Unit Built Concrete Snowsheds

A Feature of the Double-Tracking of the Ogden Route of the Southern Pacific Company Over the Sierra Nevada

The Southern Pacific Company completed the double-tracking of the 28-mile section from Emigrant Gap to Andover, over the summit of the Sierra Nevada on the Ogden Route, about November 1, 1925. This section eliminates a 'bottleneck' that during the past few years especially has seriously interfered with the rapid handling of the perishable fruit crop of Central California, which has grown from 6000 tons in 1884 to over 200,000 carloads in 1925. The Ogden Route from San Francisco to Sparks, Nevada, a distance of 251 miles, has been made into a double-track line at a cost of $12,000,000. The re-alignment of the old line in places to eliminate sharp curves and steep grades and the location of the new double-track line, in this 28-mile section, was of course the most difficult part of the double-track construction. On account of the heavy snowfall, from 8 to 16 ft., it was essential that the line be so constructed that traffic could be maintained without interference and with the least amount of upkeep.

EAST PORTAL OF NEW TWO-MILE TUNNEL. OLD LINE WITH WOODEN SNOWSHEDS OVER TUNNEL

The new double track line over the summit from Emigrant Gap to Andover involved the construction of seven new tunnels of a total length of 14,192 ft., the longest being 10,322 ft., the third longest railroad tunnel in the United States. There are now 38 tunnels in the Sierra Nevada from Roseville, Calif., to Sparks, Nevada, having a total length of 38,184 ft., one of the tunnels on the old line, 274 ft. long having been converted into an open cut.

The excavation of the long tunnel under the summit, 17 ft. wide and 22 ft. high in the clear, at an elevation of 6885 ft. or 133 ft. lower than the old line, makes possible a practically level grade through Summit Valley and does away with the necessity for the helper engines continuing over the summit as must be done on the old line. The tunnel is bored through granite and about 55% of it is lined with concrete. It is straight and has a single track, but is wide enough for gauntlet track. The grade is easterly and sufficient to give natural ventilation. Excavation started April 1, 1924, and the tunnel was holed through on August 15, 1925, crews working from both ends. Over 220,000 cu.yd. of granite was removed, requiring 900,000 lb. of dynamite.

The west portal is opposite Tunnel 6 on the old line and the east portal at Lakeview, east of Tunnel 12 on the old line, thereby replacing for eastbound traffic seven of the tunnels on the old line (total length 3604 ft.), which is hereafter to be used principally for westbound traffic. The new line is also 1¼ miles

Digitized by Google

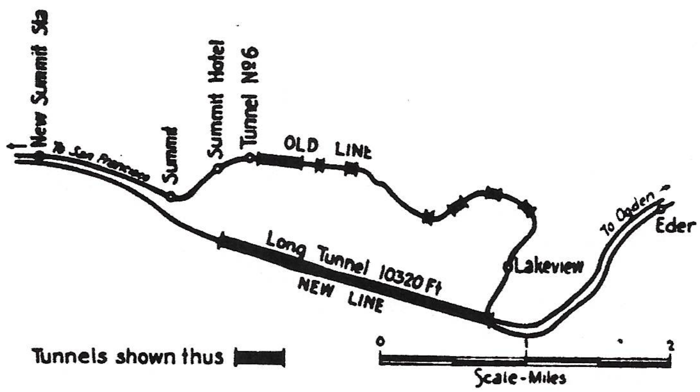
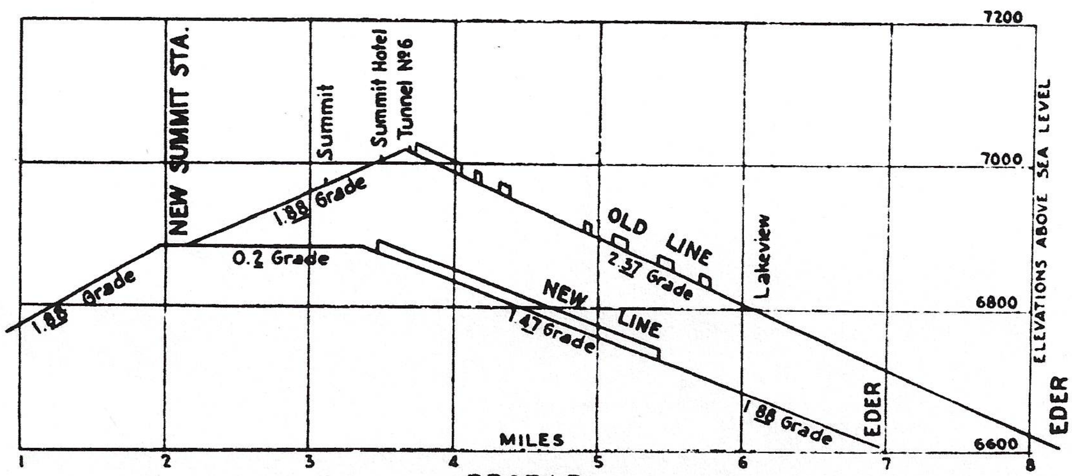
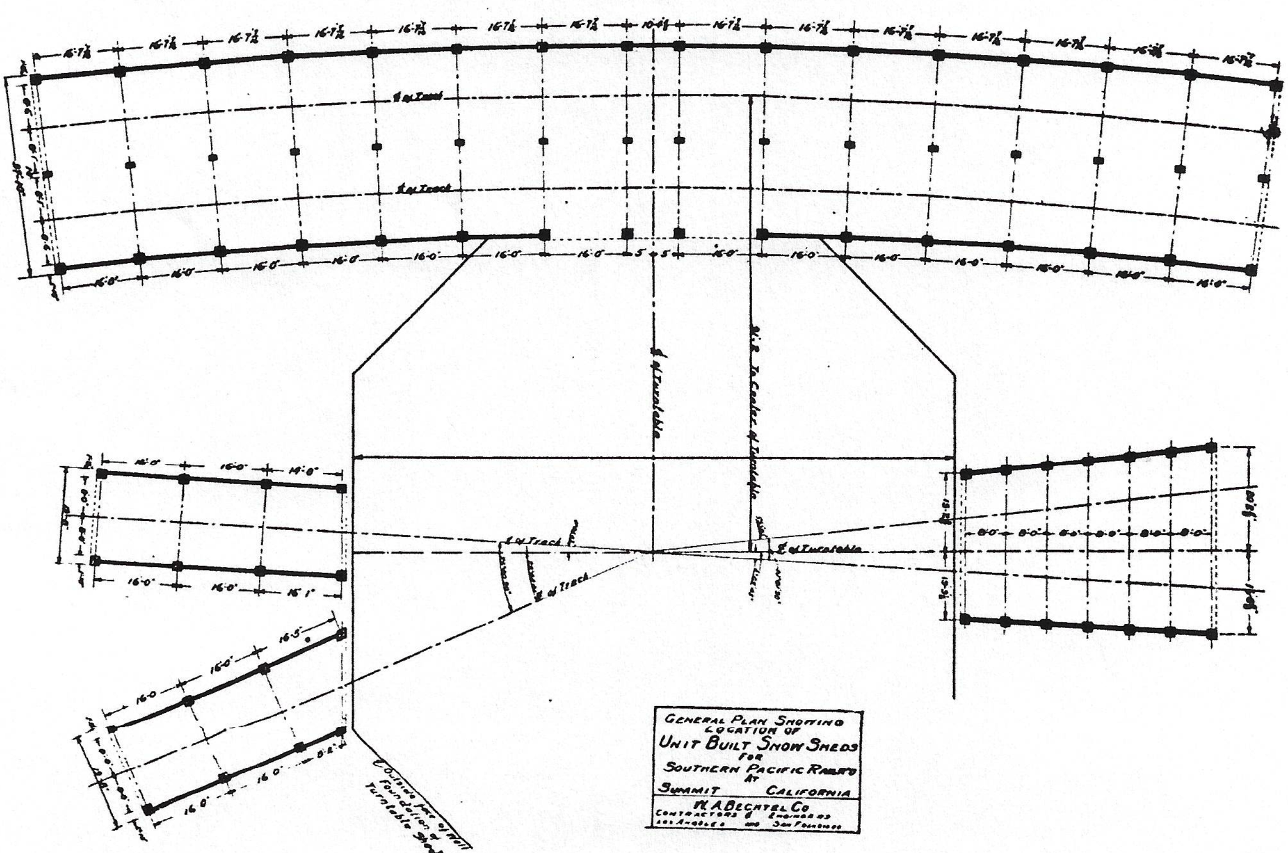


TABLE OF COMPARISONS Between New Summit Station and Eder	OLD LINE	NEW LINE	Favorable to New Line
Length-Miles	6.14	4.87	1.27
Max Curve	9°-48'	7°-45'	2°-03'
Total Curvature	1056°	377°	679°
Max Grade	2.37%	1.88%	0.49%
Tunnel Grade	1.92%	1.47%	0.45%
Summit Elevation	7017	6885	133
Total Ascent West in Feet	412	280	132
Total Ascent East in Feet	142	9	133
Tunnels-Total Length-Ft	7-3610	10320	



PROFILE

OGDEN ROUTE OF SOUTHERN PACIFIC COMPANY. COMPARISON OF OLD AND NEW GRADES OVER SUMMIT OF SIERRA NEVADA



Digitized by Google

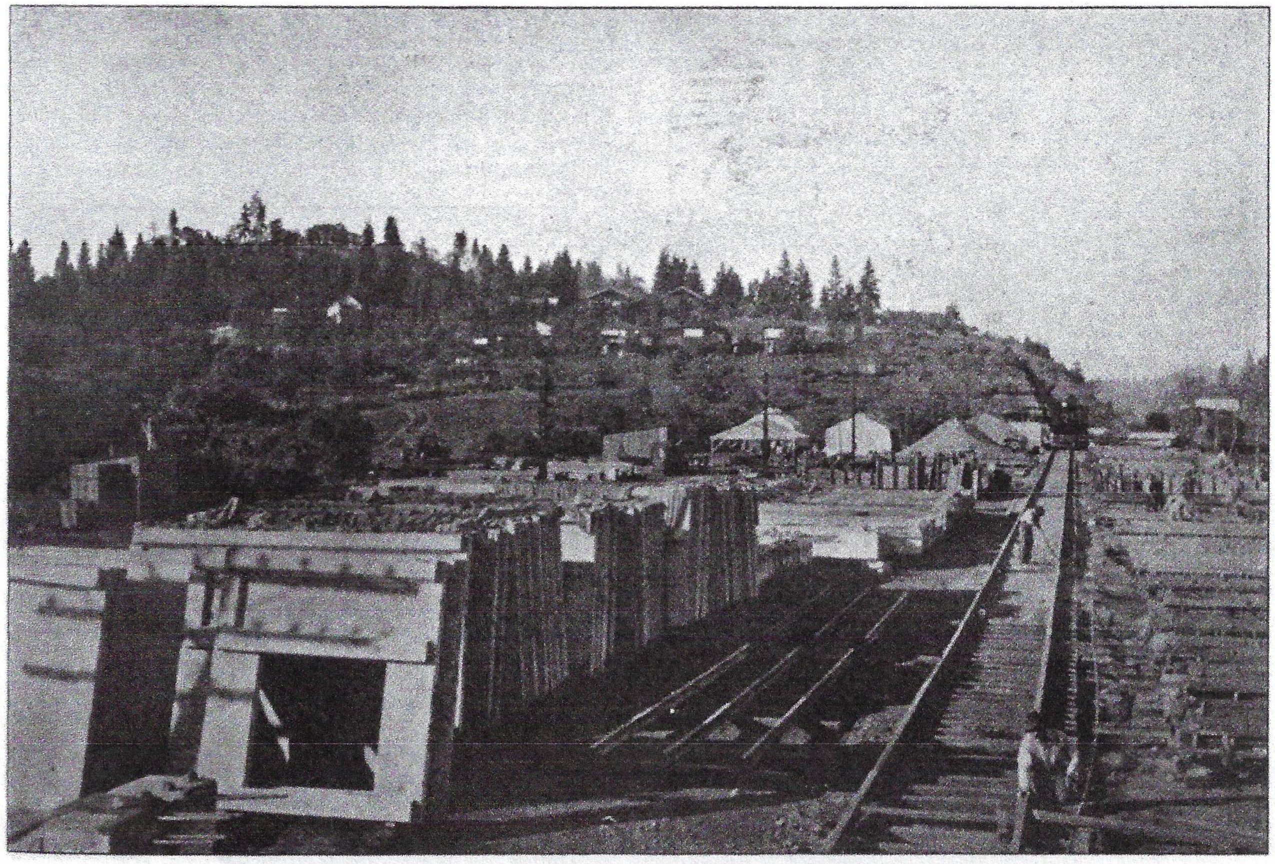
shorter. Most of the construction of the summit double-tracking was done by the Utah Construction Co., in a little over one year, a remarkably short time considering the amount of work involved and the heavy freight and passenger traffic over this route. H. J. Lawlor was general superintendent for the contractors, and E. E. Mayo was resident engineer for the Southern Pacific Company.

In addition to these tunnels there are 25 miles of snowsheds in the summit section, all above the 5000-ft. level. Prior to 1921 there were 29½ miles of snowsheds. In 1868-69 about 23 miles of the first snowsheds were constructed, with a peaked roof having a very steep pitch, and with a clearance of 17 ft. above top of rail. By 1873 more than 30 miles had been built, in the construction of which 44,640,000 F.B.M. of sawed timber, 1,316,000 lin.ft. of round timber, and 721 tons of iron and spikes were used. The original cost was at least $2,000,000, labor and materials being high at the time, and the later reconstruction of the peaked roof to flat roof with a clearance of 22 ft., including an additional seven miles of double and three-track shed, cost over $2,100,000. Since 1902 renewals and repairs have cost $3,835,000. From 1896 to 1899, the average labor cost was $4 per 1000 F.B.M. and lumber $9 as compared with $20 for labor and $22 for lumber, the present prices.

Although the timber snowsheds have been a success, the cost of fire protection and maintenance is a big item.

The snowsheds are of two general types, one for localities where the weight of the snow only is a factor, and the other for side-hill cuts exposed to slides and the slower but almost irresistible glacial movement of the snow. The types of construction developed have proved a complete success, and although frequently covered with snow to a depth of 10 or 20 ft., and in some places 50 ft., have afforded a safe passage for trains at all times. There have been comparatively few fires serious enough to cause a lengthy interruption of traffic, due to the efficiency of the fire protection and fire-fighting measures enforced. The use of oil in place of wood for fuel has greatly reduced the fire hazard. Traffic interruptions from blizzards have been few on account of the protection afforded by the efficient snow-fighting equipment. Prior to 1889 snow fighting, outside the snowsheds, was done with 'bucker' plows driven by 6 to 12 engines, and by a large force of shovelers. The 'flanger' was, and still is, used to clean out ice and snow between the rails. The first rotary was used in 1889. Today this division has six rotary plows, seven flangers, and three spreaders. The spreader was developed in 1908 by C. T. Green, superintendent, and is effective in snow 4 to 5 ft. deep, spreading it level with top of rail for a width of 20 ft. from the track.

The winter of 1889-90 was the most severe on record. It started snowing in the latter part of September and by October 4, there was 6 ft. of snow at the summit. Although it stormed almost continuously during October, November, and December, the line was kept open. Near the end of December there was 14 ft. of snow on the level at the summit. The snow continued during January, until it was 20 to 25 ft. deep on the

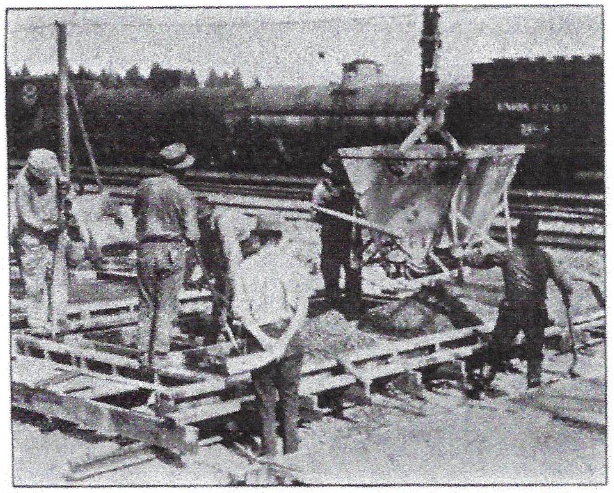


No. 1. PRE-CASTING YARD AT COLFAX FOR UNIT-BUILT CONCRETE SNOW SHEDS

Digitized by Google

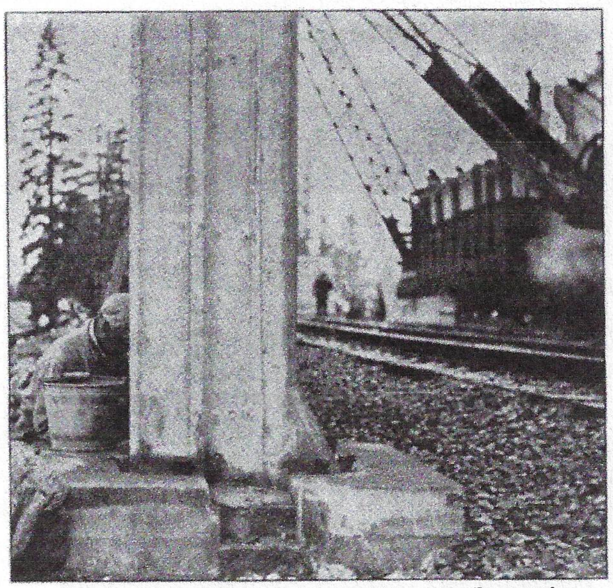
level, with recorded depths in places of 50 to 200 ft. and 500 ft. in isolated places. From January 15 to 31, the road was completely blocked in spite of the continuous night and day efforts of all forces available, the use of all equipment, and more than 2000 shovelers.

The development of improved snow-fighting equipment has made possible the elimination of some of the snowsheds on fills and in light side-hill cuts where the



No. 2. Pouring Pre-Cast Units at Colfax, Concrete Being Deposited by Locomotive Crane

lower side can be 'daylighted'. This is being done wherever possible. Although some snowsheds have been constructed on the new double-track line, about 10 miles of the old shed will be permanently abandoned. Nevertheless, there will probably always be necessary a considerable mileage of snowsheds, and the engineers of the S. P. Co., for some time have been considering the construction of concrete snowsheds,

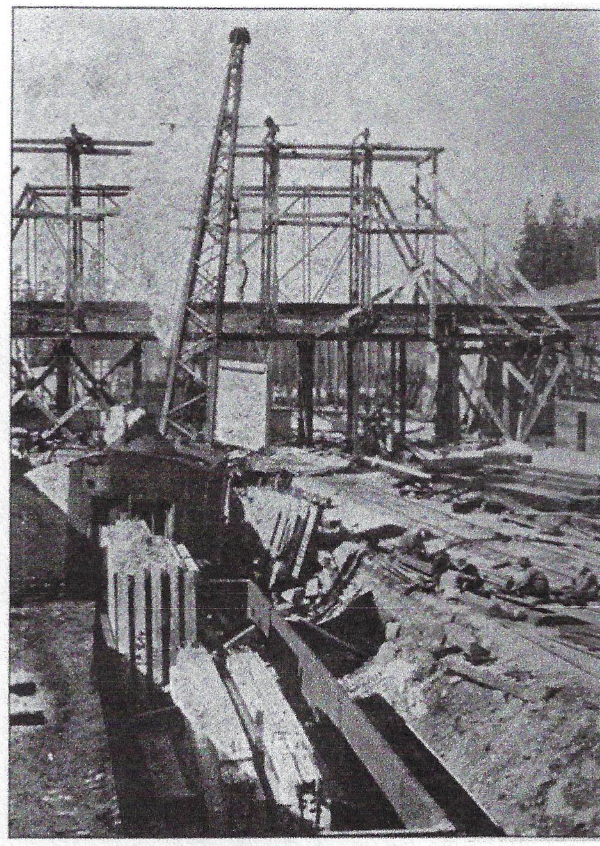


No. 4. Wall Column Being Grouted Into Recessed Column Footing

Monolithic construction is difficult, practically impossible, without interruption of traffic, and it is also hard to secure by this method the density of concrete necessary to resist the destructive acid gases from locomotive exhausts. A few years ago some light-weight, unit-built, pre-cast concrete snowsheds were constructed for the Union Pacific Railway in the Rocky Mountains, by Shirly Houghton, now associated with W. A. Bechtel, contractor, of San Francisco.

The reconstruction of the road over the summit necessitated the installation of a new 100-ft. turntable, at the junction near the summit of the eastward and westward tracks. This turntable is for the use of helper engines and snowplows, and as it is a very important factor in the operation of the road, it had to be carefully protected from fire hazard as well as snow blockade. To protect the turntable house it was decided to build the connecting sections of snowsheds of concrete, to act as a fire-break on each side of the turntable.

It was the middle of August, 1925, before the S. P. Co. completed the plans and decided to proceed with the project. The heavy traffic over the Ogden Route, especially during the fall when the fruit-shipping season is at its peak, necessitated the selection of a method that would not in any way interfere with



No. 3. Unloading Pre-Cast Units at Summit

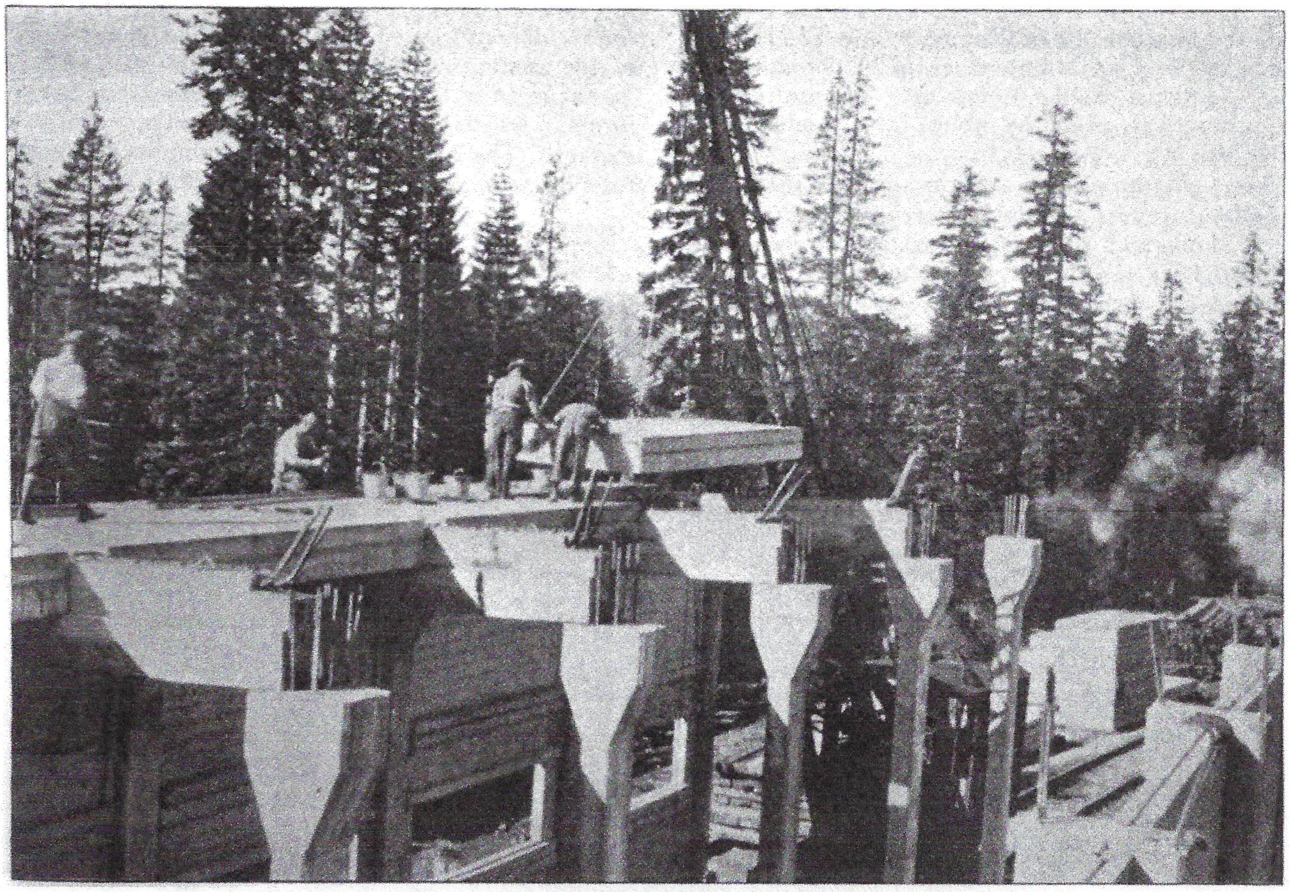
traffic. An arrangement was therefore made with W. A. Bechtel, general contractor of San Francisco, to build these snowsheds by the pre-cast unit system.

This system has been extensively used for all types of railroad and industrial structures, and is now controlled by W. A. Bechtel and John E. Conzelman.

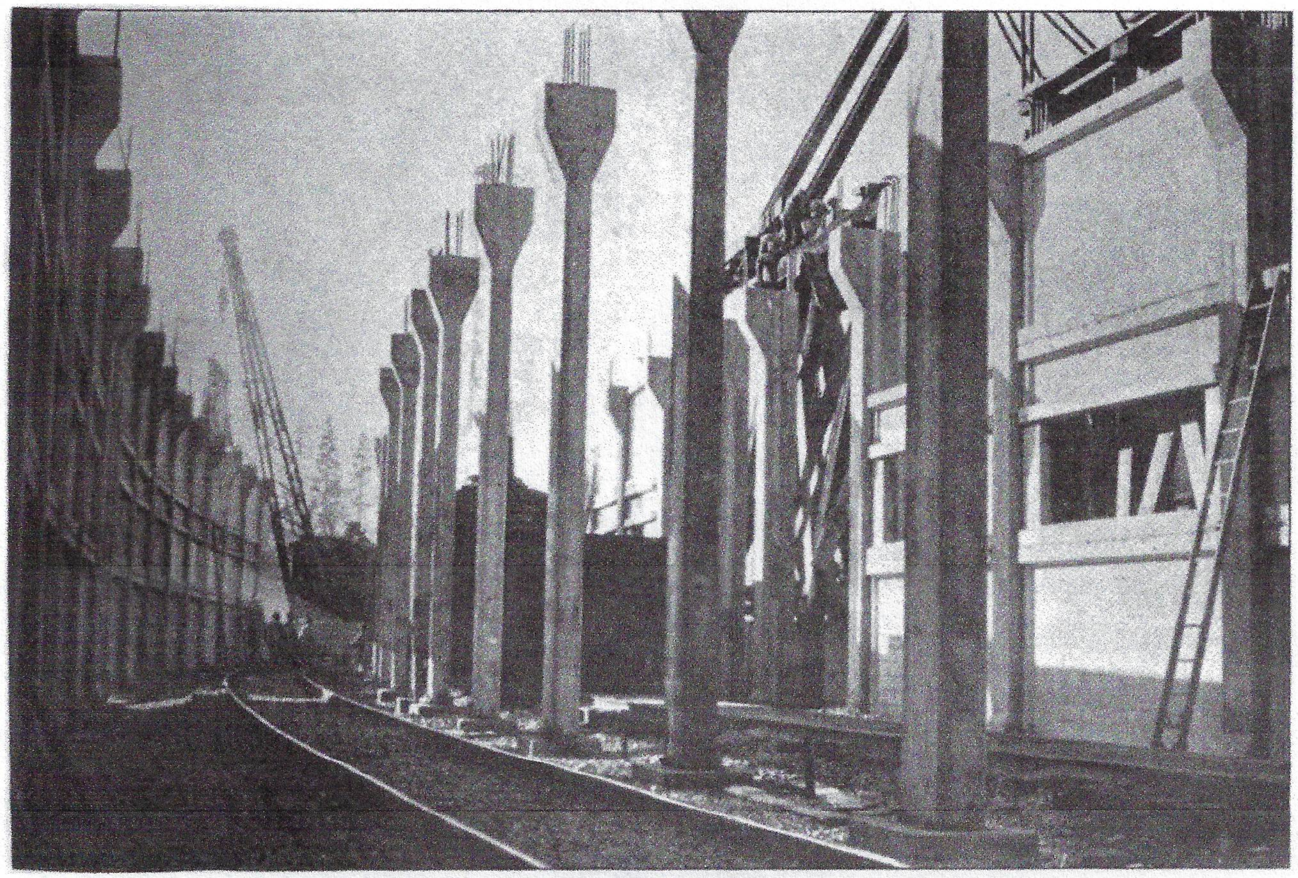
The unit system involves the use of pre-cast columns, girders, roof slabs, and wall slabs. Reinforcing bars, projecting from the units, lap with similar steel from adjoining units, and the pouring of a small percentage of concrete in place, welds the whole into a rigid and continuous mass.

The general design of the turntable, housing, and connecting sections of snowsheds, as shown on the

Digitized by Google



No. 7. PLACING ROOF SLABS

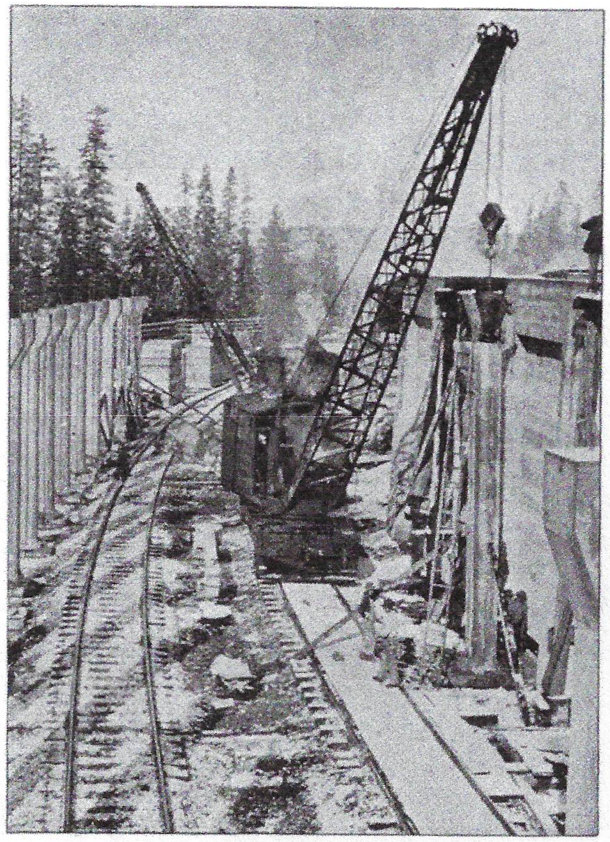


No. 6. ERECTING WALL SLABS. OPENINGS LEFT FOR WOODEN SHUTTERS

Digitized by Google

plan herewith, was made under the supervision of Geo. W. Boschke, Chief Engineer, and W. H. Kirkbride, Engineer of Maintenance of Ways and Structures, Southern Pacific Company. The unit system adaptation was made by John E. Conzelman, Engineer, for W. A. Bechtel.

There are three main sections of snowshed. Section No. 1 covers the double-track main line. It is 234 ft. long and consists of fourteen 16-ft. sections and one 10-ft. panel. A clear width of 16 ft. 7 in. is provided for each track and the vertical clearance is 22 ft. Section No. 2 comprises two sheds, each consisting of three 16-ft. panels, the two end bays being beveled to join the side of the turntable house. The horizontal clearance is 16 ft. and vertical 22 ft. Section No. 3 covers two tracks which diverge from the turntable. The girder span is 28 ft. 6¼ in. adjoining



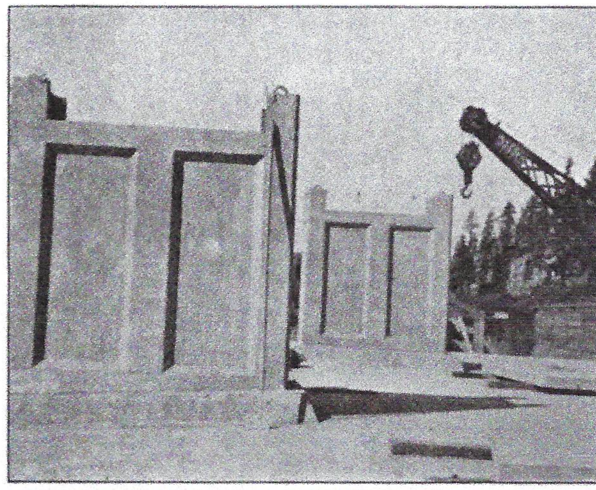
No. 5. Erecting Wall Columns

the turntable, and 37 ft. 11¼ in. at the outer end.

The design of the work involved no special problems. On account of the heavy snows that occur in this region, the roof construction was figured for a live load of 250 lb. per sq. ft., and the side pressure at 50 lb. per square foot.

On account of probable inclement weather at the summit, it was decided to cast the units at Colfax, which is 51 miles west of Summit and at a much lower elevation. The choice of location was fortunate as the weather remained pleasant throughout the casting period. The first units were cast August 31, and the casting was completed and all units stored at Summit by October 12. Column footings were poured at Summit while the units were being cast at Colfax, and erection was completed by November 1.

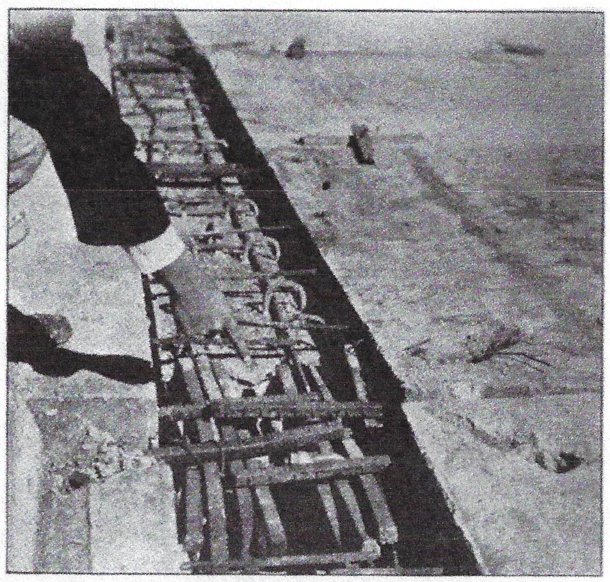
The pre-casting yard occupied one end of the railroad company's yard at Colfax. The general view of the casting yard is shown in illustration No. 1. To the right of the yard track may be seen the various forms in which the units were cast; to the left units in storage. The locomotive crane in the background is receiving concrete from the mixing plant to later dis-



No. 9. Pre-Cast Concrete Ventilators Before Setting Flat Covers. Timber Snowsheds on Old Line at Right

charge it in a wall-slab form as shown in illustration No. 2. The nature of the mix may be judged from this picture. A nominal 1:2:4 mix was used, with the addition of diatomaceous earth, celite, equivalent to 2% by weight of the cement.

Materials were carefully measured and slump tests frequently taken. The concrete was well worked into



No. 8. Interlocking Reinforcement Between Roof Slabs Before Grouting

the forms and settled with an electric vibrator made from an electric chipping hammer.

An excellent quality of concrete of unusual density and strength was obtained. A minimum amount of water was used to produce the best workable concrete giving an average slump test of 3½ in. The mixing time averaged 2 minutes. Celite was added to the concrete mix to give easier workability to the con-

Digitized by Google

crete. Compression tests were made on field specimens, the average for 14 days being 2666 lb. and for 28 days 3582 lb. Tests on cement concrete aggregate and field specimens were made by B. Stankovich, Chief Tester, Southern Pacific Company.

After the units had been made and cured they were transported to Summit by rail, and illustration No. 3 shows the unloading of a car of units.

Illustration No. 4 shows the top of a typical column footing, with a wall column in place. Note the slot in the column to receive the wall slabs, and the corresponding recess in the footing to receive the bottom slab. The columns were set in openings in the reinforced footing caps. The photograph shows the grouting operation.

Illustration No. 5 shows the setting of a wall column in the inner circle of Section 1, adjacent to the turntable house. Illustration No. 6 shows the center columns of Section 1 in place and the erection of wall slabs in the background. Illustration No. 7 gives a good view of roof-slab erection. In the picture the roof slab looks very heavy; it consists of a comparatively thin slab with beams on the sides and ends. The roof slabs are supported on ledges cast on the sides of the girders. Illustration No. 8 gives a view of the top of a girder after the roof slabs had been set, but before any grouting was done.

Concrete ventilators were placed on Section 1, as shown in illustration No. 9. At the time the photograph was taken the reinforced concrete cover or top on the ventilator had not been placed.

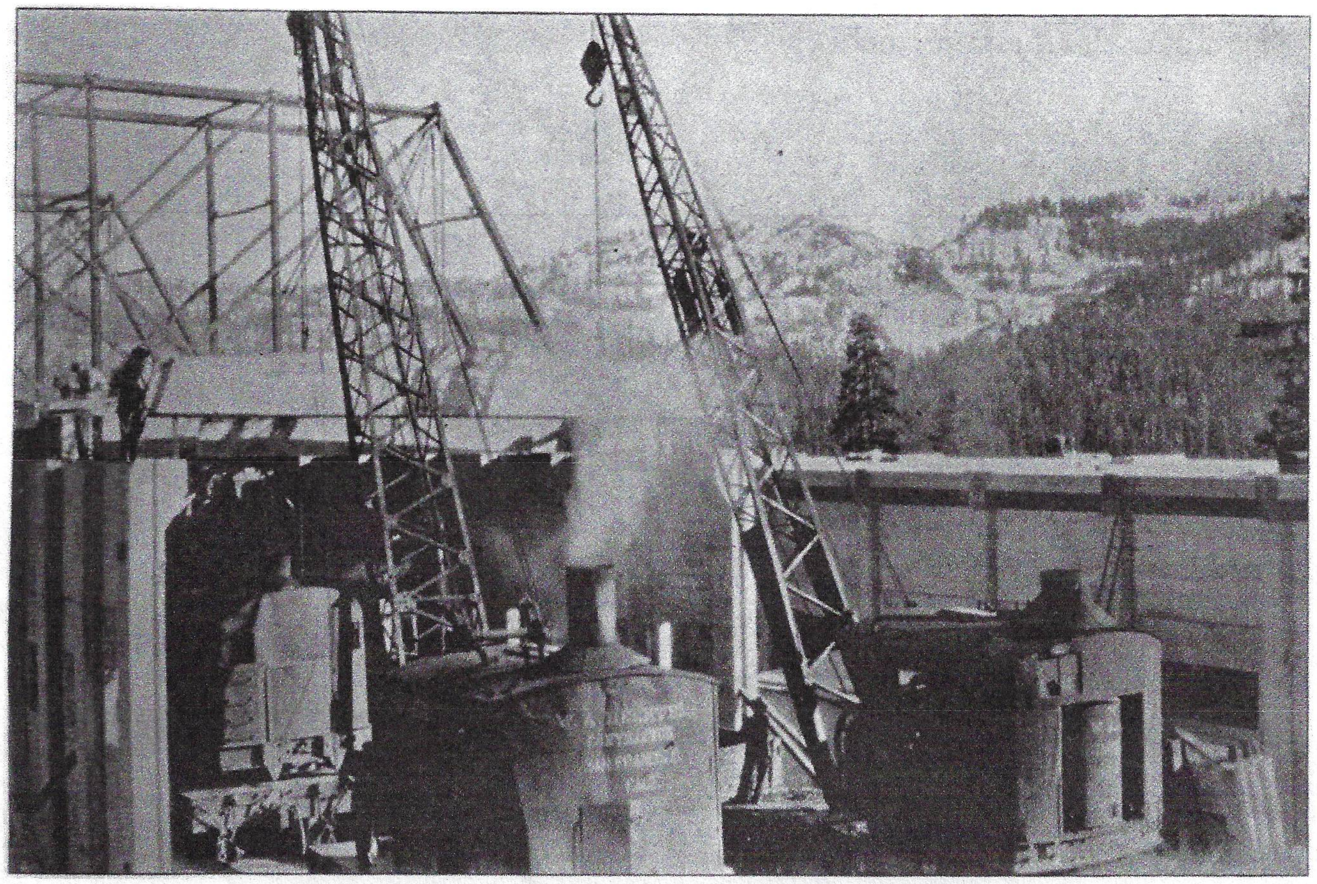
Illustration No. 10 shows the setting of a 38-ft. girder at the wide end of Section 3. Note the openings in the walls of Section 1. The lower openings are at car window height and are equipped with bolts to hold wooden shutters. The upper opening is for ventilation and is protected by the overhanging roof slabs.

The illustration on the front cover gives a general view of the operation. Section No. 1 is seen to the right. The bridge trusses form the support for the roof of the turntable house.

The work proceeded on schedule time and demonstrated conclusively the many advantages of the unit system for work of this kind and under the conditions obtaining. The ideal conditions under which the casting of the units was carried out, permitted obtaining concrete of the highest quality. This was important in view of the corrosive and abrasive action of the engine exhaust. Erection was carried out under the supervision of S. D. Bechtel, with minimum interference with traffic and was completed in less than three weeks. The entire contract was completed in 75 days and contractors outfits were shipped from the job on October 31.

The difficulty of the task of constructing these sheds as well as the tunnels and new track, within the short time available and without interruption of traffic, may be appreciated from the fact that as many as 1994 freight and passenger cars, a train every 15 or 20 minutes, had to be handled over the summit, in one day, in addition to all the material trains on the snowshed work, tunnel excavation, and re-alignment construction. This was considered a record achievement.

As most of the snowshed line is continuous, it was



No. 10. ERECTING 38-FT. GIRDER ACROSS WIDE SECTION OF SHEDS

Digitized by Google

early recognized that a fire break at intervals was imperative. Galvanized iron sheathing of the sheds was first tried, but this proved a failure. Then followed the telescope shed, consisting of a 96-ft. length of shed mounted on wheels so arranged that in summer it can be pulled back within the adjacent shed which is of an enlarged section. In addition to this method the company is taking down 100 ft. of shed every quarter mile or so wherever possible. Unit-built concrete sheds will hereafter be constructed as fire breaks and probably used to replace the old timber sheds when they are destroyed by fire or other causes.

SAN MATEO-ALAMEDA TOLL BRIDGE ACROSS SAN FRANCISCO BAY

Frank C. Towns and his associates, Mark E. Noon and Wm. A. Deuel, filed detailed plans and specifications with the Board of Supervisors of San Mateo, California, on Thursday, March 11, 1926, for the new toll bridge for which they secured a franchise several months ago.

The bridge was designed by an eastern engineer, and borings have been completed to determine depth to hard pan.

The bridge will be about eight miles long, a concrete pile trestle with lift span in the center of the stream 200 ft. long. The bridge will be 40 ft. wide, 27 ft. being provided for highway traffic and 13 ft. for railroad track.

Bids have been received and it has been determined that the bridge will be built within the estimate of $11,500,000. Contract will be awarded shortly.

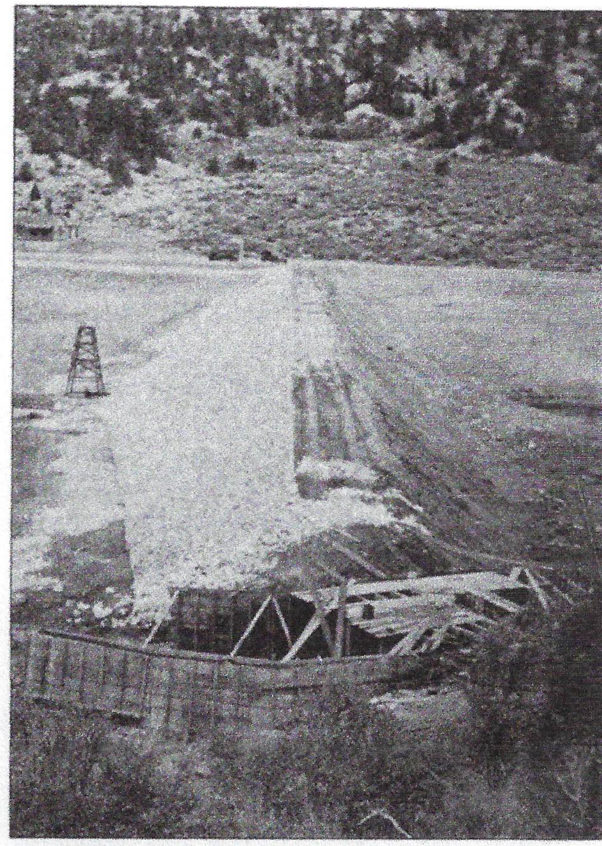
LAKE OF THE WOODS DAM

Small Earth Dam for Park Reservoir Near Lebec on Ridge Route, California

The Lake of the Woods Company of Los Angeles has subdivided practically all of an old mountain ranch, the 'Cuddy Ranch', situated eight miles west of Lebec on the Ridge Route Section of the inland highway, between Los Angeles and San Francisco. Roads are being built and small lots will be sold for summer cabin sites. The average elevation is 5000 feet.

For park and recreational purposes a lake has been formed by constructing across a creek, an earth dam 30 ft. high and 605 ft. long on crest, with upstream slope of 2 to 1, and downstream slope of 1½ to 1. The upstream slope has a riprap facing of rock, 12 in. thick. The spillway is a concreted channel cut through solid material around the right abutment. The dam has a freeboard of 8 ft. above bottom of spillway channel. A core trench 4 to 6 ft. wide was excavated along the axis of the dam, penetrating alternate thin layers of gravel and clay, and extending down 4 ft. into a thick stratum of blue clay, at a maximum depth of 30 ft. Cross trenches 4 ft. deep, every 50 ft., failed to penetrate the stratum of blue clay. The core trench was filled with puddled clay.

Material available at the dam-site for the earth fill was considered of too loose a character but suitable material was obtained from sandy clay deposits 1¼ miles away. This material was placed in the center of the dam and occupies a width equal to the height of the dam at each point. The material was thoroughly wetted, and compacting was done by the trucks, teams, fresnos, and a small roller made from a piece of corrugated metal pipe weighted with concrete.



Lake of the Woods Dam. Concrete Spillway Under Construction in Foreground

Rock for riprapping was quarried at a point 3¼ miles from the dam-site. The reservoir formed will impound 104 ac.ft. and has a watershed of 20 square miles.

The contract for the construction of the dam was awarded to Lewis Construction Company, of Los Angeles, and work is now being completed.

The following were the unit bid contract prices:

	Per cu.yd.
Trench excavation, including stripping and general clearing, 14,000 cu.yd.	$1.00
Clay core (1.3 mile-haul) 4000 cu.yd.	1.40
Earth fill rolled	0.35
Rock riprap, hand placed (¾ mile haul)	2.00
Plain concrete in spillway	15.00

Horton Whipple, Civil Engineer of Hollywood, designed the dam and supervised construction of the same.

Digitized by Google

WESTERN CONSTRUCTION NEWS

CONSTRUCTION ENGINEERING AND THE STEEL INDUSTRY

ISSUED SEMI-MONTHLY

INDEX

VOLUME I

January 10, 1926 to December 25, 1926

PUBLISHED BY

WESTERN CONSTRUCTION NEWS, INC.

24 CALIFORNIA STREET

SAN FRANCISCO

Digitized by Google