DESIGN, MAINTENANCE AND OPERATIONS OF A TRANS-SIERRA HIGHWAY, CALIFORNIA

By
Roland I. Nicholson 1/

The purpose of this paper is to present as briefly as possible, a discussion of the above subject especially as related to snow removal. I have chosen to discuss U. S. 40, Interstate 80, since that highway, nearing completion, is new, and poses a large variety of problems.

The western slope of the Sierra is gradual, rising from the Sacramento Valley from about 30 feet above sea level at Sacramento to slightly over 7,000 feet at Donner, a distance of about 95 miles; the eastern slope is more abrupt, dropping about 1,400 feet in ten miles to Truckee. Our snow problems generally occur above the 3,000-foot elevation, although it is not uncommon for the snow line to drop to 1,800 feet.

The original design for the freeway was to provide for separate roadways divided by a median in the lower elevations and completely separated roadways in the higher elevations where the snow pack is greater and drifting, as well as visibility, is a serious problem. In higher elevations the separation is not only lateral, but also vertical at some locations.

The traveled way consists of 24 feet of Portland Cement concrete pavement with 10-foot asphalt concrete paved shoulders on each side. On steep upgrades, a third lane of Portland Cement concrete was added for slow, heavy trucks.

At locations where our best experience showed to be the most logical, shoulders were widened to 14 feet to provide for chain control areas where the public had room to stop and put on chains, and on the opposite roadway, an area whereby they could remove them. These areas are all designated by signs which may be turned away from traffic when not in use.

On each separate roadway the cross fall is in one direction from the inside edge of the pavement except, of course, on super-elevated curves. Our original design provided for a 1½% cross fall for the full width of the traveled way and paved shoulders to the toe in cut with provisions for an additional six-foot gutter where erosion could be expected.

On fill sections asphalt concrete dikes were constructed to contain and control drainage, which was directed to downdrains. On superelevated curves the cross fall carried from shoulder point to shoulder point.

Since we planned to plow snow from left to right and use the right shoulder for storage, plus the six-foot gutter for additional storage where provided, the original designed cross slopes and cross section appeared adequate.

This design worked very well in the regions of light snowfall; however, at the higher elevations the snow left on the high side of the roadbed would melt and flow across the pavement and start freezing in the early evening. The snow reef in the unpaved gutters was difficult to remove and would freeze and plug the entrances to culverts before we could dispose of it with the rotary plows.

After the first winter the design was changed to provide a paved gutter on the high side of the superelevated curves on cut sections with an asphalt concrete dike at the intersection of gutter and cut clope. This gutter provided drainage from the snow stored in the area at the top of the super, as well as from the snow pack lying on the cut slope. The normal cross section was changed to provide a 2% cross fall on the Portland Cement concrete pavement and a 5% slope on the paved shoulders away from the traveled lanes. This method allows for more snow storage on both shoulders and provides for

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1/ District Maintenance Engineer, California Division of Highways.

drainage away from the traveled way. The stored snow, however, is removed as soon as possible.

Along with the revision providing for better gutter drainage, downdrains were enlarged and better entrances were provided by lengthening the flare and providing an entrance pocket which lays just outside the normal line of dike. This prevents the traveling public from dropping into the depression, and also allows the Maintenance Department to keep the drains open by mechanical means.

A continuing problem we have in higher locations where the terrain in many cases consists largely of boulders placed by ancient glaciers, water percolates into cut slopes, freezing into iceberg proportions, which gradually flows into and blocks gutters and drainage structures. This problem has been so severe in the past three winters that it has been necessary to break the ice with front end loaders and haul it away. Otherwise, in a short time the accumulation of ice prevents daytime melt from following in its prescribed course.

Crossing the top of the Sierra Range, the topography effected our design. Due to the steep slopes on theeasterly side of the Sierras, and the almost bare granite rock found in so many areas, it was necessary to separate our roadways in many sections, but the desired 100 feet could not be obtained except at an astronomical cost, so there are sections on the summit where the roadways are much closer than 100 feet apart and where it will be necessary to carefully direct our snow stream in order not to bury the traffic on the lower roadway. Before this section of the highway was located, an extensive aerial survey was made during the winter time to study the pattern of drifting on the line that was eventually followed. At the present time this section of the highway is not completed and open to public traffic. Observations taken during severe storms during this past winter indicate that the aerial study of drifting was worthwhile.

Observations made during this winter indicate that the drifting in the roadway will not be as bad as it is on the existing highway since the blowing snow following the direction of the highway appears to blow over the fills and cuts instead of depositing in heavy drifts on the roadway. We expect to have visibility problems on this section the same as on the old road, but we hope that the drifting problem will be much less.

On the existing traveled way the Division of Highways has been troubled during heavy snow fall by numerous short run avalanches or snow slides onto the traveled way from the cliffs above Donner Grade. These are not only a great nuisance, but also pose a hazard, as at time vehicles have been covered by them, and also swept off the grade.

We have engaged the U. S. Forest Service to shoot down these avalanches while they are still only potential. Mr. Atwater, who is present, will no doubt go further into this subject.

On another Trans-Sierra Highway, U. S. 50, we have engaged the services of the California National Guard, with a 105 mm recoilless rifle, to bring down potential avalanches in an area where they have been most severe in the past. Other sections along this highway have been handled by the Forest Service, and with their advice we have purchased a contrivance known as the Avalauncher, which is actually a modified baseball thrower operated by compressed CO_2 and firing small charges for a limited distance.

The Forest Service Avalanche Control Specialist has instructed our men in the use of the "Avalauncher". I will leave further discussion of this operation to Mr. Atwater.

The operation of a Trans-Sierra 4-lane divided freeway in winter time requires a considerable amount of planning, preparation, equipment, manpower and weather guessing to handle the volume of modern-day traffic on the highways. We attempt to keep all four lanes open at all times and we are seldom stopped by the amount of snowfall, but are sometimes stopped by blizzard conditions where visibility becomes zero. During those times, for safety of the tranfeling public, we close the sections of the road where necessary, with the view in mind that the traveling public may find food and lodging or comfort stations within reasonable distance. This is not always possible; however, we endeavor to put our points of control so that these facilities may be as close to the

people as possible.

At the beginning of a storm, of which we normally have considerable warning, we move our light, fast plows out on the road; since we have to work on both sections of the divided highway at the same time, we attempt to space our vehicles to take advantage of highway interchange areas so that each group of equipment will maintain a certain section of both lanes of the highway. This may be modified due to conditions such as breakdown of equipment, or change of intensity of the storm, or change in location of the storm.

Following the light, faster plows and in tandem if the operation is feasible, we use the larger plow trucks and motor graders and then if the snow rate becomes heavier, we also plow to the left side of the roadway. Heavy duty snow removal equipment with plows store the snow at the edge of the roadway. These are followed as quickly as possible by rotary snow plows to blow the snow over the fill slopes or over the adjacent cut banks and away from the opposing roadway as much as possible.

The Division of Highways has developed and modified directional chutes for the rotary plows which have proved of considerable worth in the areas where we must restrict the direction of the rotary-thrown snow. We have in the past few years accumulated a great number of sanding and salting units. These large sand trucks are similar to the ones used all over the eastern states and Canada, and are operated by one man. They are equipped with radios as are most of our equipment, in order that the Highway Foremen may instruct them to an area where quick freeze has occurred.

We have built, and are in the process of building, large sand storage buildings in the maintenance yards, as well as at various locations along the highway in order to facilitate the loading and spreading of sand quickly. Salt is quite often spread on the pavement to retard the freezing snow melt or to facilitate the elimination of ice already formed. A certain amount of salt is also incorporated with sand on the trucks.

Last year the various salt companies developed a means of hauling and unloading bulk salt into our bunkers by an air blown method. This has cut the price of salt almost in half and also facilitates our loading of the salt on our mechanical spreaders.

The particular operation of keeping our pavements ice free in the winter time is most important. Due to the relatively high humidity this year and last year, even without much snow, we had miles and miles of pavement covered with frost and ice which our crews endeavored to eliminate by the salt and sanding methods.

To provide for facilities for operation and maintenance, the Division of Highways started in advance of the construction on U. S. 40, to plan for, and construct, modern maintenance stations in locations and at elevations whereby the dispersal of equipment and manpower would be most feasibly handled. This maintenance station program covered not only Interstate and U. S. Routes, but also other mountain highways in the District. We built not only for the present, but for the future in these stations, providing the most modern equipment available for garageing, maintaining and servicing the various types of equipment by installing shop equipment for the day-in and day-out maintenance required.

I have some slides showing some of these facilities which will be shown later.

This effort required a great deal of coordination, planning and budgeting to provide for the program in order that the stations would be ready for use before, or at the time a considerable portion of the 4-lane freeway section was completed. We completed our last large facility on U. S. 40 about a year and a half in advance of the time of completion of the highway facility.

These stations are manned in the winter time by a very large crew in order to provide for the snow removal, sanding and salting equipment. Take into consideration the fact that we have to operate 24 hours a day, seven days a week during the periods of stormy weather and/or severe cold and icy conditions. The winter crews live at the stations so that they may be on call if needed at any time. The Division of

Highways has managed to place a great number of these equipment operators on a preferred Civil Service list for this type of work. These equipment operators normally work on construction projects and logging operations. Many of them return year after year to work with us. During summer time we close the dining facilities and operate from the stations with the permanent crew, which is considerably smaller than our winter crew.

The biggest problem, and our first obligation, of course, is the handling of traffic. In order to achieve this we have constructed and set up various chain control areas of sufficient length to accommodate various volumes of traffic. These stations were set after years of observance as to the manner in which storms were set after years of observance as to the manner in which storms came in order that they might be utilized to best advantage. Advance warning signs are located well ahead of control points and are up at all times, and may be turned in the socket to face traffic when needed. I have slides showing operations of these signs which will be shown later.

On all of U. S. 40 we have constructed various chain control areas to operate, if possible, where most convenient for the traveling public. These chain control areas are set up near interchanges where people who may not wish to go on may turn around and return, or where they may avail themselves of public businesses along the frontage road for the purpose of purchasing and putting on chains. After some unhappy experiences with the chain installers, the Division of Highways placed before the Legislature a bill permitting the Division of Highways to license and control the activities of these individuals in order to provide services to the traveling public and to prevent abuse. The Highway Patrol enforces the regulations; the Division of Highways may revoke the permit at any time. This system is working very well.

I have some slides which will show you the operations of chain controls at various locations.

Our experience this past winter with its two tropical storms, enabled us to find certain weaknesses in our drainage system which can be corrected. We have learned that where heavy runoff is to be expected at a cross gully or waterway on the highway, that the culvert should be placed on a fairly steep grade, steep enough to carry small boulders, and that an entrance basin with a much flatter grade should be constructed to provide for the heavy debris carried by these tropical storms to be deposited in the basin, and the steep grade will permit lighter debris and boulders to flow through the pipe and be deposited below the outlet.

Wherever possible cut slopes were flattened as much as economically feasible. These flatter slopes provide for considerable snow storage and also are instrumental in preventing the flow of debris and the falling of rocks on the traveled way during a storm. Steeper cut slopes, unless in solid rock, shed a great deal of debris during stormy weather. We have attempted to provide sufficient space between the edge of pavement and toe of slopes to catch the rocks and boulders, and where this was not feasible, a heavy wire mesh fence was constructed, anchored at the top but free at the bottom,and placed adjacent to the toe of slope. Talus and/or boulders fall into this wire mesh which slows the velocity of the rocks and forces most of them to fall from the fence into the gutter. At intervals the maintenance crew pick up the material with the front end loader and haul it away. Otherwise these rocks and boulders would be bounding onto the traveled way, thus posing hazards to the traveling public.

I hope that I have been able to show some of the problems we have on mountain highways and the method of combating them, knowing that each winter we will learn how to use newer and better methods in keeping the highways open and safe across this mountainous area.

I will now show some slides of our snow removal equipment, maintenance buildings, and also a chain control operation. I hope they will be of interest to you.