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Closure to the Discussion of "Long-term Performance of a Highway Embankment Build with Lightweight Aggregates"

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The authors thank *Dr. Diyaljee* for his interest on the subject and providing assessments based on the two research articles (Saride et al. 2010 and Puppala et al. 2017). Authors appreciate the comprehensive analysis done in the discussion. Following the comments noted in the discussion, we would like to provide our explanations on the discussion.

As reported in the present article (Puppala et al, 2017), the actual height of the embankment is 9.0 m. The embankment height was mentioned as 6.0 m in the Fig. 2a of Saride et al (2010) and we regret the error and thank the discusser for pointing out. It should be mentioned that the FEM analyses of the same paper (Saride et al. 2010) as shown in Fig. 10 incorporated correct geometry details of embankment height and upper pavement layers. A detailed cross-section of the ECS embankment with slope and inclinometer details is presented here in Fig. 1 for clarity and further analysis.

It should be noted that, the vertical inclinometer No. 2 (VI-2) was advanced through the ECS embankment layer and terminated at about the mid depth (~3.0 m) of underlying clay layer as shown in Fig. 1. The intention was to measure the relative lateral movements in the ECS layer resulting from the traffic operations. Since the ECS is a lightweight granular material (pea gravel type) lateral movements are possible.

Lateral movement of VI-2:

In reference to Fig. 8b (Puppala et al. 2017) and Fig. 4b (Saride et al. 2010) –

As the thickness of the ECS fill is 9.0 m, and the embedment depth of VI-2 is about 3.0 m in the foundation soil (clay layer), it only suggests a possible rotation of the inclinometer with a fixity at the interface of ECS fill and clay layer. This is also apparent from the inclinometer's data for about 5.5 years as reported in Fig. 8b (Puppala et al. 2017) and Fig. 4b (Saride et al. 2010). The ECS material, being lightweight with a near zero cohesion component, offers limited confinement to the movement of the inclinometer. Hence, the point of inflection is not observed at the interface as postulated by the discusser.

It is also evident from the Figures that the erosion of top 1.0 m thick clay cover along the slope resulted in sliding of the access slab over the clay cover, which ensued in excess movement of the inclinometer over the top 1.0 m. The physical movement of the access slab (up to 120 mm), towards down the slope, with reference to the pavement can be seen in Fig. 1 (inset, Zone B). It is also important to note that the ECS is a free draining material with a coefficient of permeability (k) of 0.88 m/day and combined with deep ground water table at the site (typical in North Texas conditions), unsaturated conditions prevail here and would not cause any excess pore water pressure at the interface of ECS and clay cover (Zone A of Fig. 1). Hence, the soil erosion is noted only at the interface of the top clay cover and the base of the access slab due to ingression of rainwater surface runoff through the gaps as shown in the Fig. 1.

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Also, the foundation clay medium being a moderate compressible clay layer with a compression index (Cc) of 0.27 supporting a lightweight embankment section, would not have experienced excess settlements to cause a lateral (horizontal) movement in VI-2. We also did not observe any slope stability issues at the site.

Overall, in authors' opinion, the movement of the inclinometer is mostly due to the movement of the access slab due to soil erosion at the interface. We also note that a relative low lateral movement of the ECS material from traffic loading may contribute to the lateral movements and this quantification is not considered here due to lack of such information. We agree with discusser that more instrumentation at the site would have certainly improved the understanding of the behavior of ECS material at the surficial condition. We thank discusser for insights into the practical aspects of the project covered in the paper.

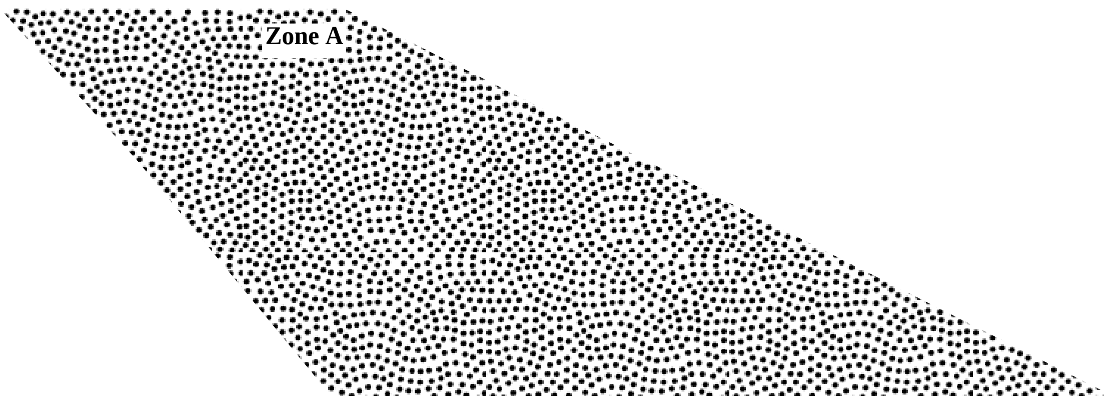

Figure. 1 Cross-section of ECS fill embankment showing slope and inclinometer details

References

Saride, S., Puppala, A.J., Willammee, R., and Sirigiripet, S.K. (2010). "Use of Lightweight ECS as a fill material to control approach embankment settlements." J, Mater. Civ. Eng., Vol. 22, No. 6, 607-617.

Puppala, A.J., Saride, S., Yenigalla, R.V., Chittoori, B.C.S., Archeewa, E. (2017). "Long -Term Performance of a Highway Embankment Built with Lightweight Aggregates." J, Mater. Civ. Eng., 10.1061/(ASCE)CF.1943-5509.0001043.