CONTINUING STUDIES OF PAVEMENT GROOVING IN CALIFORNIA

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The development of specifications for pavement grooving projects is presented. The normal groove is ⅛ to ¼ in. in depth, cut by a blade 0.095 in. wide, spaced on ¾-in. centers, and cut in the longitudinal direction. Minimum acceptable coverage of the specified pattern is 95 percent. Water and residue from the cutting operation are picked up by vacuum pumps. A maximum operational noise level of 86 dB on the A-scale is allowed. Before-and-after accident studies of pavement-grooving projects are presented. Pavement grooving has resulted in an 85 percent reduction of wet-pavement accidents in the grooved areas.

The use of pavement grooving by the California Division of Highways for reducing wet-pavement accidents has continued to be applied to the problem of the skidding vehicle (1). This report relates further developments in pavement grooving in California.

GROOVING PATTERNS

All grooving is longitudinal, and grooves are rectangular in form. A minimum depth of ⅛ in. is required. Depths over ¼ in. may produce spalling between cuts. The normal spacing is ¾ in. center to center, but this spacing may be changed to ½-in. centers or 1-in. centers for special conditions.

In earlier grooving projects, a ⅛ in. wide blade was used for cutting the grooves. However, there is a tendency for the groove to widen out on small radius curves with high superelevation. As the groove widens the "tracking" effect increases, and the grooves are felt by vehicles, particularly motorcycles. In an effort to reduce this effect, a blade 0.095 in. wide is specified (2).

The first grooving contracts required complete coverage of the specified area. Complete coverage is not a practical approach because of surface irregularities, and the contractor was allowed a small amount of skipped areas (areas with no grooves whatsoever). This allowance needed definition. It was decided that 95 percent of any selected 2 by 100 ft longitudinal area must be grooved as specified.

CONTRACT SPECIFICATIONS

Grooving on existing highways is done by closing lanes to create a work area and allowing traffic to flow by the operation on unclosed lanes. The residue and water from the cutting machine have to be controlled. If they flow into the traffic lanes, they are hazardous.

The water and residue are vacuumed by pumps and stored in tank trucks and carried away. Lanes are marked by raised pavement markers and, because of the vacuum devices, grooves are not placed within 1 ft of the lane lines. Therefore, only 10 ft of a 12-ft lane is grooved.

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In metropolitan areas when the daytime traffic demand will not allow lane closures, the grooving work is done at night and during the early morning hours. The contractor usually works a full 8-hour shift at night.

The projects are often located in residential areas, and noise from the grooving operation must be kept as low as possible. We have found that the maximum allowable sound level is 86 dB on the A-scale measured at 50 ft from the side of the machinery. This amount of noise does not generate many complaints from the local residents. The contractors have muffled their equipment and are able to meet this requirement.

Working at night has also required the development of special traffic control devices. We use portable flashing beacons and portable illuminated signs as advanced warning of lane closures. We use illuminated traffic cones for lane control.

Most of the projects involve grooving approximately 100,000 sq yd of pavement surface. Bid prices for grooving have been decreasing during the past few years. In 1966 prices were about 90 cents/sq yd. Early in 1969 with the introduction of the 5-ft grooving machine, the low bid was 75 cents/sq yd. Later in 1969 the low bids were near 65 cents/sq yd. In 1970 bids as low as 50 cents/sq yd have been received. For estimating purposes, we are using 60 cents/sq yd. The decrease in grooving costs reflects the development of improved equipment for doing the work.

ACCIDENT STUDIES

Four of the 6 accidents studies presented earlier (1) are again presented to show the effect of grooving. Since the earlier report, wet-pavement travel and the wet-pavement accident rate have been added to the accident summary. Wet-pavement travel is a determination of the number of vehicle-miles driven on wet pavement.

An estimate of wet-pavement travel (exposure) was made as follows. U.S. Weather Bureau records from 3 locations in the Los Angeles area were obtained, and the hours showing precipitation of 0.01 in. or more were multiplied by appropriate traffic factors (higher factors for peak periods, lower factors for late night periods) and by the ADT (and length of road grooved) to obtain the vehicle-miles driven on wet pavement. (It is estimated that, on the average, 2½ percent of vehicle travel in Los Angeles occurs during hours when precipitation exceeds 0.01 in. This average is useful in forecasting future wet-pavement accidents, but it was not used to calculate wet-pavement rates for past performance.) These figures are approximations subject to adjustment in a study now in progress by the Division of Highways, but the difference in bare (unadjusted) number of wet-pavement accidents are so dramatic that any amount of adjustment cannot alter the conclusions.

Of course, it must be remembered that the reason these early jobs were done in the first place is that they had built up concentrations of skidding accidents. Much caution is required in extrapolating the reduction in wet-pavement accidents to other locations where such concentrations do not exist.

Case 1

This grooving was done on I-5, 50 miles north of Los Angeles, and was completed in 1963. The grooves are ⅛ by ⅛ in. on ½-in. centers. The ADT on this roadway is 24,000. There were 7 wet-pavement accidents during the 2 years before the grooving and none during the 7 years after the grooving.

Case 2

This grooving was done on I-5 at Laguna Canyon Road near the El Toro Marine Air Station, and was completed in 1966. The grooves are ⅛ by ⅛ in. on ½-in. centers. The ADT on this roadway is 53,000. The radius of curvature is 2,000 ft. Before skid tests averaged 0.25 with a low of 0.17. After skid tests averaged 0.30 with a low of 0.27. Before grooving there were no wet-pavement accidents in 1963, 8 in 1964, and 47 in 1965. For the following 4 years after the grooving, there were 6 wet-pavement accidents. This study shows how rapidly the wet-pavement accident problem can develop as traffic wear on the pavement surface causes the friction values to drop from a safe to an unsafe level.

Case 3

These grooves are ⅛ by ⅛ in. on 1-in. centers and are on I-405 near Bellflower Boulevard in the City of Long Beach. The grooving was done in 1966, and the ADT here is 159,000. Before skid tests averaged 0.20 with a low of 0.14. After grooving skid tests averaged 0.24 with a low of 0.17. After 1½ years the skid tests averaged 0.20 with a low of 0.14. There were 20 wet-pavement accidents in the year before grooving and 2 for the next 4 years after. This location is on a tangent section of freeway, and the skidding started at the sag point where the vehicles start to accelerate as they approach the Bellflower Boulevard overcrossing. It appears that the skid tests are not well correlated to performance in this case.

Case 4

A broader approach to pavement grooving is shown in this case, where 1 mile of the southbound I-405, also in Long Beach, was grooved. There were 2 curves in the mile, one with a radius of 2,800 ft and 4 percent superelevation and the other with a radius of 2,500 ft and 6 percent superelevation. The ADT at this location is 174,000. The grooving was done in 1966 and is ⅛ by ⅛ in. on ¾-in. centers. Before skid tests varied from 0.12 in the right lane to 0.38 in the median lane. After skid tests varied from 0.26 to 0.44 respectively. There were 61 wet-pavement accidents during the year before grooving (60 percent occurring in the 2 median lanes) and 8 accidents in the 3 years following the grooving. A comparative study of accidents was made on the northbound freeway lanes where there were 7 wet-pavement accidents in the year before and 16 the 3 years after. There was no significant change in the number of dry-weather accidents.

Because of the length of the grooved area in Case 4, the accident rates become more meaningful than in the other cases, which were very short sections. The dry-pavement accident rate for the grooved area is 1.28 accidents per million vehicle-miles. The wet-pavement accident rate for the grooved pavement is 3.48 accidents per million vehicle-miles.

CONCLUSIONS

Pavement grooving as a correction for wet-pavement accidents has been used at many other locations similar to those reported here. In each case, grooving has reduced the number of wet-pavement accidents and has continued to be effective.

TABLE 1

SUMMARY OF ACCIDENTS AT PAVEMENT-GROOVING LOCATIONS

Pavement Location	Pavement Type	Grooving Pattern (in.)	Accidents					
			Before			After		
			No. of Years	Dry	Wet	No. of Years	Dry	Wet
LA-5, 78.6/78.9	PCC	⅛ by ⅛ on ½	2	2	7	7	32	0
Ora-5, 23.3/23.6	PCC	⅛ by ⅛ on ½	3	17	55	4	22	6
LA-405, 2.1/2.6	PCC	⅛ by ⅛ on 1	1	10	20	4	34	1
LA-405, 4.9/6.1	PCC	⅛ by ⅛ on ¾	1	41	61	3	123	8
LA-101, 0.5/0.8	PCC	⅛ by ⅛ on ¾	1	28	23	2	42	3
LA-5, 29.5/30.5	PCC	⅛ by ⅛ on ¾	1	10	12	3	20	5
LA-101, 8.9/9.3	AC	¼ by ¼ on 1	1	55	139	3	116	26
LA-101, 7.7/8.9(S/B)	AC	⅛ by ⅛ on ¾	2	110	89	1	47	14
LA-10, 22.6/22.8	PCC	⅛ by ⅛ on ¾	1	17	26	4	23	5
LA-10, 44.9/45.6	PCC	0.095 by ⅛ on ¾	2	79	35	1.5	62	3
Ven-101, 27.0/27.6	PCC	⅛ by ⅛ on ¾	3	16	8	2	10	1
Ven-101, 29.0/29.7	PCC	⅛ by ⅛ on ¾	3	20	16	2	9	1
LA-5, 75.0/75.5	AC	⅛ by ⅛ on ¾	3	12	14	1	3	0
Ven-101, 10.9/11.2	PCC	⅛ by ⅛ on ¾	1	3	10	2	8	3
Total			25	420	515	39.5	551	76

A summary of 14 studies of pavement-grooving locations in the Los Angeles area is shown in Table 1. In the before period (1 to 3 years), there were 515 wet-pavement accidents; in the after period (1 year or more up to 7), there were 76 wet-pavement accidents.

Pavement grooving is a solution to the problem of wet-pavement accidents caused by skidding on worn pavements. However, the grooving operation interferes with traffic on existing highways and is an additional expenditure of funds. One of our goals is the production of better pavement surfaces with wear-resistant qualities.

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