CS-231 An attempt aiming to improve cost effectiveness regarding reinforced earth wall

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1. Introduction

It is needless to say that seeking a cost reduction regarding construction cost is an urgent subject, while securing quality is also an important concern.

A thin wall-facing unit for Terre Armee wall and Multi-anchored retaining wall, has been developed by Japan Highway Public Corporation since 1996. Successful trials of the thinner reinforced earth panel has resulted in cost reduction of about 20% in total construction cost of reinforced walls, thus greatly increasing their application.

Cost analysis carried out concerning retaining structures including RC retaining wall has shown that those reinforced earth structures using the thin panel are economically excellent. As an appropriate selection turned to be dependable upon a variety of conditions, this article presents efforts to reduce the construction cost regarding the reinforced wall method, mainly the reduction realised in a short time by the introduction of thin wall.

2. Review of the conventional reinforced soil methods from economical point of view

2.1 The cost analysis on the reinforced earth retaining wall

Table-1 Breakdown of construction costs

Reinforced soil method	Facing element	Reinforcement	Labour, plant and operatives
Terre Armee method	53	35	12
Multi-anchored method	43	44	13

The Terre Armee wall and Multi-anchored retaining wall, both of which have a concrete wall face and have been adopted widely by JH. They have covered an area of about 200,000 m^2. The cost composition of both techniques was examined from the viewpoint of economic efficiency. A material cost by each composition material was shown in the ratio in the Table -1. It shows that the proportion of the reinforcement material, which is thought to be a main element, is smaller than that of the concrete material, the secondary element.

Therefore the development of the new economical concrete facing element has been carried out with satisfying the function required on facing units.

2.2 A thinner facing unit

So far 18cm is the standard as for the facing unit thickness in the two conventional techniques above. The facing unit has been designed under the earth pressure equivalent to the height of 15m on the condition which has a uniform load on the simple two-dimensional beam. Furthermore, by strengthening structure of the connection between the facing unit and the reinforcing material, the thinner panel of 10cm thickness has been developed.

This development has rendered the reduction of about 40% on the cost of facing unit and about 20% on a whole cost of construction.

3. Comparison of construction cost

For an economically appropriate selection of the reinforced earth retaining wall, simulated ground and fill material conditions were prepared, and construction cost was calculated under the different wall heights and embankment heights overloaded, and then those costs were compared. This attempt included

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a conventional RC cantilever retaining wall.

A cost of construction consists of the material fee concerned with the reinforced earth wall, and an execution fee, including labour, machine, and tool, but earthwork fee concerning to backfill is excluded.

This comparison was performed on 7 typical techniques, which have been applied by JH, as shown in the Table -2. A basic section examined is shown in the Figure - 1.

Table-2 All reinforced walls compared

Slope angle	Reinforced soil retaining wall
(1:0.0)	①Terre Armee ②Multi-anchored③Websol④RRR ⑤TUSS
(1:0.3)	⑥Terratrel structure⑦Geotextile

3.1 Comparative result of construction cost depending on the techniques

Figure-2 shows the comparative result when the soil ground is equivalent to the N value =8～15, and fill conditions are $\gamma t=1.9tf/m^3$, c=0, $\phi = 30°$.

Each reinforced earth wall is found to have specific economical characteristic. Furthermore, most reinforced earth walls become relatively cheaper than the RC cantilever retaining wall. Pile foundation required on the RC cantilever retaining wall over the height of 6m makes the difference larger in the cases.

Multi-anchored retaining wall and Terre Armee wall have cost efficiency when they exceed 10m in height, though geotextile reinforced soil wall has lower cost when there is no overload. This is caused by the following reason. Reinforcement area of geotextile reinforced soil wall becomes larger than that of other methods as height of a wall becomes tall. This is because the necessary length of geotextile is decided by the circular slip failure method, which is likely to estimate the length longer regarding the internal stability. When height of overload is more than 5m, this tendency appears remarkably, and geotextile reinforced soil wall becomes rather expensive in any heights.

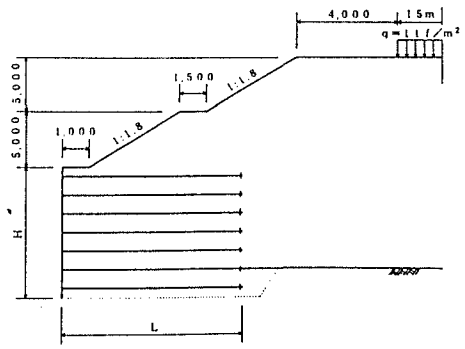
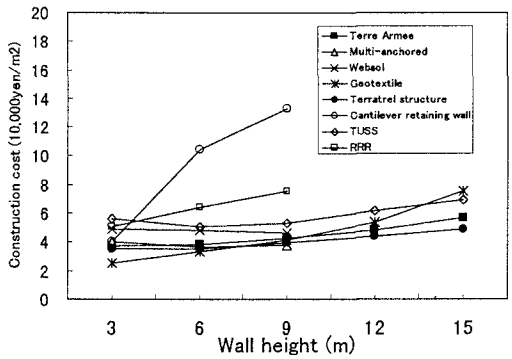
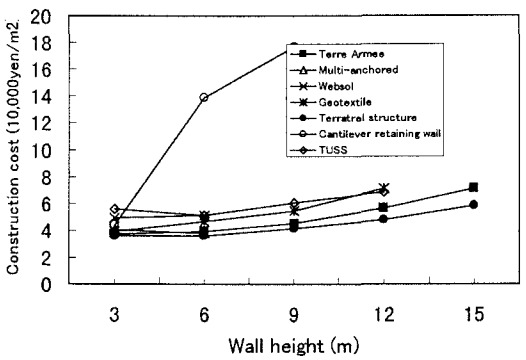


Figure-1 Basic section examined



a) Embankment height : 0m



b) Embankment height: 5m

Figure-2 Comparative results

4. Conclusion

A new thin wall-facing unit for Terre Armee wall and Multi-anchored retaining wall was presented briefly. This development has already rendered JH a remarkable cost reduction of about 300 million-yen per year. Moreover, the appropriate selection process mentioned above also leads us other cost reduction.