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The Choice of Reinforcement and Its Impact on Project Cost: A Case study of mild steel and fabric reinforcements in road construction

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Abstract

Roads and Highways are vital lifelines. Roads are needed for accessibility and for transporting of people, goods and services. Roads are therefore needed for socio-economic purposes. This research aims at assessing the choice of reinforcement and its impact on Construction cost in road construction. The objectives were as follows; to determine the initial cost of pavements constructed using fabric (mesh) reinforcement and mild steel rods respectively, to compare the differences in construction cost between pavements constructed using fabric reinforcement and mild steel rods, to determine the cost implications of using the two types of reinforcement in road construction. The use of fabric (mesh) reinforcement will result in potential savings of GH¢559,650.00 per kilometre which represents a savings of 41.826%. Hence fabric (mesh) reinforcement is cheaper than mild steel rod in road construction

Keywords: Roads, Highway, Reinforcement, Project.

1.0 Introduction

Roads may be constructed for many reasons. Most roads are built to facilitate the transport of people and goods, and so to promote development (Robinson & Thagesen, 2004). Road project like all construction projects must be well managed using the appropriate project management tools. The Project Management Institute defined project management as the process and activity of planning, organising, motivating and controlling resources, procedures and protocols to achieve specific goals in scientific or daily problems. The Project Management Institute (2014) also defined a project as a temporary endeavour design to produce a unique project, service or results. Chatfield (2014) stated that a project has a defined beginning and end and often constrained by funding or deliverables. Nokes (2007), projects are undertaken to meet unique goals and objects, typically to bring about beneficial change or added value. Lewis (2010), the primary challenge of project management is to achieve the entire project goal, that is, to finish the project within the time, quality and budget. Philips (2002) further added that in addition to achieving all the project goals and objectives, the preconceived constraints must be honoured. PMI (2010), the primary constraints of projects are scope, time and budget. The secondary objective is to optimise the allocation of necessary inputs and integrate them to meet pre-defined objectives. To achieve all these objectives and goals, there is the need for proper and efficient planning and control system.

Project control is that element of a project that keeps it on track, on time and within budget (Lewis, 2010). Control systems are needed for cost, risk, quality, communication, time, change, procurement and human resources.

According to Osei-Tutu and Adjei-Kumi (2003), the cost of infrastructure has been found to be increasing at a rate of 17.33% per annum. This coupled with other factors have made construction very expensive.

Seeley (1993), highlighted that using prices, restriction on use of capital and high interest rates have caused clients to demand that their professional advisers should accept cost as an element in design. This calls for suitable balanced costs throughout all part of the project as well as an accurately forecast overall cost.

Osei-Tutu and Adjei-Kumi(2003), suggested that due to rising cost of projects, there is the need to adopt strategies to make construction projects more affordable. These include material development programme, manpower development, Research and Development, and cost saving techniques. Cost saving techniques includes the use of innovative techniques and strategies for controlling cost.

Seeley (1993) stated that cost control aims at ensuring that resources are used to the best advantage. Seeley (1993), defined each cost control as all methods of predetermined sum, throughout the design and construction stages. Seeley (1993), vividly stated that it is vital to operate an effective cost control procedure during the

design stage of a project to keep the total cost within clients budget, where the lowest tender is substantially above the initial estimate, the design may have to be modified considerably or even case the project may have to be abandoned.

Seeley (1993), stressed the importance of effectively controlling construction project cost at the design stage. There is also the need to continue the monitoring of costs throughout the construction stage. The idea of cost reduction has brought about many strategies and techniques aimed at resource optimization which helps achieve the aim of cost reduction.

Gohar (1987), suggested that construction cost can be reduced through selection of cheap materials, savings in labour and through appropriate technology. Gohar (1987), looked at the development and use of cheap construction materials. Materials absorb most of the cost in construction.

Gohar (1987), insisted that the development of new materials and their application in the construction industry of India has demonstrated that cheap materials can play an important role in bringing down cost of construction to a greater effect. Materials used in constructing roads include the following; asphalt, tar, clinker, crushed rocks crushed stones, hardcore or hogging, gravel, concrete, brick, pavement block, coarse aggregates, chippings, steel reinforcement, etc. These materials must be free from impunities and must be tested to ensure that they meet the requirement of the specification and quality. This research aims at assessing the choice of enforcement and its impact on the cost of road projects.

1.1 Aim

The research aims at assessing the impact of the choice of reinforcement on the cost of road projects.

1.2 Objectives

1. To determine the initial cost of pavements constructed using fabric (mesh) reinforcement and mild steel rods respectively.
2. To compare the differences in construction cost between pavements constructed using fabric reinforcement and mild steel rods.
3. To determine the cost implications of using the two types of reinforcement in road construction.

2.0 Methodology

As part of data collection to determine the impact of the choice of reinforcement on road project costs, primary and secondary sources of data were employed. This was achieved through informal interviews with professionals at Ghana Highway Authority, Department of Feeder Roads, Road Consultants, literature review of previous theses, Journals and textbooks. Field surveys were also done at various places.

As part of the data collection to determine the cost of road construction using mild steel reinforcement and fabric reinforcement respectively, a profile of a road one kilometre long and ten meters wide were designed. Measurement of the qualities used in the road construction was done and Bill of quantities produced in order to get the costs of the road constructed using fabric reinforcement and mild steel reinforcement respectively.

2.1 Cost of Pavement Using Mesh Reinforcement

		Amount in GH¢
1.	Oversite excavation 300m^2 @ GH¢4/m^2	12,000.00
2.	Disposal of excavated materials 300m^2 @ GH¢10/m^2	30,000.00
3.	Compacting bottoms of excavation 10,000m^2 @GH¢2/m^2	20,000.00
4.	Consoled stone base 10,000m^2 @ GH¢10.50/m^2	105,000.00
5.	Blinding layer 50mm thick, 10,000m^2 @ GH¢ 6.00/m^2	60,000.00
6.	Polythene sheet 10,000m^2 @ GH¢3.00/m^2	30,000.00
7.	Concrete Grade 30, 1,500m^3 @ GH¢400/m^3	600,000.00
8.	Dowel bars (20mm bar) 4,465kg @ GH¢3.80/m^2	16,967.00
9.	Fabric Reinforcement 10,000m^2 @ GH¢ 16/m^2	160,000.00
10.	Taping 25mm thick mater 10,000m^2 @ GH¢19/m^2	190,000.00
11.	Power floating of concrete bed 10,000m^2 @ GH¢2/m^2	20,000.00
12.	Wood for expansion Joint 6350m @ GH¢3/m	19,050.00
13.	Sealant for expansion Joint 6m^2 @ GH¢120/m^2	720.00
14.	Formwork 303m^2 @ GH¢35/m^2	10,605.00
	Sub – Total	GH¢1,274,342.00
	Add 5% for Preliminaries	GH¢ 63,717.10
	Total	GH¢1,338,059.10

2.2 Cost of Pavement Using Mild Steel Reinforcement

		Amount in GH¢
1.	Oversite excavation 300m^2 @ GH¢4/m^2	12,000.00
2.	Disposal of excavated materials 300m^2 @ GH¢10/m^2	30,000.00
3.	Compacting bottoms of excavation 10,000m^2 @GH¢2/m^2	20,000.00
4.	Crushed stone base 10,000m^2 @ GH¢10.50/m^2	105,000.00
5.	Blinding layer 50mm thick, 10,000m^2 @ GH¢ 6.00/m^2	60,000.00
6.	Polythene sheet 10,000m^2 @ GH¢3.00/m^2	30,000.00
7.	Concrete Grade 30, 1,500m^3 @ GH¢400/m^3	600,000.00
8.	Dowel bars (20mm bar) 4,465kg @ GH¢3.80/m^2	16,967.00
9.	Mild Steel rod 210,000m^2 @ GH¢ 3.30/Kg	693,000.00
10.	Topping 25mm thick mater 10,000m^2 @ GH¢19/m^2	190,000.00
11.	Power floating of concrete bed 10,000m^2 @ GH¢2/m^2	20,000.00
12.	Wood for expansion Joint 6350m @ GH¢3/m	19,050.00
13.	Sealant for expansion Joint 6m^3 @ GH¢120/m^3	720.00
14.	Formwork 303m^2 @ GH¢35/m^2	10,605.00
	Sub – Total	GH¢1,807,342.00
	Add 5% for Preliminaries	GH¢ 90,367.10
	Total	GH¢1,897,709.10

3.0 Comments and Analysis

Table 1: Cost of Pavement Using Mesh (Fabric) Reinforcement

Item	Description of Works	Amount (GH¢)	Percentage of Total (%)
1	Oversite excavation	12,000.00	0.90
2	Disposal of excavated materials	30,000.00	2.27
3	Compacting bottoms of excavation	20,000.00	1.49
4	Crushed stone base	105,000.00	7.85
5	Blinding layer 50mm thick	60,000.00	4.48
6	Polythene sheet	30,000.00	2.27
7	Concrete Grade 30	600,000.00	44.80
8	Dowel bars	16,967.00	1.27
9	Fabric Reinforcement	160,000.00	11.96
10	Toppings	190,000.00	14.20
11	Power floating	20,000.00	1.49
12	Wood for expansion Joint	19,050.00	1.42
13	Sealant for expansion Joint	720.00	0.05
14	Formwork	10,605.00	0.79
15	Preliminaries	63,717.10	4.76
16	Total	1,338,059.10	100

Analysis of the breakdown of the cost of construction of pavement using fabric (mesh) reinforcement is given in Table 1 above. The major components are concrete walls, toppings, fabric reinforcement, crushed stone base and blinding layer.

These elements constitute 44.80%, 14.20%, 11.96% 7.85% and 4.48% respectively of the total cost of constructing the pavement.

Also analysis of the breakdown of the cost of construction of pavement using mild steel reinforcement (12mm diameter) are given in Table 2 below. The major components are concrete works, mild steel reinforcement, crushed stone base, toppings and blinding layer. These elements constitute 31.62%, 36.52%, 5.53%, 10.01%, and 3.15% respectively of the total cost of constructing the pavement.

Table 2: Cost of Pavement Using Mild Steel Reinforcement

Item	Description of Works	Amount (GH¢)	Percentage of Total (%)
1	Oversite excavation	12,000.00	0.63
2	Disposal of excavated materials	30,000.00	1.58
3	Compacting bottoms of excavation	20,000.00	1.05
4	Crushed stone base	105,000.00	5.53
5	Blinding layer	60,000.00	3.15
6	Polythene sheet	30,000.00	1.58
7	Concrete Grade 30	600,000	31.62
8	Dowel bars	16,967.00	0.89
9	Mild Steel Reinforcement	693,000.00	36.52
10	Topping	190,000.00	10.01
11	Power floating	20,000.00	1.05
12	Wood for expansion Joint	19,050.00	1.03
13	Sealant for expansion Joint	720.00	0.04
14	Formwork	10,605.00	0.56
15	Preliminaries	63,717.10	4.76
16	Total	1,338,059.10	100

4.0 Findings

i. For one kilometre length of road, the cost of pavement constructed using mesh reinforcement cost GH¢1,338,059.10 whilst the pavement constructed with mild steel reinforcement cost GH¢1,897,709.10

ii. The pavement constructed with mild steel reinforcement is more expensive than the pavement constructed with the mesh reinforcement. Using mild steel reinforcement resulted in an increase of GH¢559,650.00 per kilometre. This represents an increase of 41.826%. Therefore using mesh (fabric) reinforcement will result in savings of 41.826%.

iii. Using mesh reinforcement will result in a potential savings of GH¢559,650.00 per kilometre. This will result in substantial savings. Whilst the use of mild steel in pavement construction will result in an increment of the cost of construction.

5.0 Conclusion

The use of fabric (mesh) reinforcement will result in potential savings of GH¢559,650.00 per kilometre which represents a savings of 41.826%. Hence fabric (mesh) reinforcement is cheaper than mild steel rod in road construction.

6.0 Recommendation

Hence fabric (mesh) reinforcement is cheaper than mild steel reinforcement in road construction.

References

1. Chatfield, C (2014) Microsoft Office Project step by step, New York: Microsoft
2. Gohar, R (1987). International Council for Building Research Studies and Documentation, A case study, Development and use of Cheap Building materials in low income housing.

3. Lewis (2010). Project management, New York: McGraw Hill Professional
4. Nokes, S (2007). The Definite Guide to Project Management, 2nd Edition: Prentice –Hall
5. Osei-Tutu, E & Adjei-Kumi, T. (2003): The cost trends of residential Housing provision in Urban areas in Ghana 1991-2001. The Ghanaian Surveyor, Issue I, Accra.
6. Philips, J (2003). PMP Project Management Professional Study Guide, New York: McGraw Hill Professional
7. PMI (2014), 'What is Project Management" PMI .org retrieved 4th June 2014.
8. Robinson, R & Thagesen, B (2004). Road Engineering for Development London: Taylor & Francis
9. Seeley, I.H (1993: Building Economics, 3rd Edition, Basingstoke, Macmillan.