



National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

Log H-507

Date: March 24, 1988

In reply refer to: H-88-11

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Acting Administrator
Federal Highway Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

About 10:40 a.m. mountain daylight time on August 10, 1987, a 1986 MCI Grey Lines tour bus carrying 28 passengers was traveling westbound on U.S. 40 near Winter Park, Colorado. The tour bus was on a scheduled daily summer tour from Denver to Grand Lake, Rocky Mountain National Park, Trail Ridge Road, Estes Park, Lyons, Boulder, and back to Denver. As the bus descended the west side of Berthoud Pass, it was struck by a 13,640-pound boulder, which tore the right side of the bus open from the front door to the rear wheel well area. The bus stopped in the center of the eastbound lane about 279 feet beyond the point of impact. There were eight fatalities and four serious injuries. The busdriver was not injured.

U.S. 40 through Berthoud Pass is a three-lane highway in mountainous terrain. The collision occurred in the middle level of the double switchback at milepost 237.1, where two curves result in a three-level switchback. At the accident site, the asphalt pavement is 45.7 feet wide with a 3.1-foot shoulder and a 13-foot travel lane westbound and a 13-foot passing lane, a 13-foot travel lane, and a 3.6-foot shoulder eastbound. The westbound lane had a 4-percent downgrade.

In May 1987, two large boulders fell into a drainage ditch on the uphill slope of the mountain above the accident site. In July, a highway maintenance crew broke the larger of the two boulders into four smaller boulders by drilling holes and filling them with "Brightstar," a liquid that expands as it dries. The crew did not have enough "Brightstar" to break both large boulders and apparently never returned to break up the remaining boulder, which eventually was involved in the accident.

On the day of the accident, a Colorado Department of Highways Winter Park patrol maintenance crew was scheduled to clean drainage ditches. A crewmember drove an A66 Ford loader (front end loader) with a 2 1/2-yard bucket to the work site on the upper level of the first switchback. He placed "Men Working" signs in both directions and started moving boulders while waiting for the truck and traffic control crews to arrive. He had loaded and successfully moved two of the smaller boulders before he picked up the third (large) boulder, and drove the loader several hundred feet up the road, across a 70- to 80-foot fill section. He stopped at the edge of the fill section and looked down the bank to determine if the area could accommodate the boulder. He tilted the bucket, let the boulder slide out, and pushed it over the embankment.

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The maintenance worker stated that the boulder did not slide down the 214-foot fill section and stop like the two previous boulders, but instead rolled and bounced down the fill section and into the trees. Previously, other rocks that had rolled and bounced down the embankment had been stopped by the trees, so he proceeded to get another load of rock. However, the boulder involved in this accident was not stopped by the trees but fell another 511 feet down the side of the mountain, severing several 9 1/2- to 12-inch-diameter trees as it descended the 60-percent slope to the lower road. After being deflected by a 30-inch diameter tree, the boulder bounced on the edge of the westbound lane and crashed into the bus. The boulder traveled 138 feet along with the bus and came to rest in the westbound shoulder. The boulder's path downhill covered a slant distance of 725 feet and a vertical distance of 375 feet from its initial elevation of 9,725 feet.

On August 12, 1987, the Colorado Department of Highways issued a report on this accident. The report stated that it was normal practice for road crews to dump boulders in this area and that the practice had been routine for 20 years. This was the first reported incident of a boulder not having been stopped by the trees. Additionally, the report also stated that even if traffic control crews had been present, they would have stopped traffic only at the dumping level to protect the loader and trucks and not on the lower road where the accident occurred. The report made the following recommendations regarding the disposal of large rocks:

1. Deposit large rocks in wide areas currently available, that are level with roadway but farther than thirty feet away from traveled way.
2. When there is a possibility that a rock pushed over an embankment could damage persons or property, the traffic will be stopped temporarily in the affected area.
3. Bench dump areas in a way that will assure that rocks would not roll to any area not intended as dump areas.

On the day of the accident, the governor of Colorado appointed a board to investigate the accident. On August 21, 1987, the board issued a report to the governor, which contained recommendations for the Colorado Department of Highways in the following areas:

1. As a minimum, adopt the recommendations made by the Colorado Department of Highways Investigation Committee.
2. Map the mountainous areas of State highways and report on the general procedures established for pushing rocks over the edge of the highway.
3. Report the extent to which the mountainous area of State highways can be mapped and general procedures established for stopping traffic temporarily before a rock is to be pushed.
4. Where possible, backfill or ridge the dump areas for rocks to stop slides.
5. Immediately review any procedures for rock disposal which have been formally or informally adopted or implemented by mountainous states.

6. Review its safety procedures and re-examine and improve training of supervisory personnel so that all such personnel receive the same safety information.
7. All road maintenance personnel working in mountainous areas should attend training on highway maintenance safety and such training should be part of a continuing safety education program for all highway personnel.

The Safety Board concurs with these recommendations as interim measures but encourages the State of Colorado to formulate and implement longer-term improvements in rock removal and disposal. As part of the Safety Board's investigation of this accident, an informal telephone survey of some of the Western mountain states was conducted regarding their maintenance practices for rock removal and disposal. The results of that survey follow. Wyoming, Utah, and Idaho do not have specific policies on rock fall management or traffic control during rock removal. However, Nevada and California do have rock fall management policies.

In the late 1970s, Nevada started a program of rock fall management throughout the State. Accident records and areas of known rock fall were used to determine the sites for conducting preventive rock maintenance. Once a year, maintenance crews scale loose rock and haul it to the downhill side of the road. When scaling, the maintenance crews, at a minimum, close the lane on the uphill side and, if warranted, temporarily close the highway. The State has only a few switchbacks on State highways. On Interstate 80, near the California state line, sections of chain link fence are bolted to stable rocks along a cut section of roadway to retain the smaller rocks. New Jersey barriers are used along the shoulder edge to keep rocks off the roadway.

In California, traffic control during rock fall maintenance is not well-defined. Maintenance crews stop traffic when they think it is necessary. When they scale rock, the crews close at least the near lane. However, the State does try to anticipate the areas where rock removal will be necessary. In these areas, maintenance crews widen the bottom of the cut section, use telephone poles and railroad ties as bulkheads, and install New Jersey barriers and chain link fence. Environmental concerns make each dump site different and maintenance crews dump in fill areas and stream beds and use rock debris for erosion control on headwalls. The State has recently tried to set up a program to identify and mitigate rock fall areas, and the geology lab of the California Department of Transportation has published a report with the aid of the Federal Highway Administration, entitled "Rockfall Mitigation." This report defines a method to set priorities for capital outlay, and California hopes to fund some level of rock fall mitigation each year.

The "Rockfall Mitigation" report expresses the following concerns:

[The State recognizes that] the most direct way of minimizing rock fall is to use adequate design criteria and proper construction techniques in the design and construction of new slopes. However, California has 3,000 miles of highway where rock fall occurs. Therefore, a program designed to mitigate these problems is needed. The locations are too numerous and the total costs of mitigation are too high for this program to be completed in a short time. Thus, an ongoing program in which the sites are assigned a priority should be developed. Several types of information should be considered:

1. Maintenance costs, including removing rock from the roadway and the patrols needed to observe (and protect) the area.

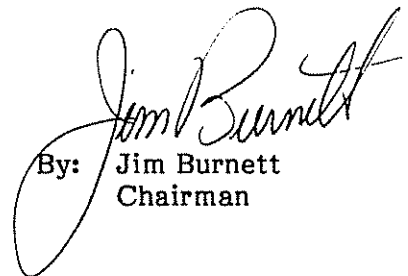
2. Degree of risk, including the frequency of fall and accidents at the site.
3. Estimated cost of mitigation.
4. Potential benefit from the repairs. For example, the repair of an isolated rock fall site could eliminate the need for part of the rock patrol. However, the repair of that same site if it were clustered with others would not reap the same benefit.
5. Importance of the route including the average daily traffic and the problems caused by blocking a lane for cleanup as well as the availability of detours if needed. 1/

Colorado and other mountainous States spend millions of dollars each year on rock debris removal. The Safety Board believes that safety benefits would be realized if these States adopted a systematic approach similar to the one developed in California for rock fall mitigation.

Therefore, the National Transportation Safety Board recommends that the Federal Highway Administration:

Issue a Technical Advisory to the various States that describes the circumstances of the accident near Winter Park, Colorado, on August 10, 1987, encourages the States to use a systematic rock fall management program, and stresses the importance of proper traffic control during maintenance operations. (Class II, Priority Action) (H-88-11)

BURNETT, Chairman, and LAUBER, NALL, and KOLSTAD, Members, concurred in this recommendation.


By: Jim Burnett
Chairman

1/ McCauley, M., Works, B., and Naramore, S., "ROCKFALL MITIGATION," Office of Transportation Laboratory, California Department of Transportation, Sacramento, California, FHWA/CA/TL-85/12, September 1985.