Reconstruction of Failed Roadway Embankments Using Tire-Derived Aggregate Mechanically Stabilized Earth Walls – Ortega Ridge Road Case Study

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ABSTRACT

This paper describes the design methods used for mechanically stabilized tire derived aggregate (MSTDA) walls in the context of a real-world pilot project reconstructing a failed County road embankment on Ortega Ridge Road near the town of Summerland, California. Roadway repairs using either lightweight fill or mechanically stabilized earth (MSE) walls are common techniques to address roadway embankment failures. This paper presents a case study in the use of a hybrid method for roadway embankment repair including both lightweight fill made of tire-derived aggregate (TDA) and geosynthetic reinforcement to create a MSTDA wall supported roadway.

TDA is an environmentally friendly, low-cost lightweight fill option, which has not been widely used due to the unfamiliarity of its unique design and installation methods by agencies, designers and contractors. The California Department of Resources Recycling and Recovery (Cal Recycle) has been working to overcome barriers to the increased use of TDA by collaborating with local agencies on pilot projects and making available TDA grants to agencies in order to demonstrate is effectiveness. This pilot project on Ortega Ridge Road near the Town of Summerland, CA combines the load reduction of lightweight fill with the strength of a mechanically stabilized earth (MSE) wall. The use of MSTDA provides a cost-effective, resilient method to repair slopes and embankments while also helping divert from landfills the over 40 million tires discarded in California each year.

INTRODUCTION

With a low density of approximately 720 kg/m^3 (45 lb/ft^3), TDA exerts about half the earth pressure of traditional earthen fills. TDA has a relatively high shear resistance (ϕ=35°) and permeability is greater than 1 cm/sec (24 in/min), which allows installations to drain effectively, reducing loading on the underlying earthen materials. These qualities make it well suited for landslide mitigation and reducing the rate of creeping and soil sloughing in failing embankments.

THE ORTEGA RIDGE ROAD MSTDA PILOT PROJECT

Ortega Ridge Road was originally constructed in the 1950s, and had the profile raised in 1969, and has experienced episodic settlement of the road surface and supporting embankment for the past several decades. Poor construction materials (expansive shales) and inferior construction methods of the approximately 7.6 m (25 FT) high earthen embankment led to creeping of the soil and failure of the roadway surface due to expansion-contraction cycles, which cracks and settled the roadway surfacing more than 76 cm (30 in) over the decades. In 2017, the County closed the road temporarily due to significant settlement in order to construct a temporary roadway realignment in order to reopen the road to one lane of traffic. CalRecycle and the County met and agreed that this project site would be an excellent candidate for a pilot project to demonstrate the hybrid use of TDA within an MSE wall design, and began collaborating on the design and funding of the project.

Combining load-reducing TDA and geosynthetic reinforced MSE wall retaining units at this site allowed the County to construct a cost-effective long-term repair, with a smaller project footprint than traditional slope reconstruction techniques, while reducing the loading on the underlying expansive shale embankment. A 4.5 m (15 FT) high MSTDA wall with 0.9 m (3 FT) of toe embedment and a 72° wall batter, with geosynthetic reinforcement embedded 4.5 m (15 FT) into TDA fill at 0.45 m (18 in) vertical spacing.

<u>Photo 1.</u> (Left) Arcuate cracking and failure of roadway surface prior to temporary realignment.

<u>Photo 2.</u> (Right) Installation of MSE Wall using TDA lightweight backfill (MSTDA)

Construction began in late May 2019 and finished July 2019. The contractor completed the project on schedule and within budget. GHD, Inc. and CalRecycle installed geotechnical instrumentation within the TDA for continual monitoring of the loads experienced within the TDA. The County installed a survey monument at the top of the wall to measure settlement and deflections within the roadway, wall and underlying embankment slope over time.

CONCLUSION

MSTDA walls are a cost-effective alternative to traditional methods of mitigating landslide and soil creep causing roadway and embankment failures. Design methods are nearly identical, with minor adjustments to account for material type. Construction uses traditional methods with minor modifications due to the method of placement and compaction of the TDA material. TDA is a lower cost alternative lightweight fill, can achieve higher factors of safety than denser materials, and provides the environmental benefit of diversion of tires from landfills. Agencies should consider the use of MSTDA walls as an effective alternative to traditional slope repair methods.