventh Street and Grangeville Boulevard and on Laton Highway between Last Chance Ditch and Kings River, about 2.9 miles, portions to be graded and surfaced with plant-mixed surfacing and existing pavement to be surfaced and widened with plant-mixed surfacing on the other portions of the project. District VI, Routes 568, 623, 820. Oilfields Trucking Co. and Phoenix Construction Co., Inc., Bakersfield, $77,893; Valley Paving and Construction Co., Inc., Pismo Beach, $80,093; P. J. Moore and Son, North Sacramento, $81,515; Rice Brothers, Inc., Marysville, $84,352; Louis Biasotti and Son, Stockton, $86,701; Gene Richards, Fresno, $88,853; Harms Brothers, Sacramento, $89,018; Volpa Brothers, Fresno, $90,-228. Contract awarded to Ted F. Baun, Fresno, $76,-287.50.

MONTEREY COUNTY—On Carmel Valley Road, near Carmel, between State Route 56 and Robinson Canyon Road, about 5.8 miles to be graded and surfaced with untreated rock surfacing. District V, Route 661. M. W. Brown, Redding, $134,331; Rice Brothers, Inc., Marysville, $134,441; Edward Keeble, San Jose, $141,333; Louis Biasotti and Son, Stockton, $142,978; M. Malfitano and Son, Inc., Pittsburg, $154,561; Clements and Co., Hayward, $158,220; Granite Construction Co., Watsonville, $159,394; Pacific Contracting Corp., Long Beach, $165,157; Eugene G. Alves, Pittsburg, $171,766; Transocean Engr. Corp., San Lorenzo, $175,459; Madonna Construction Co., San Luis Obispo, $177,641; Peter Kiewit Sons Co., Arcadia, $182,520; S. A. E. Co., Redwood City, $183,072; Chittenden and Chittenden, Auburn, $184,893; John Delphia, Patterson, $193,226; John F. Blakemore, El Monte, $197,211; Klein Smid Construction Co., Bakersfield, $198,820; M. J. B. Construction Co., Stockton, $207,205; H. Earl Parker, Inc., Marysville, $210,355; E. Barbettini, San Francisco, $217,613. Contract awarded to Nevada Constructors, Inc., Reno, $127,067.70.

TULARE COUNTY—Lover's Lane, between Federal Aid Secondary 1143 and State Route 10 and Ben Maddox Way, between State Route 10 and State Route 133, about three miles to be graded, surfaced with plant-mixed surfacing on cement-treated imported base material, and a reinforced concrete bridge to be constructed. District VI, Routes 1137, 1138. Anderson Co., Visalia, $182,753; Oilfields Trucking Co. and Phoenix Construction Co., Inc., Bakersfield, $198,972; Louis Biasotti and Son, Stockton, $200,-020; Ted F. Baun, Fresno, $206,715; P. J. Moore and Son, North Sacramento, $218,272; A. Teichert and Son, Inc., Sacramento, $221,995; Harms Brothers, Sacramento, $226,272. Contract awarded to Rice Brothers, Inc., Marysville, $179,935.30.

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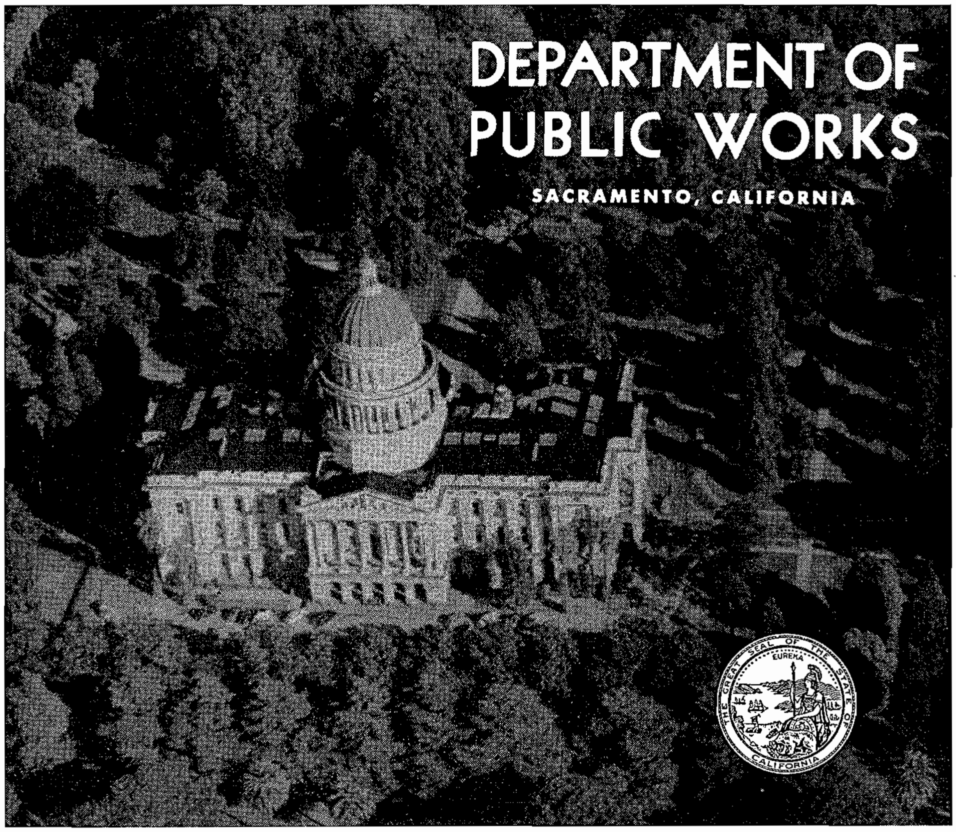

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