IMPACT SIMULATION OF SAND FILLED GEOCELLS BY FEM

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1. Introduction

Cellular has been used as a cushion close contact with protection structures. It not only absorbs impact force efficient but also be very stable. That's why many recently researches have carried out these structures by full scale tests and numerical emulation. These field experiments obtain highest reliability but need a large amount of cost, so it is generally difficult to conduct popularity. There was a research take a series impact tests for many kinds of filled materials, problems that aims of study to apply these geo-cells for protection embankment (impact loading vector is perpendicular to gravity direction), but model of experiment was designed in vertical direction (impact loading and gravity direction are parallel) [1]. Many numerical tests have carried out sand as a cushion layer above of protection gallery rather than for protection embankments [2]. Goals of this study were to analysis behavior of geo-cells in front of protective structure as like embankment under impact loading.

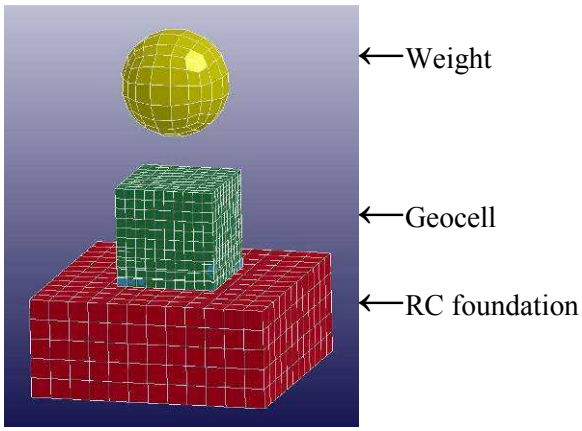

Figure 1 Vertical impact of sand geo-cell

Table 1 Parameters of sand used in analysis

Case	Damping (D)		Young modulus (Pa) (E)
	Before impact	After impact	
1	5	0.025	4.05E+07
2	*10*	*0.05*	*8.10E+07*
3	20	0.1	4.05E+08
4	40	0.2	8.10E+08

Italic line is standard case

2. Computation model of geo-cells

In order to confirm accuracy of computation model, this paper has proceeded to calculate impact behaviors of geo-cell filled sand in vertical direction (Figure 1). The results can be utilized to comparison with physical model tests. Geo-cell is composite structure consisting of a bag and a certain amount of sand. The bag envelopes and sand absorbs impact energy. In order to form an assembly of geo-cells and increase its sustainability, each geo-cell is sometimes covered outside with such as a steel wire net.

Geo-cell used in this study was cubic shape of each side length 0.5m. It was placed on the reinforced concrete foundation with 0.5m in height and 1.2mx1.2m in vertically sides respectively. It was assumed that a weight as a rockfall was a steel sphere filled with concrete 0.5m in diameter. Its mass was 260 kg. Falling heights of the weight were 7.5m. Table 1 shows the characteristics of the materials used in this analysis. Thereafter, D, E respectively presents the series concerning damping factor, Young modulus. With each factor of characteristic of sand, 4 cases were chosen to analysis around standard case 2.

Keywords: Impact, geocell, numerical analysis, rockfall
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3. Numerical results

Dynamic analysis had been done by FEM code LS-DYNA. Figure 2 shows the time history of impact force of the weight on geo-cell obtained by physical experiment [1]. On the other hand, Figure 3 shows the results of E series by numerical analysis in this study. The number after character E is corresponding to the case number shown in Table 1. From the results, it can be seen that there is acceptable similarity between experimental result and numerical analytical results of single sand filled geo-cell impact in vertical direction. This similarity is expressed in impact duration (0.05s and 0.06s respectively) and maximum impact force (90KN and 88KN respectively).

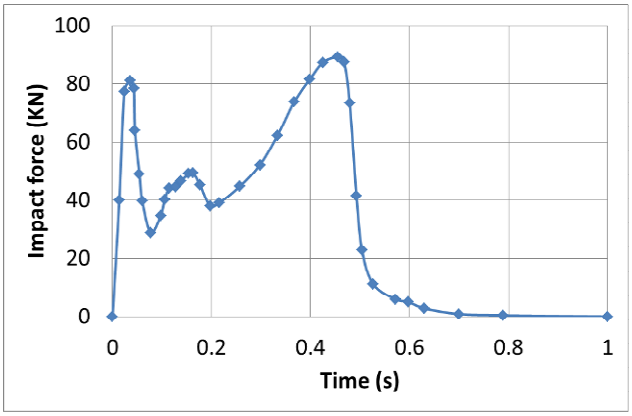

Figure 2 Impact loads of physical experiment [1]

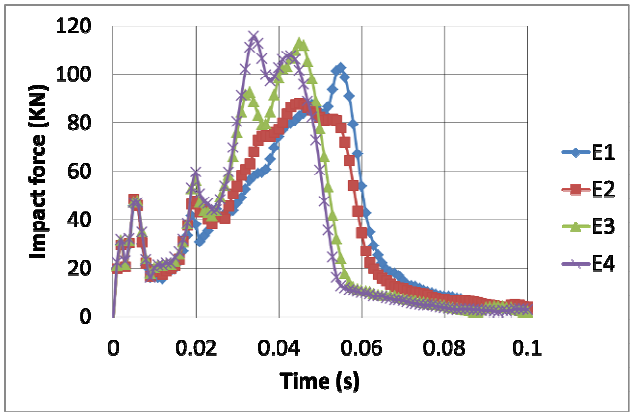

Figure 3 Impact loads of numerical analysis (series E)

It was assumed that parameters shown as case 2 in Table 1 were basis parameters to investigate effects of each parameter. Numerical analysis had been achieved. Obtained results namely impact force, transmitted force and energy during impact were investigated in different damping factors (D series), Young modulus (E series) of sand material.

4. Conclusions

Based on these results, some conclusions are as follows:

1) The time history curve of the impact force on harder material cell is steeper and has larger peak than soft material cells (Figure 3).

2) It became clear that geo-cell used in this study absorbs approximately 60% kinetic energy of weight.

3) It became clear that damping factor gave no significant affect to impact force, transmitted force and energy dissipation.

Here, fundamental results about geo-cell cushion have been shown as one of research concerning protection system. We are going to conduct research more.

References:

[1] S. Lambert, P. Gotteland, F. Nicot, *Experimental study of impact response of geocells as component of rockfall protection embankment*, Natural Hazards and Earth Systems Science, Vol. 9, P.459-467, 2009.

[2] Norimitsu Kishi, Shin-Ya Okada, Hisashi Kon-no, *Numerical impact response analysis of rockfall protection,* Structure Engineering International, Vol. 19, Number 3, p.313 – 320, 2009.

[3] Livermore Software Technology, *LS-DYNA Keyword User's Manual*, Vol. I, Version 971, May 2010