Tire-Anchored Timber Walls

In recent years, substantial interest in soil reinforcement has emerged. Soil (or earth) reinforcement is a technique by which members with high tensile resistance are embedded in a soil mass to enhance its strength and stability. Facing elements of various designs, materials, and configurations are attached to the embedded reinforcement at exposed surfaces to prevent raveling of material.

California has long been interested in and has recognized the potential for soil reinforcement, and the California Department of Transportation (Caltrans) has researched and experimented with several designs. One such design incorporates used automobile tire sidewalls normally considered a waste material. The end result is an economical, functional, and aesthetically pleasing soil reinforcement system.

Problem

The economical construction and maintenance of stable slopes within limited rights-of-way, or at locations with other physical restrictions, has been a continuous concern. In the past, conventional concrete retaining walls were constructed to eliminate fill slopes or accommodate steeper-than-normal slopes. However, the cost of constructing concrete retaining walls has been steadily increasing. Soil reinforcement provides an economical alternative because of reduced material cost and ease of construction. This technique also provides opportunities for innovation.

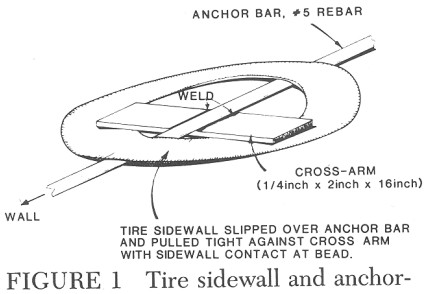


FIGURE 1 Tire sidewall and anchor-bar assembly.

Solution

Prompted in part by legislation passed in California on the recycling or disposal of used tires, the use of tire sidewalls in a reinforcement was originally conceived during a Caltrans federally financed research study in 1973. Laboratory tests indicated that the inclusion of certain high-strength, non-biodegradable materials such as tire sidewalls increased the strength of soil masses. The results of the study showed that embankment construction using discarded automobile tire sidewalls as reinforcement not only provided the beneficial effect of mechanically increasing the embankment's static and dynamic stability, but utilized a non-biodegradable waste product and reduced right-of-way requirements and fill construction costs by permitting steeper fill slopes. The success of this research and an experimental embankment project led to the development of the tire-anchored timber wall system.

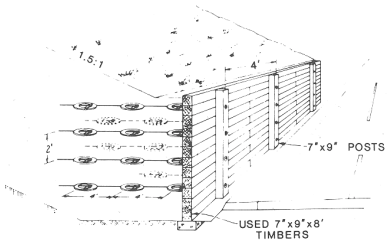
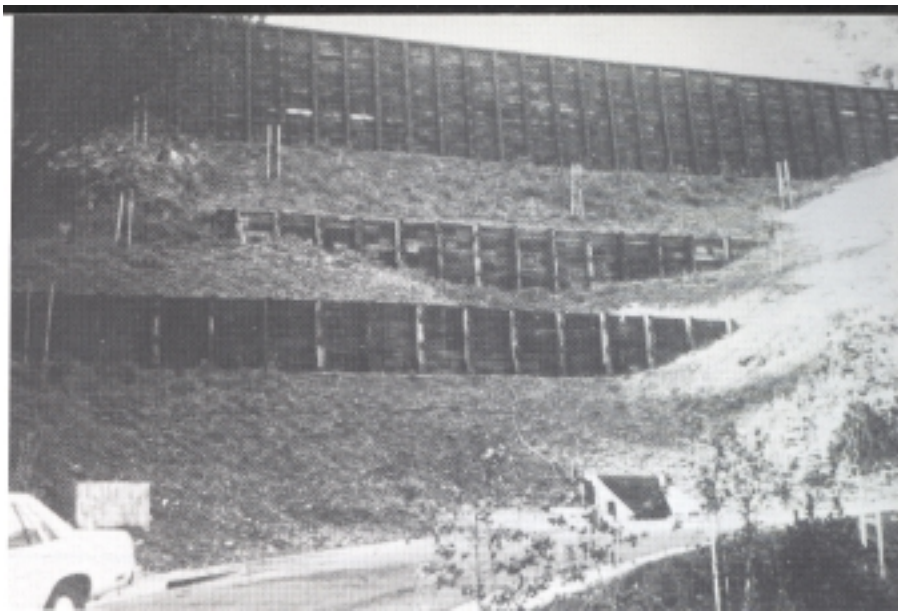


FIGURE 2 Oblique drawing of the tire-anchored timber wall.

The tire-anchored wall system is composed of tire sidewalls from used automobile tires. The tires are cut at the shoulder to obtain the sidewalls. The tread portion can be salvaged for possible use elsewhere as shoe soles, bumpers on boat moorings, rubbing rails in amusement parks, or as an asphalt additive. The tire sidewalls are attached to the tieback elements as shown in Figure 1. The cross-arm, welded to the tiebar, reacts against the tire bead to provide a positive grip. High-traction forces are developed by the action of the compacted soil on the sidewall's large exposed surface area.

In the development of the initial experimental tire-anchored wall, Caltrans used railroad ties that were laid horizontally and supported with the tire-anchor bar assemblies fastened to vertical timbers (Figure 2). Structurally sound, used railroad ties with three unmarred sides and adequate creosote



treatment were specified to satisfy the design life. The railroad ties were placed on a nonreinforced concrete leveling footing, but were not fixed to the footing in order to allow for movement.

Application

The tire-anchored timber wall design was first installed by Caltrans on a road-widening project on CA-203 in Mammoth Lakes, California. The project was advertised and awarded in 1981. The successful low bid was $22 per square foot, which included labor, materials, and equipment for excavation, backfilling, and erection. Wall costs for reinforced concrete, concrete crib, and a commonly used proprietary soil reinforcement system were estimated by Caltrans at $50, $35, and $30 per square foot, respectively.

Because a wall of this type had not been constructed previously, the highest of two walls constructed was instrumented through a federally financed research project to monitor performance. To date, the wall is performing satisfactorily, even under extreme rainfall conditions and earthquake activity. Futhermore, the timber facing blends well with the mountain resort architecture.

Benefits

On the basis of the success of the initial installation, the California Department of Transportation has installed tire-anchored timber walls in several other locations. Subsequent research and experimentation have resulted in the development of a soil reinforcement technique with significant economic benefits. Recent figures indicate an approximate cost savings of $10 per square foot of wall compared to the cost of a standard concrete cantilever wall. This tire-anchored wall system has also resulted in increased competition among soil reinforcement systems and in reduced costs of all systems.

Because of the difficulty of obtaining unmarred railroad ties, Caltrans now specifies new timber where aesthetics are important. However, the Department is also experimenting with the use of 6-foot timber posts obtained from the removal of guardrail installations.

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