Experimental Investigation on Geo-Synthetic Reinforced Soil Slope for RESA

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***Abstract*: There have been many air crashes in our country due to improper design and safety measures in the runway end. Air India Express Flight 812 from Dubai to Mangalore crashed while landing at the Mangalore airport on 22 May 2010, overshot runway on landing fell over cliff and caught fire, spreading wreckage across the surrounding the hill side. The aircraft overrun while landing and takeoff can be avoided by providing a safety area beyond the end of runway.**

Here in our project attempt has been made to conduct experimental investigation on geo synthetic reinforced earth to increase the strength at RESA and our study area is Mangalore international Airport, Bajpe.

***Index Terms*—Runway end safety area, reinforced earth, geogrid, paralink.**

I. INTRODUCTION

From year 2005 to 2014, 48% of fatal accidents occur during final approach and landing phases of the plane. 13% of the fatal accidents occur during the take-off and climb phases of the plane. Regarding to the on-board fatalities for the same year interval, 38% and 10% during the final approach and landing and take-off and climb phases respectively (Boeing 2015, Statistical Summary of Commercial Jet Airplanes accidents, Worldwide Operation 1959-2014). Recently, Federal Aviation Administration (FAA) standards for Airports require runways to include a runway safety area (RSA). According to FAA definition, RSA is a graded and clean area surrounding the runway that “should be capable, under normal (dry) conditions, of supporting airplanes without causing structural damage to airplanes or injury to their occupants”. Its purpose is to improve the safety of airplanes during landing and takeoff. The size of the RSA depends on the type and size of aircraft using the runway.

A. Runway End Safety Area (RESA)

A runway safety area (RSA) or runway end safety area (RESA) is defined as "the surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of undershoot, overshoot, or excursion from the runway.

B. Runway strip

The runway strip is defined as the ground area surrounding the runway and stop areas in order to reduce the damage associated with potential (longitudinal and lateral) overrunning. It does so by providing an area levelled according to certain surface slope and strength requirements. As the strip is clear of obstacles, it also protects aircraft overflying it during failed take-off and landing operations.

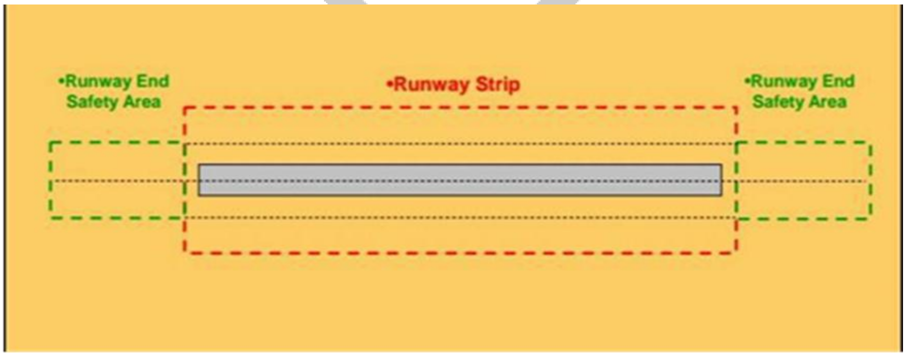

Fig. 1 Plan of RESA

C. Reinforced Earth

In 1966, Henry Vidal introduced ‘Reinforced Earth’ technique based on his extensive analytical and experimental studies. Since then, this concept has attracted the attention of practicing engineers and researchers all over the world. Though, the concept of reinforced soil is simple, the technique has not yet been fully exploited. At present, it is possible to adapt reinforced soil technique for earth retaining structures very effectively.
Reinforced earth is a composite construction material in which the strength of the earth fill is enhanced by the addition of tensile reinforcements in the form of metallic bars, strips or polymeric sheets or grids. One of the potential fields of application where the

reinforced soil proves to be effective alternative to conventional ground improvement techniques is in the improvement of bearing capacity and reduction in settlement of weak soils.

II. OBJECTIVE

- To analyze the properties of soil selected.
- To check alternatives to improve the soil strength.
- To improve the strength of soil by reinforcement of geosynthetic.
- To analyze the variation in strength with change in depths of reinforcement.

III. METHODOLOGY

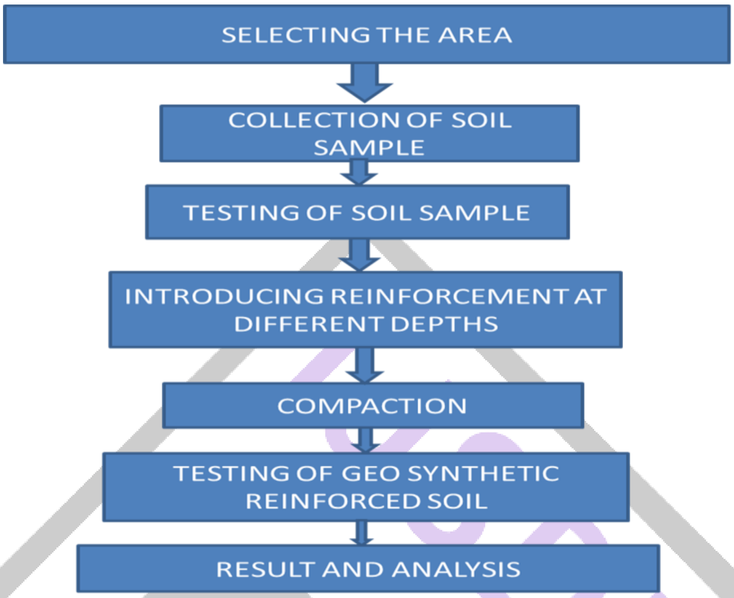

Fig. 2 Flow chart

IV. TESTING OF SOIL SAMPLE

Various tests are conducted to determining the physical properties of given soil.

Sl. No.	Test conducted		Result
1	Initial moisture content (%)		12.88
2	Specific gravity		2.448
3	Liquid limit (%)		44
4	Plastic limit (%)		40
5	Shrinkage limit (%)		13.84
6	Sieve analysis	Uniformity Coefficient, Cu	13.04
		Coefficient of Curvature, Cc	1.39
7	Classification of soil as per USC (ASTM-2487)		Poorly graded sand with gravel (SP)
8	Optimum moisture content (%)		17
9	Maximum dry density (gm/cc)		1.89
10	Field density by core cutter method		1.533
11	Coefficient of Permeability (cm/sec)		8.922×10^{-6}

Table 1 Properties of soil

V. SOIL REINFORCEMENT WITH GEOGRID AND PARALINK INCLUSION

Soil Reinforcement is the process of improving the engineering properties of the soil and thus making it more stable. It is required when the soil available for construction is not suitable for the intended purpose.
When a project encounters difficult foundation conditions, following possible alternatives can be considered;

- Avoid the particular site.
- Design the planned structure accordingly.
- Remove and replace unsuitable soils.
- Attempt to modify the existing ground.

In its broadest sense, Reinforcement includes compaction, pre-consolidation, drainage and many other such processes. However, the Reinforcement is generally restricted to the strength properties.

Objectives of Soil Reinforcement

The process of soil reinforcement has the following applications,

- Reducing the permeability of soils.
- Increasing the bearing capacity of foundation soils.
- Increasing the shear strength of soils.
- Improving the durability under adverse moisture and stress conditions.
- Improving the natural soils for the construction of highways and airfields.
- Controlling the grading of soils and aggregates in the construction of bases and sub bases of the highway and airfields.
- Reduce distortion under stress (Increase stress-strain modulus).
- Reduce compressibility (volume decreases due to a reduction in air voids or water content under loads).
- Reduce susceptibility to liquefaction.
- Reduce natural variability of borrow materials.

Materials used

A. Geogrid

A Geogrid is geosynthetic material used to reinforce soils and similar materials.

Types of Geogrids

- Uniaxial geogrids
- Biaxial Geogrids

Uniaxial Geogrids

These geogrids are formed by the stretching of ribs in the longitudinal direction. So, in this case, the material possesses high tensile strength in the longitudinal direction.

Biaxial Geogrids

Here during the punching of polymer sheets, the stretching is done in both directions. Hence the function of tensile strength is equally given to both transverse and longitudinal direction.

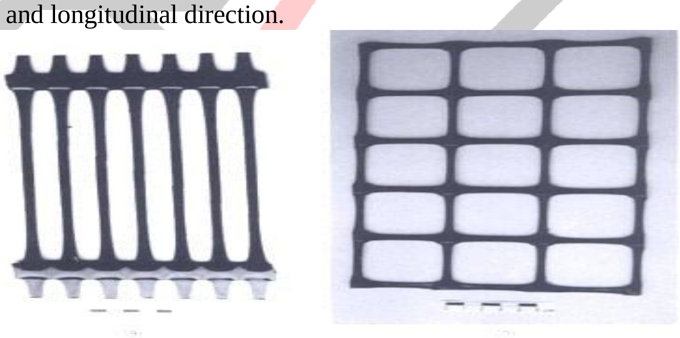

Fig. 3 Geogrid

B. Paralink

ParaLink™ products are unidirectional high strength geogrids manufactured from ParaWeb™. They consist of strips laid parallel and close to one another with lower strength cross members maintaining the distance between them. The joints are made by thermal bonding of the sheaths. The product number represents the strength in the machine direction in kN/m. Special products can be supplied with different strengths.
Each single longitudinal strip has a core of high tenacity polyester yarns tendons encased in a polyethylene sheath; the single strips are connected by non-resisting cross laid polyethylene strip that gives a grid like shape to the composite.

Fig. 4 Paralink

VI. RESULT AND DISCUSSION

The inclusion of Geogrid and paralink into the soil has to improve the bearing capacity of the soil.
The increase in the bearing capacity of soil in this project is observed in terms of reduction in the soil settlement.
The present project includes observations and discussions of the experiments carried out to examine.

- Improvement of bearing capacity
- Settlement reduction

Procedure for preparation of reinforced soil model

- Subgrade is prepared first below the loading frame over which reinforced soil model is to be constructed.
- Prepare the subgrade of size 1m x 1m x 0.6m by compacting it in 3 layers with 50 blows per layer using a rammer of 11.5 kg at optimum moisture content (OMC).
- Place geogrid over the sub grade and then place the soil over it and compact the soil of thickness 150mm.
- After the first layer of geogrid reinforcement soil place the paralink as a second layer.
- Paralinks will be placed properly by using wooden pegs. Over the paralinks place the next layer of soil and compact it at OMC.
- Place the geogrid and paralinks as a alternative layers and compact the soil.
- Steel plate of size 12" x 12" x 1" is placed on the model to transfer the load to determine its bearing capacity and settlement.
- Apply the load for each layer of compacted soil.
- At the beginning 0.1 ton of load is applied and the settlement is recorded, when the rate of settlement is less than 0.002mm/min.
- Further the loading of 0.5 ton, 1 ton and so on up to 3 tons is applied and settlements are checked respectively. Results are tabulated.
- Strengthening is carried out and it reveals that the application of geo-grid will improvise the bearing capacity and reduce the settlement of soil when compared to plain soil.

Load in (tons)	Unreinforced soil settlement in mm	Reinforced soil settlement in mm
0	0	0
0.1	0.53	0.3
0.5	2.85	1.6
1.0	4.95	2.4
1.5	6.98	3.2
2.0	8.7	3.5
2.5	10.45	4.8

Table 2 Load vs Settlement for Layer I

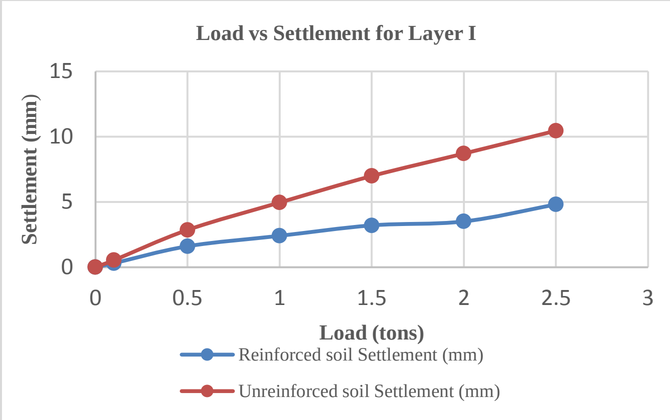

Fig. 5 Load Settlement Curve for Layer I

Load in (tons)	Unreinforced soil settlement in mm	Reinforced soil settlement in mm
0	0	0
0.1	0.8	0.6
0.5	1.35	1.1
1.0	2.7	1.8
1.5	3.88	2.6
2.0	5.4	2.8
2.5	7.18	3.5
3.0	9.15	4.2
3.5	11.2	5.3

Table 3 Load vs Settlement for Layer II

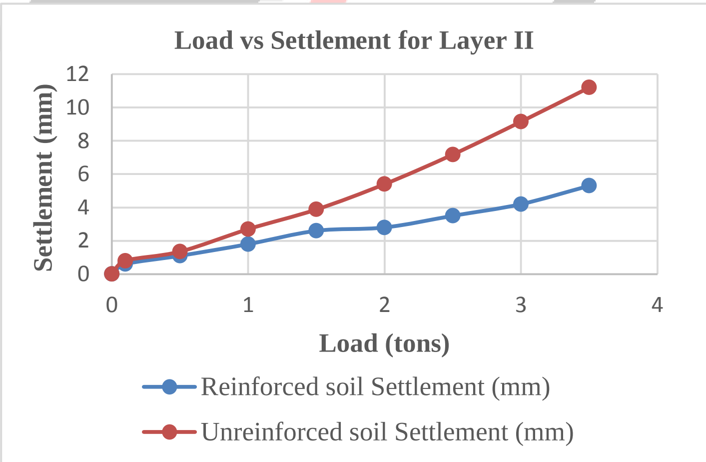

Fig. 6 Load Settlement Curve for Layer II

Load in (tons)	Unreinforced soil settlement in mm	Reinforced soil settlement in mm
0	0	0
0.1	0.7	0.3
0.5	1.95	0.7
1.0	3.25	1.0
1.5	4.5	1.2
2.0	5.35	1.6
2.5	6.75	2.0
3.0	7.95	3.1
3.5	9.45	4.1

Table 4 Load vs Settlement for Layer III

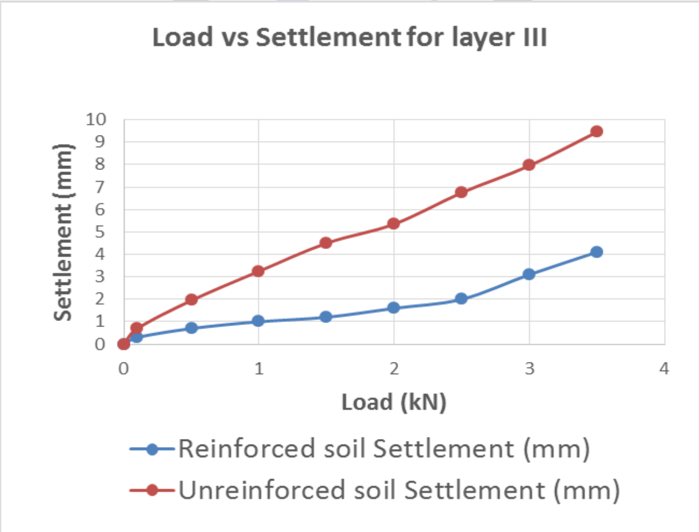

Fig. 7 Load Settlement Curve for Layer III

Load in (tons)	Unreinforced soil settlement in mm	Reinforced soil settlement in mm
0	0	0
0.1	0.5	0
0.5	1.75	0
1.0	2.7	0.7
1.5	3.6	1.0
2.0	4.45	1.5
2.5	5.25	1.9
3.0	6.4	2.8
3.5	7.6	3.7

Table 5 Load vs Settlement for Layer IV

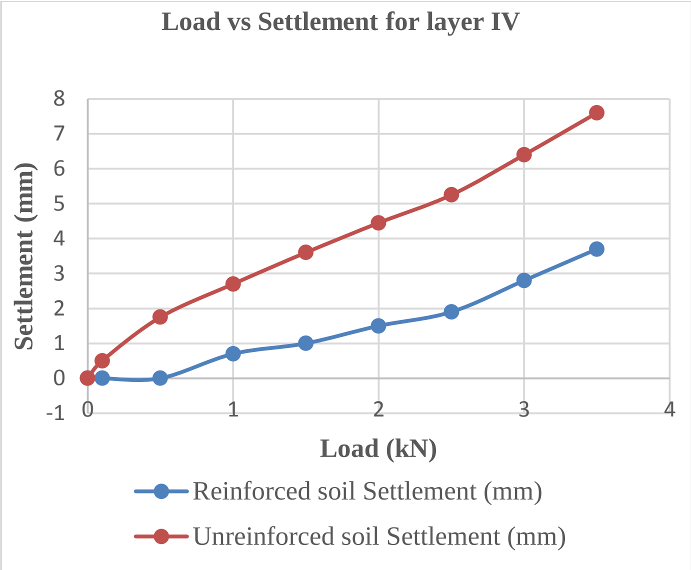

Fig. 8 Load Settlement Curve for Layer IV

VII. CONCLUSION

- Use of the geo-grid and paralink reinforcement leads to better performance from the point of view of strength improvement as well as settlement reduction.
- The project work results suggest the possibility of developing a predictive model for strength improvement due to use of geo-grid and paralink reinforcement.
- In order to get the effective utilization of geo-grid and paralink reinforcement, the soil should have higher density so that the stiffness between the soil and geo-grid reinforcement increases.

VIII. ACKNOWLEDGMENT

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REFERENCES

[1] H Vidal. The principle of reinforced earth. Highway Res.Record No. 282: 1-16, 1969.
[2] HI Ling. Performance of geosynthetic-reinforced cohesive soil mass at plane strain compression. Doctoral Thesis, University of Tokyo, Tokyo, Japan, 1993.
[3] RA Jewell, CP Wroth. Direct shear tests on reinforced sand. Geotechnique 37(1): 53-68, 1987.
[4] BB Broms. Triaxial tests with fabric-reinforcement soil. C.R. Coll. Int. Sols Text. Paris: 129-133, 1977.

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