BAGGED CONCRETE, pinch batting for unavailable stone on Erie relocation project . . .

. . . Makes a "Hit" as Riprap

Man-Made "rocks," while still in a plastic state, were laid in rows, reinforced by driven dowels and tamped to a uniform thickness and relatively smooth surface by pneumatic compactors, thereby providing highly efficient embankment protection.

By W. R. Swatosh

Assistant Engineer
Erie, Cleveland, Ohio

• Out of a large construction project—a line change to eliminate grade crossings at Corning, N. Y. —has come a rather unusual but satisfactory solution of a problem frequently encountered in the maintenance of railway embankments—adequate protection against stream erosion during high water. To a great extent necessity mothered this solution.

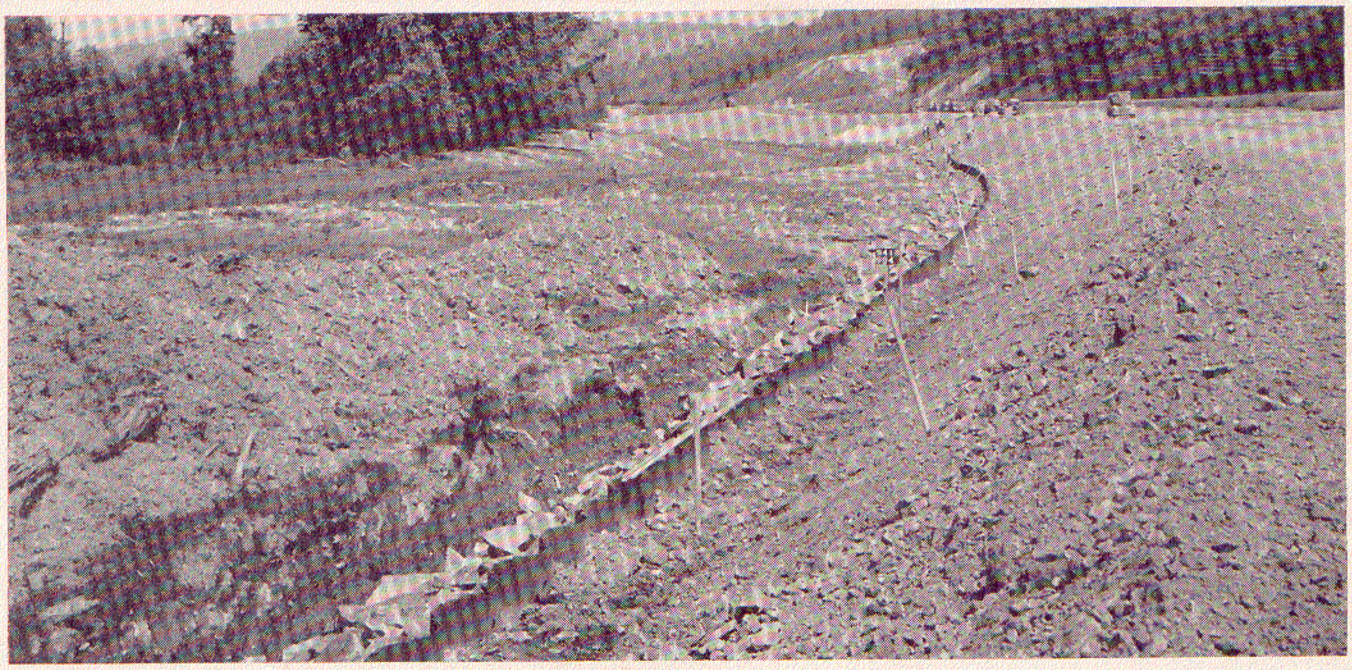
In the first place, the best location for our relocated tracks paralleled the Chemung river and Post creek on the east end and crossed the Cohocton and Tioga rivers on the west. Efficient embankment protection was essential in all these locations, at one of which the river flows almost directly toward the embankment by which the flow must be deflected.

In the second place, rock for riprap with which to pave these embankments was not available in substantial quantities in the vicinity. To import it from distant sources was too costly. Therefore, the engineers sought an economical substitute which would be as efficient as rock and easier to handle, if possible. The substitute finally decided upon was bagged concrete.

With this decision made, how could we satisfactorily anchor the toe of the bagged riprap? After considerable study, two methods were selected—one to be used where the toe of slope would normally be exposed to the direct flow of the water, and the other where it would not be so exposed. In the first method, 16-ft. Carnegie M-115, self-sustaining sheetpiling was driven 8 ft. into the ground and a rock-fill toe, approximately 4 ft. by 6 ft. by 10 ft. in section, was placed on the water side of the sheeting. In the second method the bagged riprap was anchored with toe walls consisting of rock-filled trenches approximately 3 ft. by 6 ft. in section.

Design plans for the bagged riprap indicated three typical slope sections on which it was to be placed—1 on 1¾; 1 on 2; and 1 on 2½. The plans also provided for the bags to be lapped a minimum of 12 in., and reinforced with ⅝-in. round dowels, 6 ft. long, driven through the bags on 16-in. centers.

In general the specifications adopted for the bagged concrete conform with those used by the New York Department of Public Works. They provided: (1) For the use of second-hand burlap bags (potato sacks) in good condition; (2) that each bag contain at least one cubic foot of slightly moist concrete thoroughly packed; (3) that bags were to be closed by tying, or some other approved method, so that the burlap would fold flat under the full width of the bag; and (4) that no interstices would obtain at the adjacent corners of the bags when they were laid and then tamped with heavy



1 **SHEETPILING was driven in accordance with the cross-section (4) shown on the opposite page to anchor the toe of the bagged riprap where it would normally be exposed to the direct flow of water. Elsewhere, rock-filled trenches sufficed**

wooden tampers to a minimum thickness of 9 in.

Strict adherence to these specifications was impossible. A scarcity of burlap precluded the procurement of the necessary 400,000 bags made of that material. However, cloth cement bags were available and tests indicated that these bags would meet the requirements. A cement bag which measures 28 in. by 12 in. when empty contains 1 cu. ft. when filled with concrete, and occupies a space 16 in. by 12 in. by 9 in.

To find a satisfactory manner of tying the bags various methods were tried. Hand sewing was discarded as being inefficient because of the high breakage of needles and lack of qualified seamstresses. A modified Bostitch stapler (Model C-63) was the final solution. To permit reasonably rough handling, 8 staples, ¼ in. long were used. An interesting sidelight to this solution was the debate over whether 7 or 8 staples were necessary. This appears to be a minor item, but it involved nearly half a million staples.

Tests were conducted to determine the proper moisture content of the concrete. Sample sections were placed having from 0 to 5 gal. of water added at the mixer. These sample sections were sprinkled and cured for 7 days under identical conditions. When they were broken at the end of that time it was interesting to note that no difference in appearance could be discerned. Continued testing developed that too little water in the mix led to segregation and "balling-up" of the concrete in the mixer, whereas too much water led to difficulty in placing and prevented satisfactory tamping in final position. It was finally concluded that a water content of approximately three gallons per bag produced the most satisfactory results.

Mixing Method

The concrete was mixed in the proportions of 1—2½—5. A central mixing plant using a 27E paver, which handled a 5½-bag batch (5 of portland cement and ½ of natural cement), was found to be the most efficient. The water content of 3 gal. per bag finally resolved into 15 gal. added at the mixer with slight variations due to the moisture content of the sand and small stone. The presence of natural cement was a major factor in the handling characteristics of the mix.

From the contractor's viewpoint the transportation of the concrete and the placing of the riprap were the keys to economy of operation. A special truck body was devised featuring a welded tail-gate sloping toward the front of the truck at a 45-deg. angle and equipped with short chutes and gates permitting three bags to be filled simultaneously at the site. Each of these truck bodies had a capacity of three batches.

The bags were filled and stapled at the top of the slope and allowed to slide down the embankment on wood skids to avoid disturbing the grade. In some instances tarpaulins were also laid on the slope to allow the bags to be rolled into approximate position. After being placed in final position by hand, the ⅜-in. dowels were driven and initial tamping and sprinkling begun.

The strength of the cloth cement bags permitted mechanical compaction of the riprap. For this purpose, an Ingersoll-Rand backfill tamper (Model No. 34) was used and produced a finished surface resembling slope paving. This mechanical tamping served to wedge the individual bags together and produced a uniformity that was superior to the customary hand tamping method using heavy wooden tampers prescribed in the specifications. In this manner a labor gang of 35 men mixed, transported, bagged, tied and placed an average of 600 sq. yd., or 4,000 bags, per day.

The finished product was cured by continuous sprinkling for a period of seven days. Soaker hoses and lawn sprinklers were used at various times experimentally, but the most satisfactory results were obtained from the use of a water truck or pump and a man with a 1¼-in. hose. Test cylinders which were taken periodically produced minimum strengths of 2,500 p.s.i. at 28 days.

To obtain a substantial job and at the same time secure protected slopes that were pleasing to the

2 **CONCRETE was delivered to the site in trucks equipped with special bodies designed to dump it into cement sacks . . .**

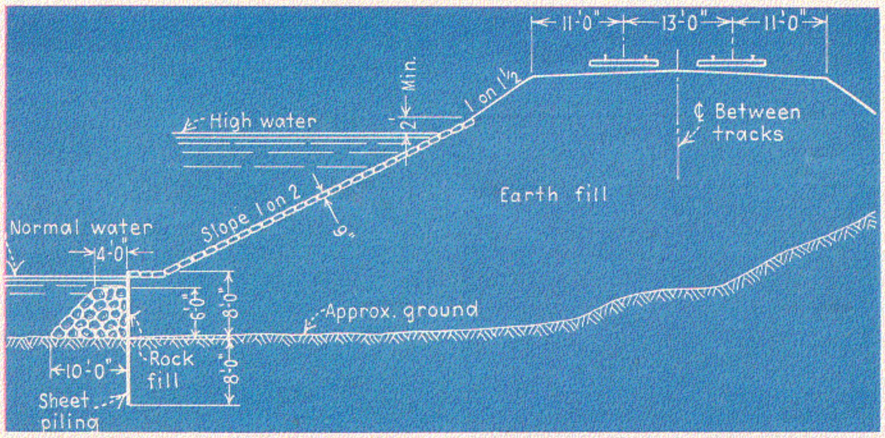
3 **. . . FILLED BAGS, stapled shut, were allowed to slide on wood skids down the embankment; then set on edge and tamped**

eye, a true, fine slope grade had to be carried at least 100 ft. in advance of the placement operation. To effect this a grade line was carried up the slope every 50 ft. If the slope distance was 30 ft. or more, an auxiliary line was carried longitudinally midway of the slope in addition to one each along the top and bottom. These lines were supported on stakes at 10-ft. to 15-ft. intervals to eliminate line sag and preclude errors in the calculation of grade.

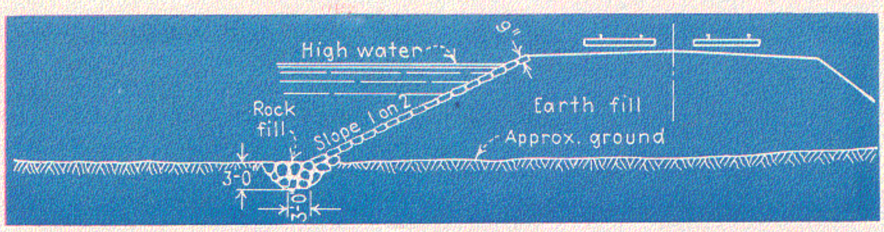
As each bag took the surface of the grade directly under it, this phase of the work was vital in securing a riprap surface that was smooth and true. Under no circumstances were the bags placed on a subgrade that was too wet, because under such conditions the movement of bags and men tended to force the earth down the embankment slope into ridges and hollows.

Next in importance in securing final surface uniformity was the use of pneumatic backfill tampers. The use of these tools made the difference between an average job and the superlative one obtained at Corning.

Where possible the bagged riprap was placed from the bottom to the top of slope in one continuous operation over an embankment area from 50 ft. to 100 ft. long. This made a better looking job than could have been obtained by carrying the lower half of the work, say for two or three days, and then returning and placing the top half. At Corning, this latter method was reserved for use in getting quick protection from high water, a necessity which did not materialize.



4 **FIRST METHOD—Employed wherever the toe of riprap started at normal water level**



5 **SECOND METHOD—Used where the top of slope is above the normal water line**

The placing of 56,500 sq. yd. of bagged riprap in this manner was only one of the many items of work involved in the elimination of Erie grade crossings in Corning all of which was carried out by Lane Construction Corporation as prime contractor under the direction of G. D. Helmer, project manager. The plans, specifications, and general conduct of the elimination project were approved and supervised by E. W. Wendell, deputy chief engineer of the New York State Department of Public Works, and I. H. Schram, chief engineer, Erie.

For their help in supplying data for this article the writer's appreciation is hereby extended to W. F. Bishop, New York State project engineer, and his associate, M. M. Bailey.