International Journal of Research in Engineering, Science and Management
Volume-2, Issue-4, April-2019
www.ijresm.com | ISSN (Online): 2581-5792

Analysis of Bridge Embankment using Plaxis 2D

Navnath Shinde[1], Mitansh H. Agrawal[2], Paresh Patil[3], Asif Bhure[4], Ankit Badjate[5]
[1]*Assistant Professor, Department of Civil Engineering, MET's Institute of Engineering, Nashik, India*
[2,3,4,5]*B.E. Student, Department of Civil Engineering, MET's Institute of Engineering, Nashik, India*

***Abstract*: EPS Geofoam can be used to support highway bridge structures without the aid of deep foundations. The development of this technology is important to accelerate construction of soft compressible soil. EPS Geofoam allows for the rapid construction of bridge foundations on such soil without the time and cost involved in installing rational foundation. Because EPS Geofoam is extremely light weight fill, it can be used to avoid settlement impact on bridge approaches. This paper includes the comparison of EPS Geofoam and traditional filling material (murum) with respect to their settlement rate and economy.**

***Keywords*: EPS, Plaxis 2D, Geofoam, Embankment**

1. Introduction

EPS Geofoam has been used for about 40 years in many geo-technical applications in many countries around the world. It is an extremely low density, a high strength two weight ratio and gives very small lateral expansion under compressive loading. The extremely light weight nature of EPS allows for rapid embankment construction on soft ground conditions without causing damaging settlement to deep foundation, bridge structure and approach pavements. Geofoam is a geo polystyrene made from expanded type of polystyrene, expanded polystyrene is a very stable compound chemically and no material decay happens in it when placed under load, expanded polystyrene (EPS) IS successfully used as a construction material in the field of geotechnical engineering for the last decades, sue to its wide variety of application such as compressible inclusion in retaining wall and light weight fill material in embankments.

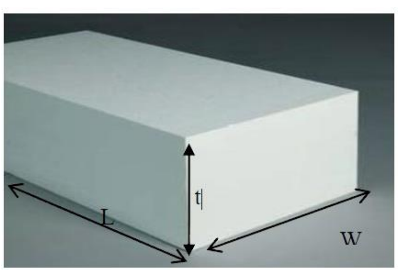

Fig. 1. EPS

Expanded polystyrene (EPS) Geofoam is rigid cellular plastic foam that has been used in a wide range of geotechnical application including rapid construction of embankment over compressible soil, slope stabilization bridge abutment, slope stabilization reduction of static and dynamic lateral loads on retaining walls and bridge abutments as a sub-base fill). EPS composite soil with its physical and engineering properties has been studied with numerical solution. Due to its special inherent properties like low density; low permeability and different mechanical behaviour, the EPS Geofoam is extensively being used in geotechnical applications.

2. Methodology

In this section, the full scale test performed by using plaxis 2D. Plaxis is a finite element program, developed for the analysis of deformation, stability and groundwater flow in geotechnical engineering. It is a part of the plaxis product range, a suite of finite element programs that is used worldwide for geotechnical Engineering and design. The same geometry and load step is used as that of the full scale test. EPS Parameters is obtained from the simulation by adjusting the output from plaxis until a reasonable fit is obtained to the full scale test result. The procedure and output are shown below.

Step-1 and *Step-2* consist of general details regarding the project those have to input before creation of geometry.

Step-3 Geometry input and details:

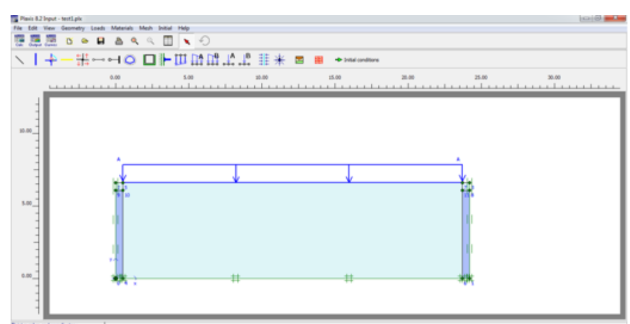
Fig. 2. Modelled Geometry

A 24.2 m by a 6.59 m high embankment is used as a geometry input. Plain strain condition with a fine mesh of 15-noded triangular element is applied for the simulation.

Apply the soil properties as given in your project.

Step-4) Assigning Material properties:

Applying the material properties as shown in table below to modelled geometry, the EPS materials properties are referred from reference no-9 and the Murum properties are obtained from ongoing site at Vilholi junction vehicular underpass in Nashik district Maharashtra State. The parameters play an important role in the calculation stages so the value should be added properly without any errors. There are many material model in it like Mohrs Coulomb, Soft soil creep model and hard soil creep model, etc.

Table 1
Parameters of materials

Material Parameters For Plaxis Input				
Parameter	**Name**	**Materials**		**Unit**
		EPS29	Hard Murum	
Material model	Model	MC		
Types of material behavior	Type	Drained	Drained	
EPS unit weight	ϒ(unsat)	18.4	18	KN/m^3
	ϒ(sat)	18.4	18	
Poisson's ratio un/reloading	ν_{ur}	-	0.15	-
Friction Angle	φ	30	30	°
Cohesion	C	35	0.42	KN/m^2
Dilintancy Angle	ψ	0	20	
Stiffness strength	E_{Ref}	6000	707.1	KN/m^2
Alternative strength	G_{Ref}	3000	307.42	
Velocities	v_s	39.970	12.94	m/s
	v_p	56.530	20.16	m/s

Step-5 Mesh Formation:

After applying the material properties based on the parameter input the initial stress would be obtained and based on that initial mesh would be formed which shows the structure of model as shown in figure below.

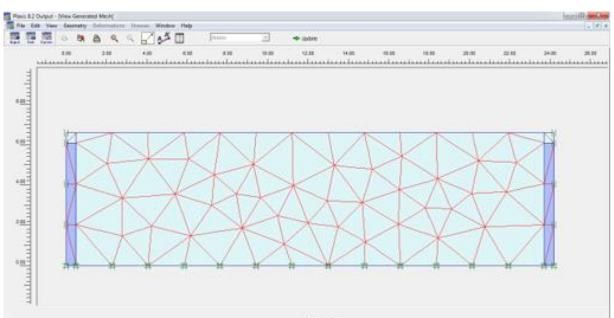

Fig. 3. Initial Mesh

Step-6 Calculation Stage:

This stage requires the input parameters like Multiplier, Number of Steps and Number of days for which the result is to be obtained.

Step-7 Output Stage:

After performing the analysis using plaxis 2D the settlement for EPS it is 22.52 mm and for murum 180.32 mm. The output obtained would be in the form of deformed mesh, vertical displacement, horizontal displacement, stress, strain. The deformed mesh can also be display in contour lines and shadings.

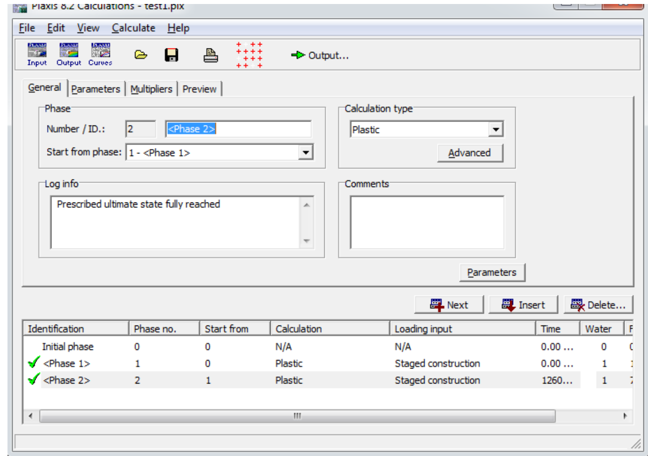

Fig. 4. Calculation

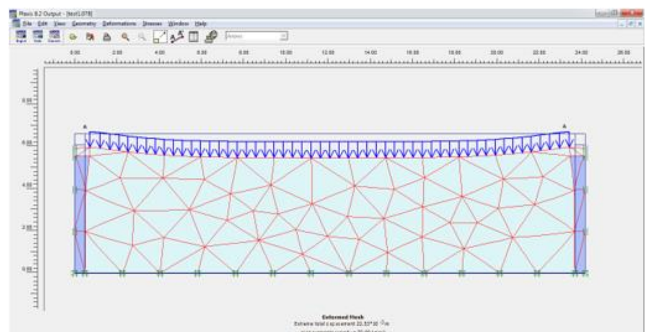

Fig. 5. Output of EPS

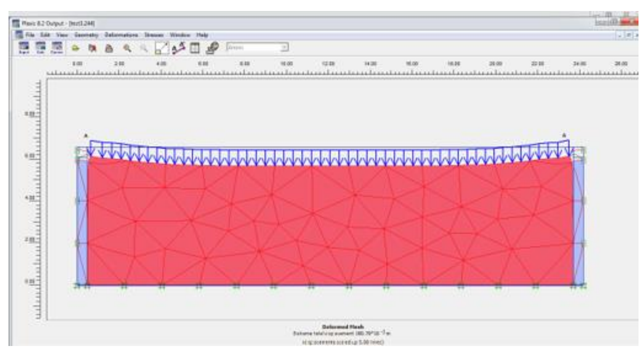

Fig. 6. Output of Hard Murum

3. Comparison of test results for murum and EPS

After undergoing the test for settlement on plaxis 2d and using the parameters from given Table 1, after the calculation stage the settlement value obtained for EPS geofoam was found to be 22.52*10^3 m (22.52 mm) while that of murum was found to be 180.32*10^3 m (180.32 mm). There is large difference between settlements caused due to load on murum and EPS geofoam. The output mesh of the EPS and murum is shown in fig. 5 and 6, using the calculated data the graphs are calculated against the time, step, displacement and multiplier.

The graphs obtained after conducting the test are given below.

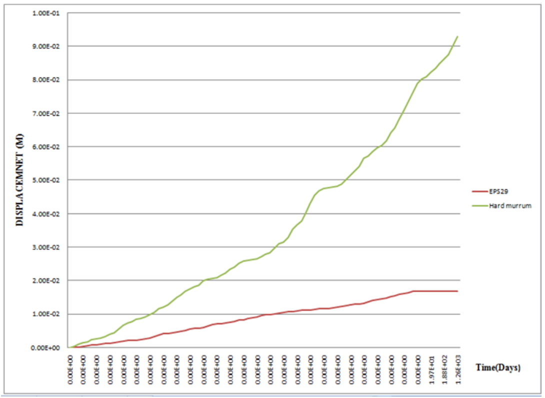

Fig. 7. Graph 1. Time (days) vs. Displacement

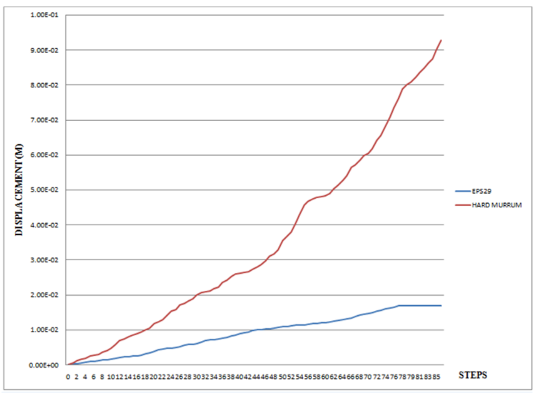

Fig. 8. Graph 2. Steps vs. Displacement

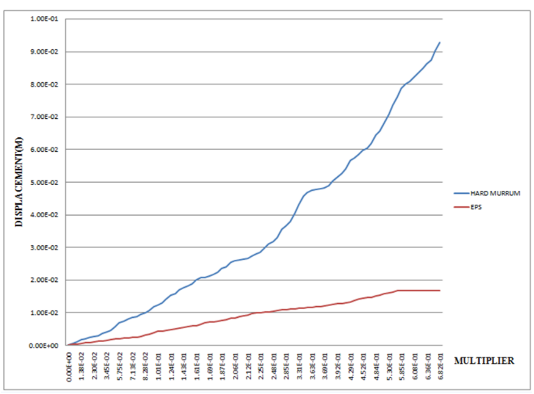

Fig. 9. Graph 3. Multiplier vs. Displacement

4. Conclusion

The settlement values after performing analysis using plaxis 2d are found to 180.32 mm for hard murum and that for the EPS Geofoam it is 22.52 mm. Result obtained from the analysis shows that settlement is more in case of murum as it is less in case of EPS, so there is more difference in settlement value between both the materials. The cost of EPS Geofoam is 4000/- per cubic meter and the cost of murum is 3100/- per cubic meter. Though the basic cost of EPS Geofoam is high but considering other factors like transportation cost, no compaction cost required, machineries, and availability of material, it makes the EPS Geofoam feasible and economical for long term consideration is concern.

Acknowledgement

We are thankful to Prof. N. T. Shinde for his valuable guidance throughout the research. We are also thankful to Prof. K. S. Chobe (HOD) of our Civil Department.

References

[1] EDO, (1992) “Expanded Polystyrene Construction Method,” Riko Tosho Publishers, Tokyo, Japan (in Japanese).
[2] Fransworth, C. B., Bartlett, S. F., Negussey, D. and Stuedlein, A. W. (2008) “Rapid Construction and Settlement Behaviour of Embankment Systems on Soft Foundation Soils,” Journal of Geotechnical and Geo-Environmental Engineering, ASCE, March 2008.
[3] Gao, H., Liu, J. and Liu, H. (2011) “Geotechnical properties of EPS composite soil,”. International Journal of Geotechnical Engineering.
[4] Hararika, H. (2006) “Stress-strain modelling of EPS Geofoam for large strain applications,” Geo-textiles and Geo membranes.
[5] Padade, A. H. and Mandal, J. N. (2012) “Feasibility Studies on Expanded Polystyrene (EPS) Geofoam,” International Conference on Ground Improvement and Ground Technique, IGCI-12, Oct 30 – Nov 2, 2012, University of Wollongong, Wollongong, Australia. (Paper Accepted for Publication)
[6] Stark, T. D., Horvath, J. S. & Leshchinsky. D. (2004) “Geofoam Application in Design and Construction of Highway Embankments,” Transportation Research Board, Washington, D.C., USA, NCHRP Web Document.
[7] Frydenlund, T.E. and Aoboe R, (2001). “Long term performance and durability of EPS as a lightweight filling material.EPS 2001, Salt Lake City, Utah.”
[8] NPRA (1992): “Use of expanded polystyrene in road embankments” Norwegian Public Roads Administration, Norway, August 1992.
[9] EPS Geofoam Application and Technical Data by EPS Industry Alliance.