VOLUME MINIMIZATION EVIDENTIAL ON DISPOSAL STATIC COMPRESSION METHOD (RP METHOD) AND ITS APPLICABILITY FOR EARLY STABILIZATION

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INTRODUCTION
After many years, the left of lifetime of final landfill sites for disposal waste has reduced. Also, construction of landfill sites are being delayed due to difficulties in maintenance of land-use as well as landlord residents’ resistance… Insufficiency of landfill sites has become serious problem. Therefore, revision of regulations relating to closing or cancellation of landfill sites, as well as establishing methods for stabilizing disposals in early stage are hoping solutions. From the above background, self-governing bodies and research organizations are conducting various experiments for volume reducing or stabilizing disposals. This time, for the purpose of prolonging the lifetime of landfill sites and early stabilizing the disposals, evidential site experiment on method of static compression of disposals (hereafter called Refuse Press, RP, method) has been carried out. The RP method is shown in Photo 1. In this paper, outline of the RP method and experimental results are first reported, then the method applicability for early stabilizing disposals is examined.

METHOD OUTLINE
The developed RP is a method developed by statically pressed disposal for minimizing its volume. This method has been designed so that when penetration body (a special screw auger) is revolving and pressed into the disposals, it will cause them compressed sideward (to the hole wall), thus reduce their volume. Figure 1 schematically describes the construction steps.

Photo 1  Construction Device in RP Method
Since the electrical motor is used for driving (rotating and pressing) the penetration body, it does not almost raise any problems with vibration and noise. Furthermore, high torque driving equipment is used, mixing oversize disposals has made possible, and disposals of various sizes, compositions and degree of compaction can be combined using different types of penetration bodies (normally of diameter from \( \phi 850 \) to \( \phi 1500 \)). More than that, as no special materials have been added in compacting disposals, this is a non-pollution method.

**EVIDENTIAL EXPERIMENT TECHNIQUE**

Evidential experiment was conducted at a site in mountain area, which has been formed as final landfill site for general disposals, where disposal layer has reached a maximal thickness of 20m. Since the general disposals here, which were left at other sites for 2-3 years, had been smashed and then mixed with burning ashes etc. to become high density reclaimed land, therefore this landfill site is quite stiff compared to other landfill sites.

Although at the site two types of penetration body (\( \phi 850 \) to \( \phi 1500 \)) were employed, only experiments using \( \phi 850 \) penetration body (shown in Photo 2) are reported here.

Experimental layout is shown in Figure 2. According to it, one set is made from one raw with three excavation points. Construction is performed in following order: the two side points (both sides) are preceded, so that when the central point is constructed

![Fig.1 Construction steps outline](image)

![Photo 2 Penetration body \( \phi 850 \)](image)

![Fig 2 Experimental layout](image)
EVIDENTIAL EXPERIMENTAL RESULTS

Volume reduction ratio measurement results

Diameter and depth of excavated holes formed after pressing at each point tests were measured, and the inner hole volume reduction ratio (excavated hole depth / 10m length of excavation) and excavation hole volume are calculated. According to measurement results, excavated hole's depth varies from 4 to 4.4m, therefore the inner hole volume reduction ratio was about 43% in average. On the other hand, diameter of excavated hole was about 1.15 to 1.2 times of the diameter of the penetration body, creating a reduction in the hole volume of 2.6m³ in average.

Before and after conducting experiment, water level evaluation was carried out. Compared to a selected average benchmark, the average ground surface settlement (final settlement) is concluded. Based on that volume reduction ratio of the site (settlement amount / excavation length) is calculated. The measurement results indicated that, even though the ground at the experimental site is quite hard, an amount of settlement of about 1.24m was obtained, corresponding to a reduction ratio of 12.4%. For the same used diameter of the penetration body, settlement amount varies with spacing distance between excavated holes: settlement amount would be greater for narrower spacing, and vice versa. Beside that, if the ground is soft, large settlement should be expected. From now on, measured data are being accumulated in order to clarify relationships between diameter of penetration body and appropriate excavation spacing, or between initial ground strength and settlement amount.

Boring investigation results

Before and after conducting experiment, standard penetration tests and inner hole water level loading tests (pesssiometer technique) were carried out using boring holes. Prediction of compressibility and status of variation of strength were examined. In Figure 3, distributions along depth of standard penetration N-value before and after experiment are compared.

According to the results of standard penetration tests, at central location of 4 excavation points, the strength (N-value) along depth down to the bottom of excavation increased compared to that one before the experiment.

Beside that, at the location of excavated hole, the N-values are almost as low as before experiment. Since such N-value result indicates a difference from the volume reduction ratio reflecting the degree of inner hole compaction, some problems about the techniques of inner hole compaction (compaction duration, quantity of throwing etc...) are now left for examination.

Furthermore, although the influence was found down to the bottom depth of the excavated hole, at 1m below
the bottom hole depth increase in strength was not concluded. Therefore, if a clearance of 1m is left below the excavation depth, the effects to the water proof sheets or buried pipes can be considered insignificant.

**Measurement results for surrounding environment**
Using vibration and noise pollution meters, measurements of vibration and noise decreasing distance are performed on the landfill site. Measured results are shown in Figure 4.

Compared to other ground improvement methods, linearly decreasing relationships between vibration/noise levels and distance, which are similar in tendency, but lower in level values, were obtained for this method. It can be understood why once the hole are back filled, the vibration and noise levels are greater. Therefore, it is concluded that conducting RP method near residential houses in metropolis area is possible.

Furthermore, before conducting the experiment, ground surface displacement devices were installed at several points in the surrounding area of the test site. The results of measured displacement of surrounding ground due to treatment indicated that at a distance of 1.5m from the excavated hole, lateral and vertical displacements were both of 1 mm, while at distance of 2m no displacement was observed.

**EARLY STABILIZATION APPLICABILITY**
The RP method was designed for reducing the accumulated volume of disposals at landfill sites. Since during pressing penetration body, the already dense disposals are subjected to excavating and agitating, and oxygen is supplied to the disposals. By that way, the anaerobic condition has changed to aerobic condition promoting stabilization. Furthermore, as demonstrated in Figure 5, throwing gravels into the formed excavated hole to enforce the oxygen supplying and water circulating etc... can be applied as techniques for disposal early stabilization. However, because permeability of the excavated hole's wall is unidentified, it is a problem to be solved.

**CONCLUSIONS**
Regardless that this final landfill site is having been hardened compared to other general landfill sites, the use of $\Phi 850\text{mm}$ penetration body for excavation of 10m depth into the disposals resulted in a inner hole volume reduction ratio of about 43% (corresponding to a volume reduction amount of $2.6\text{m}^3$). Therefore, the applied RP method is considered to be efficient measure for prolonging the lifetime of landfill sites.

**REFERENCES**