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STATE OF CALIFORNIA

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

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EXPERIMENTAL FIELD USE OF POWDERED RUBBER IN BITUMINOUS PLANT-MIX SURFACING

By

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51-08

April 2, 1951

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EXPERIMENTAL FIELD USE OF POWDERED RUBBER IN BITUMINOUS PLANT-MIX SURFACING

This report covers the installation of a test section of bituminous plant-mix surfacing to which was added reclaimed powdered rubber. The section is located in District III, between Auburn and Applegate, on road III-Pla-37-A, U. S. Route 40.

During the last two or three years, the addition of rubber either in reclaimed powder form or crude natural rubber has been advocated by the rubber industries. The addition of rubber to asphalt pavements is not a recent development. Just prior to the second world war, experimental test sections containing rubber had been placed in the East Indies and some European countries, and reportedly are still in good condition.

The advantages claimed for rubber-bituminous mixtures are:

1. Improved stability due to lower temperature susceptibility.
2. Better sealing quality, thereby preventing water from seeping through the surface mixture.
3. Reduction in maintenance expense, and
4. Better nonskid properties.

During 1949 and 1950, experimental rubber-bituminous mixtures were placed in other states, such as Virginia, Ohio, Texas, Massachusetts, Minnesota and others.

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The California experimental section is a part of the newly constructed four lane divided highway between Auburn and Applegate constructed during 1950 under Contract 51-3TC4. The test section is confined to the outer eastbound lane only and extends from Station 200+50 to Station 230+11, or a distance of 2961 ft. Approximately one half of this distance is on a 1.8% grade and the other one half on a 5.9% grade. The outer lane, especially on the steeper grade, will be subjected to rather heavy truck traffic and it was felt that the advantages from the addition of the rubber, if any, should be more easily discernable in the heavily traveled lane. Small identification markers are placed along the right of way to indicate the limits of the experimental section (See Fig. 10).

It was planned to add approximately 5% and 7% of rubber by weight of the asphalt to the plant-mix. Therefore, the length of the section was divided into three portions, the two ends to contain about 7% of rubber and the middle portion 5%. This arrangement permitted the placing of both mixtures on the flat grade as well as on the steep grade. The attached drawing, Fig. 1, illustrates the layout.

Construction:

The plant-mix surfacing conformed to Section 28 of the Standard Specifications, 3/4 in. maximum size aggregate, with 150-200 penetration paving asphalt as the bituminous binder.

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The aggregate consisted of Bear River crushed gravel and the asphalt was obtained from the Five C Refining Company. The regular plant-mix surfacing contained an asphalt content of 4.1% but an additional 0.1% of asphalt was added for the asphalt-rubber mixture to take care of the absorptiveness of the powdered rubber. The structural section consisted of a two inch thick surface course placed with a Barber Greene finishing machine on a two inch blade spread leveling course. The rubber was added to the surface course only. The base was cement treated with 3% of cement.

The powdered reclaimed rubber in the amount of one ton was furnished to the State free of charge by the Firestone Rubber Company and was delivered to the job in sacks weighing about 115 lb. each. A grading analysis of the rubber was as follows:

#4 mesh	100% Passing
8	99 "
16	99 "
30	69 "
50	17 "
100	2 "
200	1 "
270	1 "

A batch consisted of 4000 lb. dry aggregate and 168 lb. of asphalt. As the rubber was to be only 5% to 7% by weight of the asphalt, the amount added per batch was 8.40 lb. and 11.76 lb., respectively. Due to the vibrations of the plant, it was not practical to weigh out such small quantities. Therefore, a calibrated container was used and the proper amount of rubber was added by volume measurement.

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The rubber was added to the dry mix by means of an improvised chute from a platform constructed above the plant operator. The charge was then mixed dry in the pugmill for a period of approximately 20 sec. to thoroughly distribute the small amount of rubber. The asphalt was then added and mixing continued for a period of 35 sec.

The total tonnage of asphalt-rubber mixture was 436.95 tons. Based on 2000 lb. of powdered rubber furnished, a recalculation showed that actually only about 6.6% of rubber was used for the intended 7% portion and 4.8% for the intended 5% portion.

The mix was hauled in trucks from the plant site to the job and spread with a Barber Greene finishing machine in the conventional manner. The materials were mixed at a plant temperature of about 300°F and spread on the road at an average temperature of 250°F. No noticeable differences between the mix containing rubber and no rubber were observed during spreading or compaction operations. Tests made in the Laboratory on four samples of the rubber mixture, when compared with those of the regular routine field samples from this job, showed no noticeable differences in test results except there appears to be some tendency towards higher cohesion results with the rubber mixture.

A table showing test results of samples representing the rubber mixture is attached.

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Cost Comparison:

The cost of placing the experimental section, exclusive of the rubber, was $2365.00 or

$$\frac{\$2365.}{437 \text{ Tons}} = \$5.42 \text{ per ton of asphalt-rubber mix}$$

The cost of an equivalent section of regular plant-mix surfacing based on bid prices would have been -

Aggregate	419 tons at	$ 2.62	=	$1098.00
Asphalt	18 "	$20.00	=	360.00
				$1458.00

$$\text{or } \frac{\$1458.}{437 \text{ Tons}} = \$3.34 \text{ per ton of regular mix.}$$

Net Cost of Experiment -

$2365.00
-1458.00
$ 907.00

$$\text{or } \frac{\$907.}{437 \text{ Tons}} = \$2.08$$ Extra Cost per ton of asphalt-rubber mix. (Rubber furnished free) or 62% increase over regular mix.

The above cost comparison throws an extremely unfavorable balance on the rubber mixture. In this cost is included the erection of a platform for adding the rubber, additional dry mixing time, standby time for trucks, etc. The increase in price per ton for the rubber mixture cannot be considered a criterion had the surface mixture for the entire job been set up as a rubber-asphalt mixture. If this had been the case, the powdered rubber would have been added to the asphalt at the refinery and the additional cost would have been the cost of the rubber plus the time required to mix the rubber with the asphalt.

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Although the powdered rubber for this experimental section was furnished free of charge, the cost per pound in the summer of 1950 was approximately fifteen cents for reclaimed rubber and forty five to fifty cents for natural rubber. Assuming an average plant-mix surfacing requiring about 4.5% of asphalt and adding 5% rubber (by weight of the asphalt), the estimated cost of the rubber per ton of plant-mix would be

2000 lb. x	.045	= 90 lb. of asphalt per ton
90 lb. x	.05	= 4.5 lb. of rubber per ton
4.5 lb. x $ 0.15		= approximately 68¢ per ton of mix using 5% reclaimed rubber
4.5 lb. x $ 0.45		= approximately $2.00 per ton using 5% natural rubber.

With an average price per ton of plant-mix surfacing of $4.85 quoted on contract jobs during the first eight months of 1950, this would mean an increase of from 14% to 41%, depending upon whether reclaimed or natural rubber was used. Calculating this on a per mile basis for a 24 foot wide pavement and a 2 inch thick surface course, the respective costs would be:

Regular Plant-Mix - per mile approx.			$ 7370.
Plant-Mix 5% Reclaimed Rubber added	"	"	$ 8402.(Estimated)
Plant-Mix 5% Natural Rubber added	"	"	$10392. "

It is too early to predict whether the beneficial effects derived from this treatment will be sufficient to warrant the increased cost of the surfacing. However, based on reported experience elsewhere, it is doubtful if the extra cost of adding rubber can be justified.

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The experimental section was placed August 21, 1950. The pavement was subjected to some intermittent traffic during construction and was opened to traffic in October 1950. Profilograph records of the experimental rubber treated section and also of the adjacent pavement which had no rubber added to the mix were obtained on November 29, 1950. There was no discernable difference in roughness or riding qualities between these sections. An inspection of the pavement made on February 14, 1951 showed no apparent difference between the experimental section containing rubber and the rest of the job without the addition of rubber. (See Fig. 6, 7, 8, 9) Undoubtedly, it will be some time before any conclusions from the rubber treated sections can be drawn. It is planned to obtain skid resistance measurements of these sections at a future date.

The construction of the experimental section was initiated by Mr. R. M. Gillis, Deputy State Highway Engineer, with the installation to be under the general direction of Headquarters Laboratory with Mr. T. E. Stanton, Materials and Research Engineer, in charge. The Firestone Company was notified as to the date of installation but no representative was present. The project is located in Highway District III of which Mr. C. H. Whitmore is District Engineer. Mr. F. D. Hillebrand was Resident Engineer on the project and he and his assistants cooperated to the fullest extent. Fredrickson Bros. was the contractor. The writer was present as a laboratory representative during the placing of the experimental mixture.

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April 2, 1951
III-Pla-37-A
Contract 51-3TC4

EXPERIMENTAL RUBBER SECTION

TABLE I

Test No.	SIC No.	Dist. No.	Location	% Rubber Added	Test Results							Remarks
					% Bit. By Extr.	% 200	Stab. 140°	Cohes.	Swell	MVS Stab.	MVS Moist	
1667	A-4160	778	Ld. #6. 229+50 Outs. E.B. Lane	6.6	4.0	4	40	175	.002			Placing Temp. 250°F
1668	A-4162	780	Ld. #25. 221+ Outs. E.B. Lane	4.8	4.2	5	42	263	.000			Placing Temp. 240°F
1669	A-4161	779	Ld. #46. 221+06 Outs. E.B. Lane	4.8	4.1	4	42	290	.001	27	0.4	Placing Temp. 260°F
1670	A-4163	781	Ld. #70. 202+18 Outs. E.B. Lane	6.6	4.1	4	38	225	.000	30	0.4	Placing Temp. 260°F
1671	A-4164	782	Ld. #98. 198+80 Outs. E.B. Lane	0.0	4.1	3	38	116	.003	27	0.3	Placing Temp. 245°F
Above surface mixes placed on August 21, 1950.												
Average of Rubber Mixtures					4.1	4.25	40.5	238	-	28.5	0.4	
Average of Regular Surface Mixtures Entire Job					3.7	3.7	39	183	-	27	0.3	

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EXPERIMENTAL RUBBER PAVEMENT

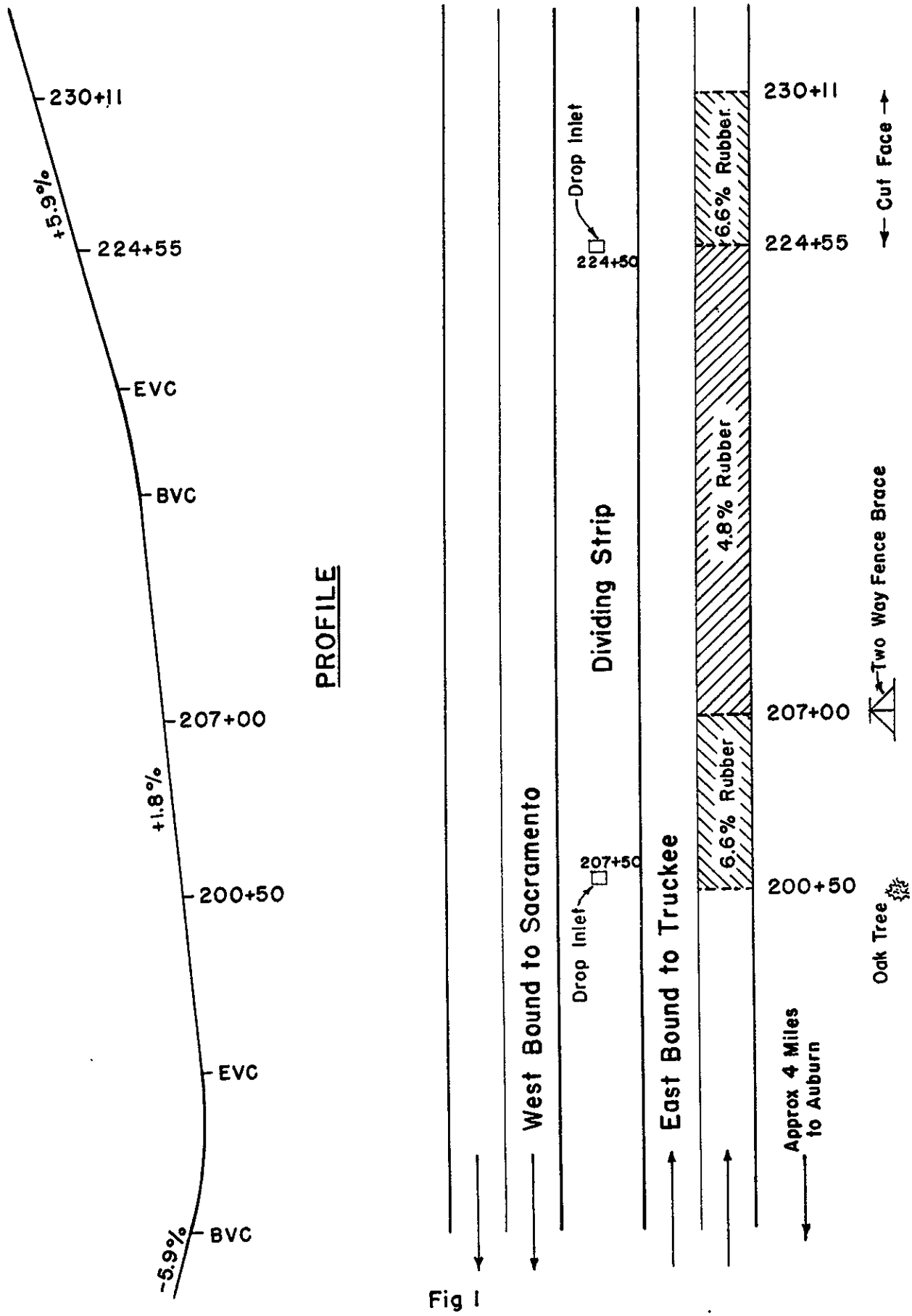

Fig 1

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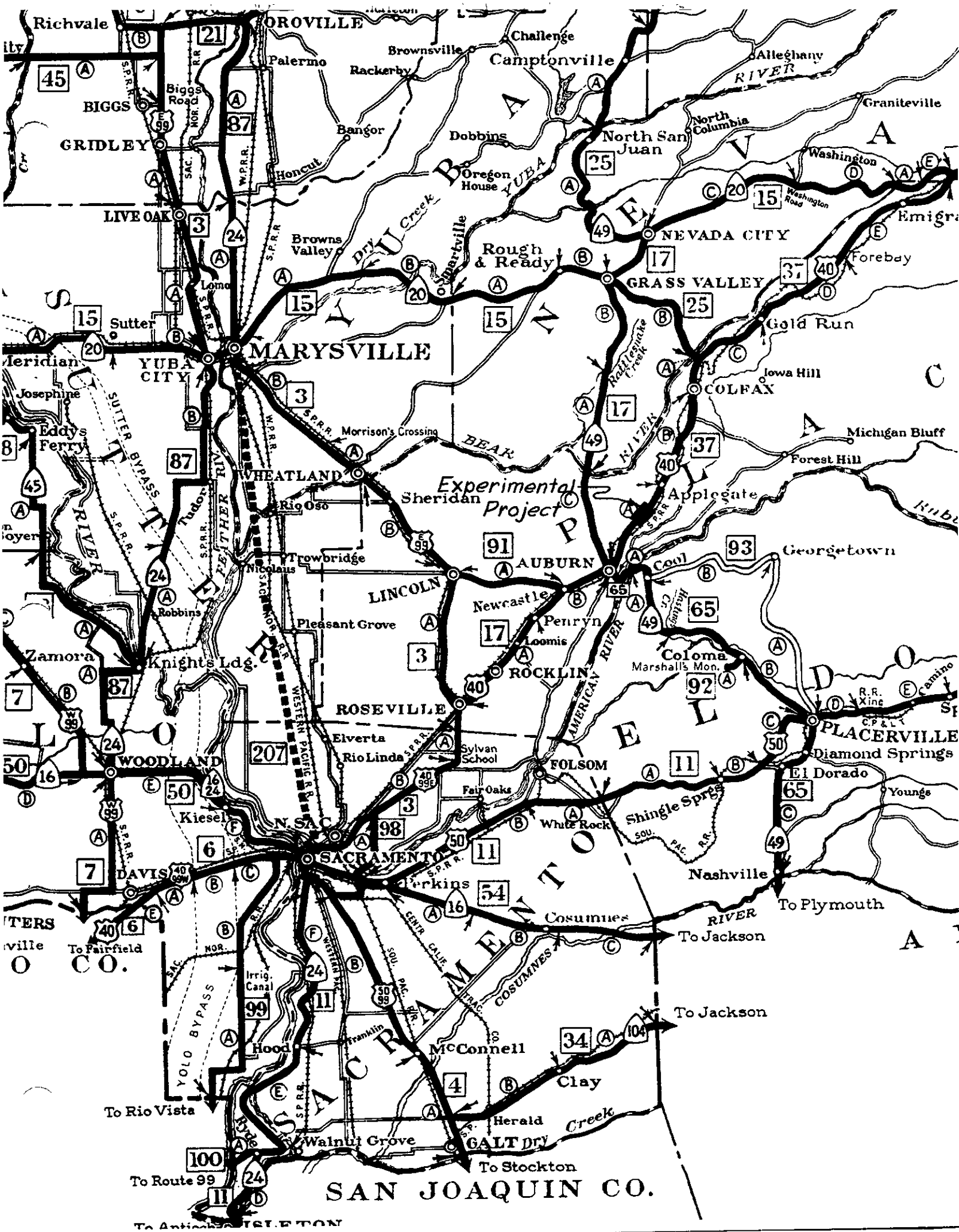

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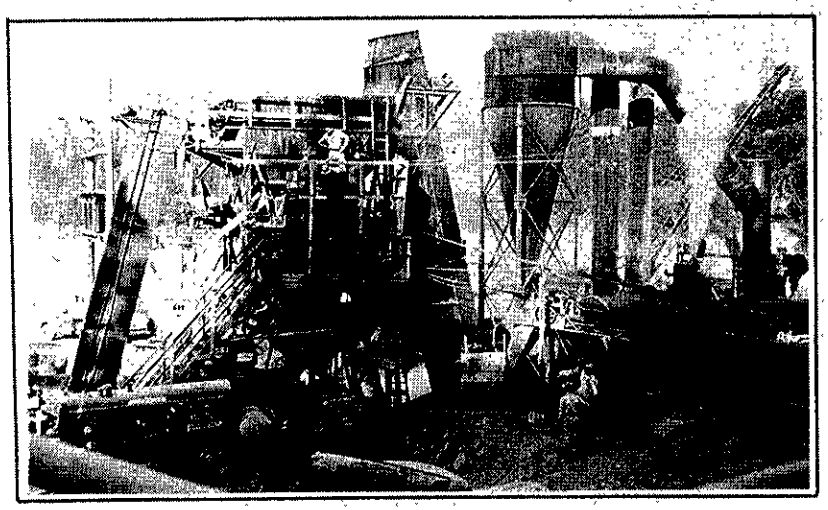

Fig. 2 General View of Plant
(Rubber added at top platform)

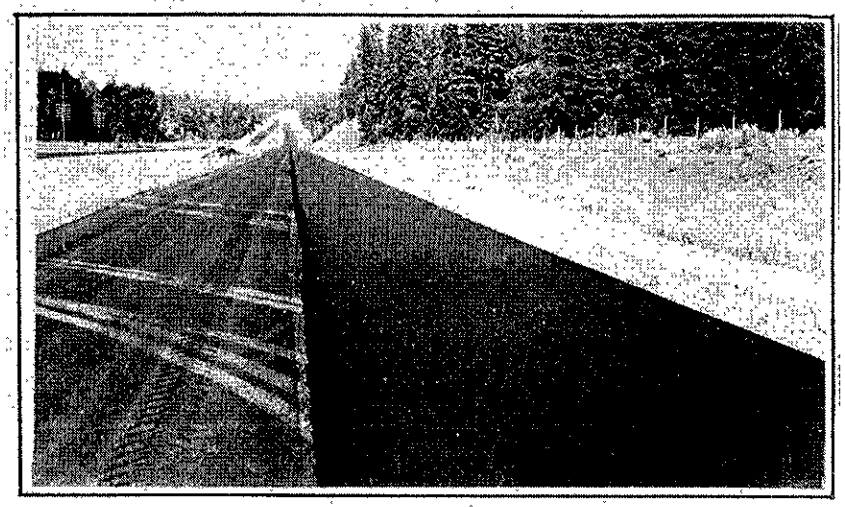

Fig. 3 Experimental section on right after rolling
(Leveling course at left)

Fig. 4 Placing surface with Barber-Greene

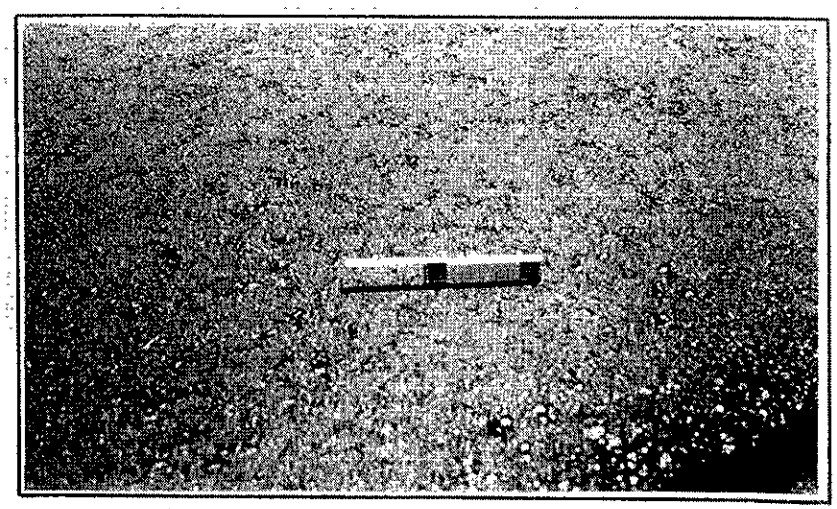

Fig. 5 Close-up of bituminous surface with rubber added

Pictures taken August 21, 1950

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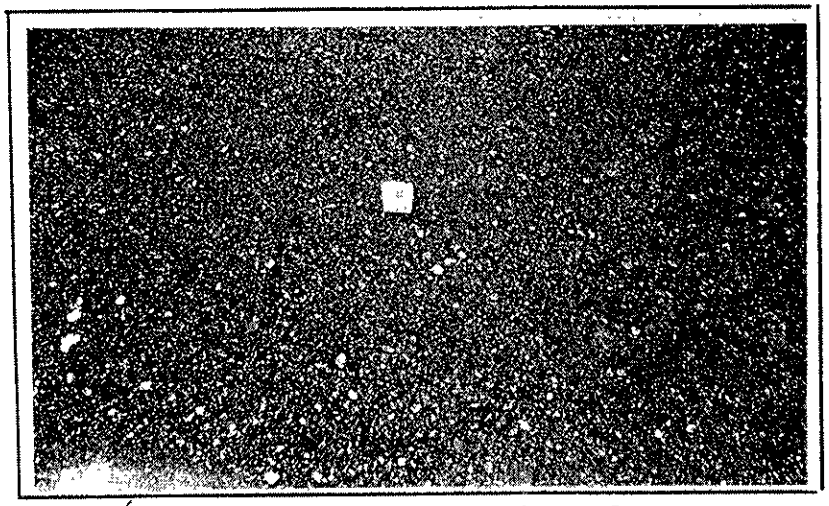

Fig. 6 Close-up of Surface
6.6% Rubber Added

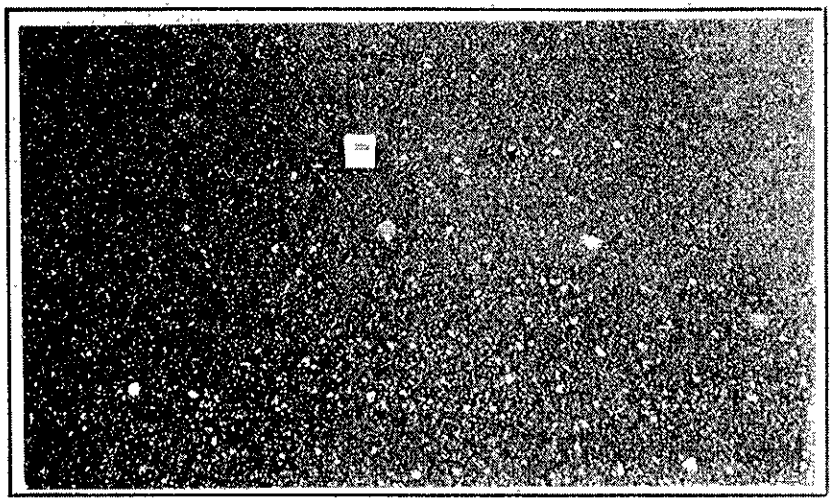

Fig. 7 Close-up of Surface
4.8% Rubber Added

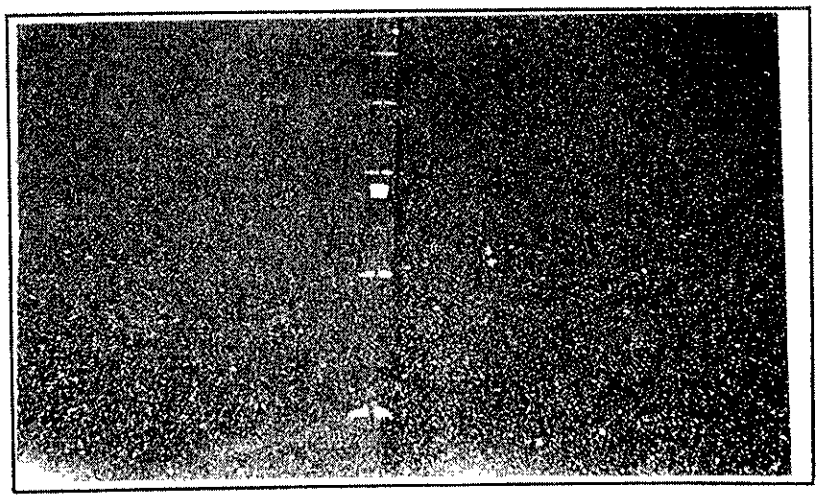

Fig. 8 Plant-Mix with Rubber - right
Plant-Mix without Rubber-left

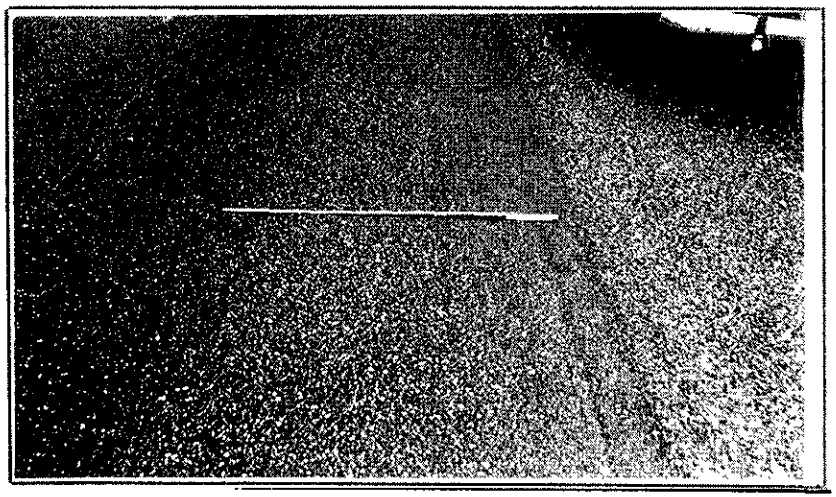

Fig. 9 Plant-Mix with Rubber-foreground
Plant-Mix without Rubber-backgroun

Pictures taken February 14, 1951

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Fig. 10 Small markers at shoulders identify experimental section

Fig. 11 General view of experimental section looking east

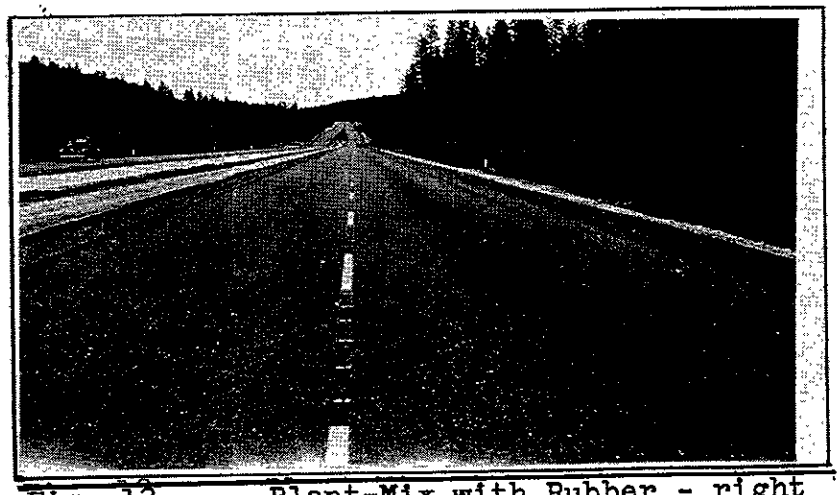

Fig. 12 Plant-Mix with Rubber - right
Plant-Mix without Rubber-left

Pictures taken February 14, 1951

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