# Compaction Characteristic of Incinerator Ash from MSW Mixed with Decomposed Granite Soil

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## 1) Introduction

The incineration of municipal solid waste produces large quantities of bottom and fly ash, which has been disposed primarily by filling in Japan. However, as landfills become undesirable other disposal methods are being sought. The promoting of utilization of incinerator ash from MSW had been a serious problem nowadays in Japan. Safe and uniform ash containing low concentration of heavy metals is produced from dealing with incinerator ash by chemical way. The MSWI ash treated by the non-hazardous process can be used in road construction safely. In the paper, incinerator ash from MSW was mixed with a kind of decomposed granite soil (Masado soil) to try to make a new subbase or base materials. The different mass ratios of mixtures of incinerator ash from MSW and Masado soil were prepared in the study. The modified proctor test and CBR test were carried out in the study. The compaction properties and CBR value of the blended mixtures were investigated and evaluated. From the result of the laboratory tests, some possible applications and commands of MSWI ash mixed with Masado soil were submitted at last.

## 2) Materials and experiments

Materials

The MSWI ash used in the study has been treated to be non-hazardous**.** A kind of chemicals called calcium sulfuration solution is used to stabilize the heavy metals in the MSWI ash. After the non-hazardous process, the leaching concentration of heavy metals is under the standard determined by the government. The MSWI ash shows weak acidity. The physical and chemical properties of MSWI ash are listed in Tables 1 and 2, respectively. In the study, the MSWI ash was dried in oven that temperature was kept at 50$^o$C. Hence, the water content of MSWI ash used in the study was almost zero.

A kind of decomposed granite soil which is called Masado soil in Japan was used in the study with optimum water content ($w_{opt}$=12.6%) under the standard proctor and optimum water content ($w_{opt}$=8.8%) under the modified proctor. The physical properties of Masado soil listed in Table 1.

Laboratory tests

In this study, the specimen combination of the incinerator ash from MSW and Masado soil mixtures was listed in Table 3. The modified proctor test was used in the study. The optimum water content of mixtures of MSWI ash and Masado soil with different content ratios was obtained by the modified proctor test.

The CBR test is commonly used to specify the bearing strength of compacted fill and road subbase. The CBR specimen size is 12.5 cm in depth and 15 cm in diameter. The specimens of mixtures were prepared at the optimum water content that obtained from modified proctor test. A compaction machine was employed to compact the mixtures with different compaction energy. After compaction, the specimens were immersed water for 4 days. Then, the CBR test was carried out.

Table 1 Physical properties of MSWI ash and Masado soil

| Classification | MSWI ash | Masado soil |
|---|---|---|
| Natural water content (%) | 40.5 | 4.0 |
| Density (g/cm$^3$) | 2.60 | 2.61 |
| LL (%) | 65.8 | 36.0 |
| PL (%) | NP | 31.0 |
| Gravel (%) | 0 | 22 |
| Sand (%) | 61 | 56 |
| Silt (%) | 20 | 10 |
| Clay (%) | 19 | 12 |
| pH | 6.5 | - |

Table 2 Chemical properties of MSWI ash

| Chemical compositions (%) | MSWI ash |
|---|---|
| $SiO_2$ | 19.0 |
| $Al_2O_3$ | 21.0 |
| $Fe_2O_3$ | 1.8 |
| CaO | 23.0 |
| MgO | 2.4 |
| $K_2O$ | 6.4 |
| $Na_2O$ | 7.5 |
| Others | 18.9 |

Table 3 Specimens combinations

| Mixtures | Mixtures ratio |
|---|---|
| MSWI ash: Masado soil ( A:M ) | 0:10 |
| | 3:7 |
| | 5: 5 |
| | 7:3 |
| | 10:0 |

**3) Results and discussion**

Fig.1 shows the results of modified compaction test of MSWI ash, Masado soil and mixtures of MSWI ash and Masado soil with mass ratios of 3:7, 5:5 and 7;3. From the Fig.1, we can find that Masado soil with 2.02 g/cm$^3$ of maximum dry density and 8.8% of optimum water content, and MSWI ash with 1.20 g/cm$^3$ of maximum dry density, 41% of optimum water content under the modified compaction energy. About the mixtures of MSWI ash and Masado soil, the influence of water content on dry density was big when the content of Masado soil in the mixtures was increased.

Fig.2 is the relationship between addition of MSWI ash and maximum dry density, optimum water content of mixtures. Increasing the addition content of MSWI ash in the mixtures, the maximum dry density of the mixtures will decrease and the optimum water content will increase. Also, addition of MSWI ash in the mixtures, maximum dry density and optimum water content of the mixtures has linearity relationships. The relation equations are listed in Fig.2. (x is the ratio of MSWI ash in the mixture)

Fig.3 shows the modified CBR (95%) of MSWI ash, Masado soil and mixtures of MSWI ash and Masado soil with different content ratio. From Fig.3, we can easily to find out the modified CBR index of mixtures of MSWI ash and Masaodo soil is bigger than that of MSWI ash and Masado soil. When the content ratio of MSWI ash is 50% in the mixtures, it can obtain the maximum CBR index. The standard from Japanese Road Association shows that as subbase materials, CBR value must be larger than 30%. All mixtures` CBR are over 30%, the mixtures of MSWI ash and Masado soil in proper content are sufficient for subbase construction.

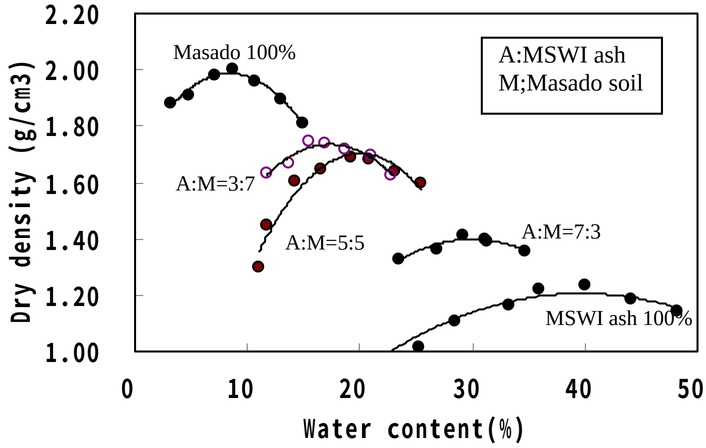


Fig.1 Compaction curves under modified proctor test

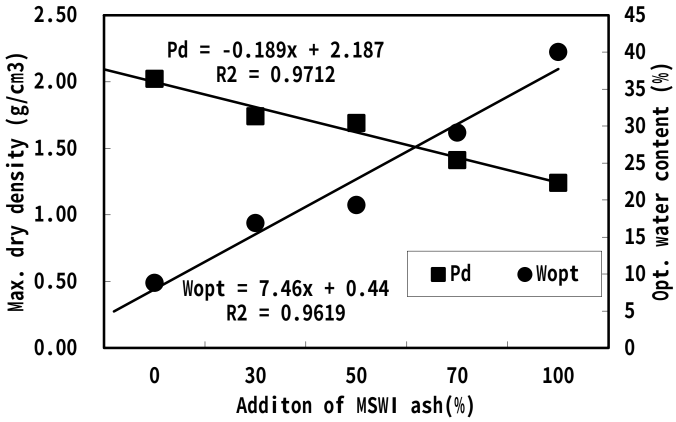
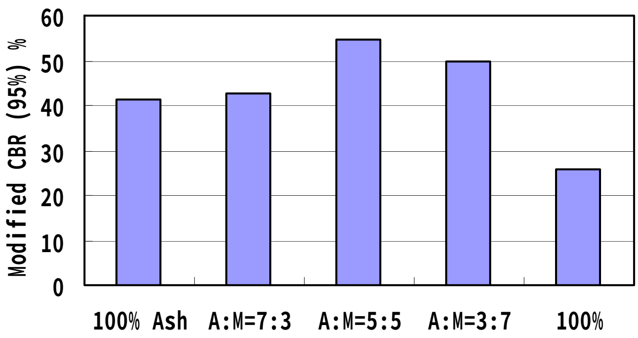


Fig.2 Maximum dry density, Opt. water content and addition of MSWI ash in the mixtures



A: MSWI ash, M:Masado soil
Fig.3 Modified CBR of the mixtures

**4) Conclusions**

From the result of the Lab tests, the mixtures of MSWI ash and Masado soil show it is possible to use as a subbase material. Both the MSWI ash and Masado soil are unbonded materials, the influence of immersing water before CBR test is serious. Hence, some bond materials will be used in the mixtures of MSWI ash and Masado soil in the next step of the study.

Reference

1) Gaofeng MA, Katsutada ONITSUKA and Takehito NEGAMI: Utilization of Molten Slag from MSW and Foamed Waste Glass as Road Materials, Proceedings of 41st Annual meeting of JGS, Kagashima, Japan, pp.567-568, 2006