A Review on Economic Analysis of Reinforced Earth Wall with Different Types of Reinforcing Materials

Harangad Singh[1], Dr. Saleem Akhtar[1]

[1]*Department of Civil Engineering, UIT RGPV-Bhopal*

***Abstract*—Reinforced earth walls play a critical role in the development of modern infrastructure due to safety, environmental, and economic reasons.This paper gives the cost analysis of the reinforced earth walls with different types of reinforced materials for different heights. Retaining walls as earth structures are frequently constructed for a variety of applications, most common being bridge abutments and road construction.When selecting a retaining wall type, mechanically stabilized earth (MSE) walls should always be considered. MSE walls are composed of reinforcing elements, e.g. geo synthetics in the soil fill to resist lateral earth pressures. The use of geo grids or geotextiles rather than metallic strips (ties) is a further development of the Reinforced Earth concept. Geo synthetics offer a variable and often economical alternative to metallic reinforcements for both permanent and temporary walls, especially under certain environmental conditions.**

***Keywords*—RE wall, Reinforced Earth Wall, Copper Strip as reinforcement, Aluminium Strips as reinforcement, Galvanized Carbon Strips, Synthetic Geo Grid**

I. INTRODUCTION

A paradigm shift occurred in the 1960s with the advent of mechanically stabilized earth (MSE) masses, i.e., reinforced layers of soil allowing for modular construction, which was clearly recognized as being advantageous in most situations. The reinforcement was initially steel straps, and subsequently welded wire mesh provided an alternative. Wall facings varied from metallic-to-reinforced concrete-to-segmental units of a variety of types and shapes. In the case of anchored earth systemthis is provided by the passive action of anchors and friction along the perimeter of anchor shaft or reinforcement. In reinforced earth technology, only friction is taken advantage of by providing specially prepared high adherence galvanized steel strips as reinforcement. Both these processes use precast different shaped panels as facia elements.The reinforced earth retaining walls are very costeffective compared to conventional concrete retaining walls. Furthermore, these systems are more flexible than the conventional earth retaining walls such as reinforced concrete-cantilever or gravity walls. Therefore, they are suitable for sites with poor foundations and seismically active areas.

Currently, most process patents covering soil-reinforced system construction or components have expired, leading to a proliferation of available systems or components that can be separately purchased and assembled by the erecting contractor. The use of geo-textiles in MSE walls started after the beneficial effect of reinforcement with geo-textiles was noticed in highway embankments over weak subgrades. The first geo-textile reinforced wall was constructed in France in 1971, and the first structure of this type in the United States was constructed in 1974. Since about 1980, the use of geo-textiles in reinforced soil has increased significantly.The first reported use of reinforced steepened slopes is believed to be the west embankment for the Great Wall of China. The introduction and economy of geo-synthetic reinforcements has made the use of steepened slopes economically attractive.The first wall to use this technology in the United States was built in 1972 on California State Highway 39, north east of Los Angeles. In the last 25 years, more than 23,000 Reinforced Earth structures representing over 70 million m^2 (750 million ft^2) of wall facing have been completed in 37 countries. More than 8,000 walls have been built in the United States since 1972. The highest wall constructed in the United States was of height 30 meters (98 feet).

II. NEED FOR THE STUDYs

Some other early examples of manmade soil reinforcement include dikes of earth and tree branches, which have been used in China for at least 1,000 years and along the Mississippi River in the 1880s. Other examples include wooden pegs used for erosion and landslide control in England, and bamboo or wire mesh, used universally for revetment erosion control. Soil reinforcing can also be achieved by using plant roots.The modern methods of soil reinforcement for retaining wall construction were pioneered by theFrench architect and engineer Henri Vidal in the early 1960s. His research led to the invention anddevelopment of Reinforced Earth, a system in which steel strip reinforcement is used. The first wall to use this technology in the United States was built in 1972 on California State Highway 39, northeast of Los Angeles. In the last 25 years, more than 23,000 Reinforced Earth structures representing over 70 million m^2 (750 million ft^2) of wall facing have been completed in 37 countries.More than 8,000 walls have been built in the United States since 1972. The highest wall

constructed in the United States was of the order of 30 meters (98 feet).

In today's world scenario the economics plays a very important role. The need for building higher and stronger walls in less time and cost is called economical construction. The replacement of Geo synthetics against the metallic reinforcements has offered an economical alternative. But, the filling material remains the same. In today's world cost economics plays a vital role in selection of a project. What if the material used in back fill behind the retaining wall is changed with some alternative material which posses the same strength but cheaper in cots or the place where soil available for fill does not meet the requirement then what will be its impact on the cost of structure?

III. REINFORCED EARTH WALLS

Mechanically stabilized earth, also called MSE, is soil constructed with artificial reinforcing via layered horizontal mats (geo-synthetics) fixed at their ends. These mats provide added internal shear resistance beyond that of simple gravity wall structures. Other options include steel straps, also layered. This type of soil strengthening usually needs outer facing walls to affix the layers to and vice versa.

The wall face is often of precast concrete units that can tolerate some differential movement. The reinforced soil's mass, along with the facing, then acts as an improved gravity wall. The reinforced mass must be built large enough to retain the pressures from the soil behind it. Gravity walls usually must be a minimum of 50 to 60 percent as deep or thick as the height of the wall, and may have to be larger if there is a slope or surcharge on the wall.

Mechanically Stabilized Earth walls (MSE) have many advantages compared with conventional reinforced concrete retaining walls. They are summarized as follows:

- Use simple and rapid construction procedures and do not require large construction equipment.
- Do not require experienced craftsmen with special skills for construction.
- Require less site preparation than other alternatives.
- Need less space in front of the structure for construction operations (facia panels)
- Reduce the requirement of space.
- Do not need rigid, unyielding foundation support because MSE structures are tolerant to deformations.
- Cost effective.
- Technically feasible to heights in excess of 25 m (80 ft)

One of the greatest advantages of MSE walls is their flexibility and capability to absorb deformations due to poor subsoil conditions in the foundations. Also, based on observations in seismically active zones, these structures have demonstrated a higher resistance to seismic loading than have rigid concrete structures.Precast concrete facing elements for MSE walls can be made with various shapes and textures (with little extra cost) for aesthetic considerations.

The retaining wall is designed on the basis that the earth is retained behind the wall and major loading is on the wall whereas, in its counterpart (Reinforced Earth Wall) the friction between the earth and the reinforcement shares the load which is then transferred to the ground. The reinforcement thus develops tension and the earth behaves as if it has cohesion. The economic benefit achieved from the Reinforced Earth Wall increases with the increase in the height of the wall. The per cent savings of the internally stabilized walls may range from 40 to 65%.

For this study we have considered a wall of different heights and changing its back filling material with Local Earth, Granular Sub base and sand to get a basic understanding of the cost economics of the backfill material. All these material were tested for the minimum requirement of backfill properties. Similarly, by changing the Various Reinforcing elements available in an RE Wall we can understand that the cost of RE wall is dependent on Reinforcing material and backfill material only. All the rates for study shall be in accordance with SOR 2014 issued by MPPWD for road and bridges.

IV. COST CALCULATION OF RETAINING WALL WITH DIFFERENT TYPES OF REINFORCED MATERIALS FOR DIFFERENT HEIGHTS

In this calculation rates are as per Schedule of Rates (SOR) 2014 issued by Madhya Pradesh Public Works Department, India for Road and Bridges.

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	40.000	2,200
4.1	GSB Below Levelling Pad	cum	943	6.000	5,658
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	50.000	66,500
4.1	Selected Filling (With Grannular Material) In Reinforced Zone	cum	943	175.000	1,65,025
7.5	Aluminium Strip	M	284	175.000	49,700
Total					2,92,512

Fig. 1 Cost RE Wall with Aluminium Strips as Reinforcements for 4.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	47.000	2,585
4.1	GSB Below Levelling Pad	cum	943	7.050	6,648
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	60.000	79,800
4.1	Selected Filling In Reinforced Zone	cum	943	252.000	2,37,636
7.5	Aluminium Strip	M	284	252.000	71,568
Total					4,01,666

Fig. 2 Cost RE Wall with Aluminium Strips as Reinforcements for 5.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	47.000	2,585
4.1	GSB Below Levelling Pad	cum	943	7.050	6,648
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	60.000	79,800
4.1	Selected Filling In Reinforced Zone	cum	943	294.000	2,77,242
7.5	Aluminum Strip	M	284	294.000	83,496
Total					4,53,200

Fig. 3 Cost RE Wall with Aluminium Strips as Reinforcements for 6.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	55.000	3,025
4.1	GSB Below Levelling Pad	cum	943	8.250	7,780
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	80.000	1,06,400
4.1	Selected Filling In Reinforced Zone	cum	943	392.000	369,656
7.5	Aluminium Strip	M	284	392.000	1,11,328
Total					6,01,618

Fig. 4 Cost RE Wall with Aluminium Strips as Reinforcements for 7.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	60.000	3,300
4.1	GSB Below Levelling Pad	cum	943	9.000	8,487
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	90.000	1,19,700
4.1	Selected Filling In Reinforced Zone	cum	943	504.000	4,75,272
7.5	Aluminium Strip	M	284	504.000	1,43,136
Total					7,53,324

Fig. 5 Cost RE Wall with Aluminium Strips as Reinforcements for 8.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	69.000	3,795
4.1	GSB Below Levelling Pad	cum	943	10.350	9,760
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	100.000	1,33,000
4.1	Selected Filling In Reinforced Zone	cum	943	630.000	5,94,090
7.5	Aluminium Strip	M	284	630.000	1,78,920
Total					9,22,994

Fig. 6 Cost RE Wall with Aluminium Strips as Reinforcements for 9.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs)
3.4	Earth Work Excavation	cum	55	40.000	2,200
4.1	GSB Below Levelling Pad	cum	943	6.000	5,658
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	50.000	66,500
4.1	Selected Filling (With Granular Material) In Reinforced Zone	cum	943	175.000	1,65,025
7.5	Copper Strip	M	323	175.000	56,525
Total					2,99,337

Fig. 7 Cost RE Wall with Copper Strips as Reinforcements for 4.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	47.000	2,585
4.1	GSB Below Levelling Pad	cum	943	7.050	6,648
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	60.000	79,800
4.1	Selected Filling In Reinforced Zone	cum	943	252.000	2,37,636
7.5	Copper Strip	M	323	252.000	81,396
Total					4,11,494

Fig. 8 Cost RE Wall with Copper Strips as Reinforcements for 5.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	47.000	2,585
4.1	GSB Below Levelling Pad	cum	943	7.050	6,648
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	60.000	79,800
4.1	Selected Filling In Reinforced Zone	cum	943	294.000	2,77,242
7.5	Copper Strip	M	323	294.000	94,962
Total					4,64,666

Fig. 9 Cost RE Wall with Copper Strips as Reinforcements for 6.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	55.000	3,025
4.1	GSB Below Levelling Pad	cum	943	8.250	7,780
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	80.000	1,06,400
4.1	Selected Filling In Reinforced Zone	cum	943	392.000	3,69,656
7.5	Copper Strip	M	323	392.000	1,26,616
Total					6,16,906

Fig. 10 Cost RE Wall with Copper Strips as Reinforcements for 7.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	60.000	3,300
4.1	GSB Below Levelling Pad	cum	943	9.000	8,487
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	90.000	1,19,700
4.1	Selected Filling In Reinforced Zone	cum	943	504.000	4,75,272
7.5	Copper Strip	M	323	504.000	1,62,792
Total					7,72,980

Fig. 11 Cost RE Wall with Copper Strips as Reinforcements for 8.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	69.000	3,795
4.1	GSB Below Levelling Pad	cum	943	10.350	9,760
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	100.000	1,33,000
4.1	Selected Filling In Reinforced Zone	cum	943	630.000	5,94,090
7.5	Copper Strip	M	323	630.000	2,03,490
Total					9,47,564

Fig. 12 Cost RE Wall with Copper Strips as Reinforcements for 9.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	40.000	2,200
4.1	GSB Below Levelling Pad	cum	943	6.000	5,658
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	50.000	66,500
4.1	Selected Filling (With Grannular Material) In Reinforced Zone	cum	943	175.000	1,65,025
7.5	Galvanized Carbon Strip	M	336	175.000	58,800
Total					3,01,612

Fig. 13 Cost RE Wall with Galvanized Carbon Strips as Reinforcements for 4.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	47.000	2,585
4.1	GSB Below Levelling Pad	cum	943	7.050	6,648
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	60.000	79,800
4.1	Selected Filling In Reinforced Zone	cum	943	252.000	2,37,636
7.5	Galvanized Carbon Strip	M	336	252.000	84,672
Total					4,14,770

Fig. 14 Cost RE Wall with Galvanized Carbon Strips as Reinforcements for 5.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	47.000	2,585
4.1	GSB Below Levelling Pad	cum	943	7.050	6,648
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	60.000	79,800
4.1	Selected Filling In Reinforced Zone	cum	943	294.000	2,77,242
7.5	Galvanized Carbon Strip	M	336	294.000	98,784
Total					4,68,488

Fig. 15 Cost RE Wall with Galvanized Carbon Strips as Reinforcements for 6.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	55.000	3,025
4.1	GSB Below Levelling Pad	cum	943	8.250	7,780
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	80.000	1,06,400
4.1	Selected Filling In Reinforced Zone	cum	943	392.000	3,69,656
7.5	Galvanized Carbon Strip	M	336	392.000	1,31,712
Total					6,22,002

Fig. 16 Cost RE Wall with Galvanized Carbon Strips as Reinforcements for 7.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	60.000	3,300
4.1	GSB Below Levelling Pad	cum	943	9.000	8,487
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	90.000	1,19,700
4.1	Selected Filling In Reinforced Zone	cum	943	504.000	4,75,272
7.5	Galvanized Carbon Strip	M	336	504.000	1,69,344
Total					7,79,532

Fig. 17 Cost RE Wall with Galvanized Carbon Strips as Reinforcements for 8.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	69.000	3,795
4.1	GSB Below Levelling Pad	cum	943	10.350	9,760
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	100.000	1,33,000
4.1	Selected Filling In Reinforced Zone	cum	943	630.000	5,94,090
7.5	Galvanized Carbon Strip	M	336	630.000	2,11,680
Total					9,55,754

Fig. 18 Cost RE Wall with Galvanized Carbon Strips as Reinforcements for 9.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	40.000	2,200
4.1	GSB Below Levelling Pad	cum	943	6.000	5,658
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	50.000	66,500
4.1	Selected Filling (With Grannular Material) In Reinforced Zone	cum	943	175.000	1,65,025
7.5	Geogrid	sqm	209	175.000	36,575
Total					2,79,387

Fig. 19 Cost RE Wall with Synthetic Geo Grid as Reinforcements for 4.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	47.000	2,585
4.1	GSB Below Levelling Pad	cum	943	7.050	6,648
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	60.000	79,800
4.1	Selected Filling In Reinforced Zone	cum	943	252.000	2,37,636
7.5	Geogrid	sqm	209	252.000	52,668
Total					3,82,766

Fig. 20 Cost RE Wall with Synthetic Geo Grid as Reinforcements for 5.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	47.000	2,585
4.1	GSB Below Levelling Pad	cum	943	7.050	6,648
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	60.000	79,800
4.1	Selected Filling In Reinforced Zone	cum	943	294.000	2,77,242
7.5	Geogrid	sqm	209	294.000	61,446
Total					4,31,150

Fig. 21 Cost RE Wall with Synthetic Geo Grid as Reinforcements for 6.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	55.000	3,025
4.1	GSB Below Levelling Pad	cum	943	8.250	7,780
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	80.000	1,06,400
4.1	Selected Filling In Reinforced Zone	cum	943	392.000	3,69,656
7.5	Geogrid	sqm	209	392.000	81,928
Total					5,72,218

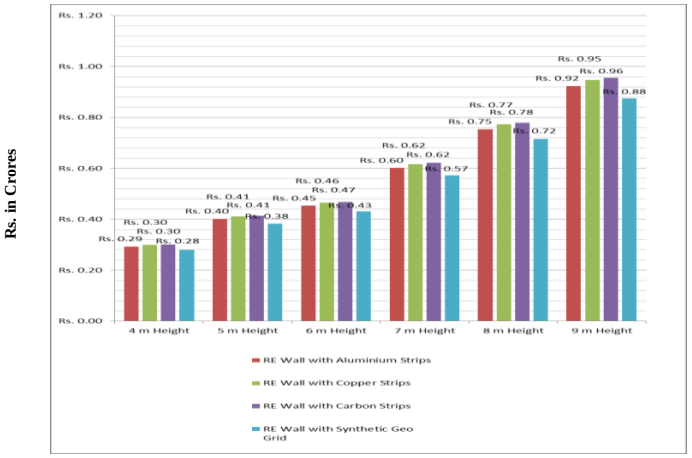
Fig. 22 Cost RE Wall with Synthetic Geo Grid as Reinforcements for 7.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	60.000	3,300
4.1	GSB Below Levelling Pad	cum	943	9.000	8,487
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	90.000	1,19,700
4.1	Selected Filling In Reinforced Zone	cum	943	504.000	4,75,272
7.5	Geogrid	sqm	209	504.000	1,05,336
Total					7,15,524

Fig. 23 Cost RE Wall with Synthetic Geo Grid as Reinforcements for 8.0m Height

Item No as per SOR 2014	Description	Unit	Rate (Rs./Unit)	Quantity	Amount (Rs.)
3.4	Earth Work Excavation	cum	55	69.000	3,795
4.1	GSB Below Levelling Pad	cum	943	10.350	9,760
12.8 A	Levelling Pad (M 15 Grade Concrete)	cum	5,080	0.675	3,429
7.5 I	Re Wall With Facia Pannel	sqm	1,330	100.000	1,33,000
4.1	Selected Filling In Reinforced Zone	cum	943	630.000	5,94,090
7.5	Geogrid	sqm	209	630.000	1,31,670
Total					8,75,744

Fig. 24 Cost RE Wall with Synthetic Geo Grid as Reinforcements for 9.0m Height



Graph1. Comparison of Reinforced Earth Walls with Different types of Reinforcing Elements

Item	Leveling Pad (m-15)	Surface Area	Filling Alternatives		
			GSB	Sand	Local Earth
	(cum)	(Sqm)	(cum)	(cum)	(cum)
RE wall	36	2,231	13,386	13,386	13,386
Unit Direct Rate (Rs.)	4,268	1,224	998	248	154
Amount (Rs.)	1,53,648	27,30,744	1,33,59,228	33,19,728	20,61,444

Amount for RE Wall (using GSB)	=	Rs. 1,33,59,228/-
Amount for RE Wall (using Sand)	=	Rs. 33,19,728/-
Amount for RE Wall (using local Earth)	=	Rs. 20,61,444/-

Table1.Cost of Reinforced Earth Wall with Different Filling Alternatives

V. CONCLUSIONS

In this study for the cost effectiveness of the reinforced earth walls, the wall for a height of 4m, 5m, 6m, 7m, 8m and 9m have been considered. The quantities and cost were calculated at the specific height and quantities were kept as same. Rates have been used according to the rate given in Schedule of rates (SOR) 2014 issued by Madhya Pradesh Public Works Department, India for Road and Bridges. From the above cost analysis it is quite clear that if the quantities are not changed and only the material is changed in the RE Wall backfill and reinforcing material is changed, then the cost of reinforced earth wall with synthetic geo grid is the cheapest with combination of local earth as a back fill material for the reinforced earth wall.

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