A pavement can exhibit different types of damage that can lead to failure such as permanent deformation, which can be associated to:

- Asphalt concrete layer
- Coarse aggregate layers
- Subgrade soil

In Costa Rica, this research project corresponds to the first study focused on permanent deformation for granular materials and soils.

Currently there is no international entity that defines an official test protocol to evaluate permanent deformation of unbound materials.

The triaxial chamber is placed with the specimen in a loading frame (UTM-25) capable of applying dynamic forces and confining stresses. To perform the test, three confining stresses with three deviator stresses varying every 5,000 load cycles were defined. In order to optimize the test time and the amount of material required for testing, a stepwise test procedure was implemented.

Where $u_i$ represents the unobservable effects that differ between samples but not in time, $e_{it}$ refers to purely random error, and $\beta_i$ are the calibration parameters.

Generalized Least Squares (GLS) Where $\beta_i$ is the plastic strain (dimensionless), $N$ is number of load cycles, $\sigma_d$ is the deviator stress in kilopascals, $\sigma_3$ is the confining stress in kilopascals, % $w$ is moisture content, $\beta$ are calibration parameters, and $\alpha_i$ are unobserved factors that are not captured by the model.

Figure 3 shows an example of the representative cumulative permanent deformation trends for all the 8 materials, where P4-P10 are the codes assigned to each test specimen.

SUMMARY AND CONCLUSIONS

- Significant changes due to low moisture variations were observed mainly in cohesive materials.
- Even though materials might have similar classifications, they can exhibit significantly different behaviors.
- Based on the developed permanent deformation predictive models, it was found that Panel Time Series Analysis was more accurate than the multiple linear regression (OLS), which is the method used to traditionally estimate the permanent deformation models.
- The Random Effects model predicts the data more efficiently and can be estimated in a probabilistic manner since the intercept term is assumed to follow a normal distribution.