Subsidence prediction of compacted subgrade soil (Kanto loam soil) using cyclic traffic loading experiments

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ABSTRACT: During road excavations for laying gas distribution pipelines, the reuse of the excavated soil for the subgrade backfill significantly reduces the environmental impact. However, when Kanto loam soil, which is a local soil that is widely distributed in the Kanto region, Japan, is employed for the backfill material, the relationship between the amount of the subsidence of the subgrade soil and the cyclic traffic loading must be investigated. In this study, cyclic loading tests on compacted Kanto loam soils are conducted to investigate the subsidence characteristics by using a confined compression apparatus. The subsidence prediction method for subgrade soil (Kanto loam soil) under cyclic traffic loading is proposed on the basis of the cyclic loading test results. Full-scale traffic loading experiments are performed on roadbeds backfilled with Kanto loam soil. Consequently, good correlation is obtained between the amount of the predicted subsidence and the measurement results.

1 INTRODUCTION

In Japan, large amounts of soil are dumped into landfills. As a result, the capacity for landfills and disposal sites is declining year-by-year, and shortage in capacity is expected in the future. Furthermore, there are other issues such as the effect on the environment from air pollution caused by CO_2, NO_x and other emissions from vehicles transporting soil and sand and from the extraction of new materials.

Confronted with this situation, the Japanese Ministry of Land, Infrastructure and Transport (JMLIT) adopted the 'Construction Recycling Promotion Plan 2002'. In this plan, the ministry set a goal for the re-utilization of 90% of the construction soil excavated for public works projects by 2010.

However, for relatively small-scale road excavation works such as the laying of gas distribution pipes, the excavated soil is not reused to backfill the roadbed, since the use of low-quality materials for the backfill can result in the gradual subsidence of the road surface under cyclic traffic loading. In particular, since the strength of Kanto loam soil, which is widely distributed across the Kanto region, can significantly decrease after being disturbed by excavation, it is not generally considered suitable for backfilling (Express Highway Research Foundation of Japan 1973). According to the soil quality classification standards for construction soil formulated by the Public Works Research Center (1997), Kanto loam soil that has been disturbed by excavation is classified as a Type 3 or Type 4 construction soil depending on its cone index, which in either case means that its use in road (roadbed) banking requires some type of special installation or stabilization technique.

Monismith et al. (1975) and Dingqing et al. (1996) proposed a prediction method for the subsidence of the roadbed based on the results of cyclic loading triaxial compression tests. According to the results, the amount of road subsidence that occurs due to cyclic traffic loading not only depends on the quality of the backfill material alone but can also vary according to the amount of cyclic traffic loading after the work is completed. As a result, even if the excavated soil is Kanto loam, there may be situations in which the soil quality and traffic loading conditions allow its use as backfill material. The use of just-excavated Kanto loam for backfill can provide benefits such as reduction in the volume of excavated soil, environmental impact and construction costs. However, it has not yet been understood what combination of backfill material and traffic loading could avoid a major subsidence.

In this study, laboratory tests are conducted on Kanto loam soil by using repeated applications of stress that corresponded to actual traffic loading, and then the amount of road surface subsidence due to cyclic traffic loading is predicted on the basis of the experimental results. Furthermore, a full-scale experiment is conducted to investigate cyclic traffic loading on a road backfilled with Kanto loam soil. Then, the measurement results are compared with the predicted subsidence values to verify the suitability of the subsidence prediction method.

2 COMPACTION CHARACTERISTICS OF KANTO LOAM SOIL

The roadbed soil conditions during the excavation and subsequent backfilling of a road affect the subsidence of a road surface. In order to investigate the roadbed soil conditions when Kanto loam is used for backfilling, compaction tests are conducted.

2.1 Soil Physical Properties

Table 1 and Figure 1 show the soil physical property test results (based on JGS 0051, JIS A 1202, JIS A 1203, JIS A 1205, JIS A 1211 and JIS A 1228) and the grain size accumulation curve (based on JIS A 1204), respectively, of Kanto loam soil used in the compaction tests. Musashino loam soil, which is known to have the typical characteristics of Kanto loam soil, is shown to have a grain density of 2.80–2.88 (g/cm^3) and natural water content of approximately 100–120 (%), and these values are similar to those of Kanto loam soil. In addition, when excavated, the cone penetration index for this soil is determined to be 334 (kPa); hence, it is classified as a Type 4 soil on the basis of the soil-type classification standards for construction soil regulated by the MLIT.

2.2 Compaction Test

2.2.1 Test Method

Table 2 shows the conditions required for the preparation of test samples. To investigate the effects of water content when compacting Kanto loam, the water contents are adjusted to 90% (test cases: A1 to A4), 100% (B1 to B4), and 110% (C1 to C4). The samples are compacted in three layers (each layer of approximately 40 mm) in steel cylindrical molds with inner diameters of 100 mm and heights of 127 mm. To investigate the effects of compaction energy, the number of compaction blows is varied for each sample. In order to avoid even the slightest variation in the characteristics due to thermal effects, the water content in the Kanto loam soil for the samples is reduced at room temperature.

The compaction energy E_c for each sample is calculated by the following Eq. (1):

$$E_c = \frac{W_R \cdot H \cdot N_B \cdot N_L}{V} \tag{1}$$

in which E_c: Compaction energy (kJ/m^3), W_R: Rammer weight (kN), H: Rammer drop height (m), N_B: Number of compacting blows per layer, N_L: Number of layers and V: Volume of compacted sample (m^3).

After the completion of soil compaction, the respective dry density (based on JIS A 1225), saturated density and the relationship between these values and the water content are obtained. Furthermore, an unconfined compression test (based on JIS A 1216) is conducted for the sample prepared under the same conditions for investigating the relationship among the unconfined compressive strength, water content and compaction energy.

2.2.2 Test Results

Figure 2 shows the relationship between compaction energy and dry density. Comparing Cases A to C, it is determined that the lower the water content, the higher is the dry density after compaction. In addition, comparing the compaction energy at 110.4 (kJ/m^3) and 882.9 (kJ/m^3), it is shown that the lower the water content, the greater is the amount of increase in the dry density. These results show that Kanto loam soil with low water content becomes more effectively compacted than that with high water content.

Figure 3 shows the relationship between the compaction energy and the degree of saturation. In all the Cases A to C, when the compaction energy is $\geq$286.9 (kJ/m^3), the degree of saturation lies in the range 94%–97%.

Figure 4 shows the relationship between the compaction energy and unconfined compressive strength. It is assumed that the unconfined compressive strength increases with lower water content. In addition, in Cases A and B, the unconfined

Table 1. Soil physical properties

Soil type	Sand mixed with volcanic cohesive soil
Soil classification type	VH_2-S
Soil grain density ρ s(g/cm^3)	2.832
Natural water content(%)	102.5
Plastic limit ω L(%)	85.3
Liquid limit ω p(%)	126.7
Plasticity index Ip	41.4
Design CBR(%)	0.7
Cone index (kPa)	334

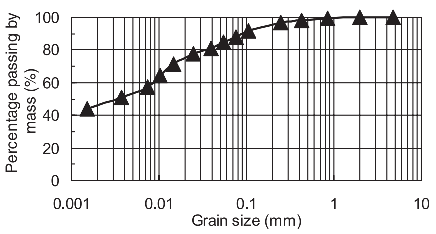

Figure 1. Grain size distribution curve.

Table 2. Sample preparation conditions

Case	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
Sample	Sand mixed with volcanic cohesive soil											
Water content w (%)	90.6	88.9	89.2	90.1	100.8	101.5	99.3	98.2	110.8	108.9	109.1	109.4
Rammer weight W (kN)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Rammer drop height H (m)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Number of compaction blows per layer N_L	5	13	25	40	5	13	25	40	5	13	25	40
Number of layers	3	3	3	3	3	3	3	3	3	3	3	3
Compaction energy (kJ/m^3)	110.4	286.9	551.8	882.9	110.4	286.9	551.8	882.9	110.4	286.9	551.8	882.9

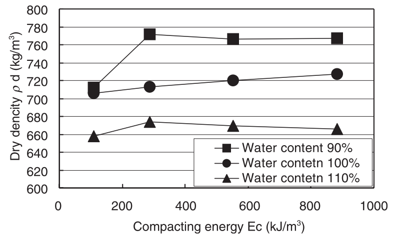

Figure 2. Relationship between compaction energy and dry density.

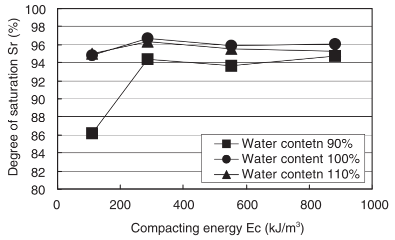

Figure 3. Relationship between compaction energy and degree of saturation.

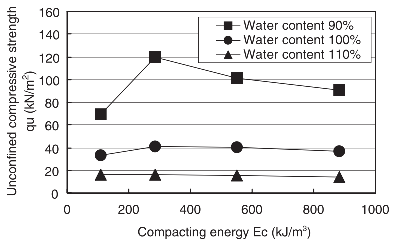

Figure 4. Relationship between compaction energy and unconfined compression strength.

compressive strength is maximized at the compaction energy of 286.9 (kJ/m^3). At higher compaction energies, the unconfined compressive strength steadily declines. These results are comparable with those in the previous publication (The Japanese Geotechnical Society 2000).

2.2.3 *Dynamic Compaction of Kanto Loam soil using Mechanical Rammer*

The optimum compaction method is experimentally investigated by using a mechanical rammer for compacting the Kanto loam soil.

The decrease in unconfined compressive strength due to the compaction that was described in the previous section is assumed to occur as follows. If excessive compaction energy is applied, the moisture absorbed into the Kanto loam soil is converted into free water; this weakens the Kanto loam soil in a manner similar to that when water is added. This phenomenon is one of the reasons for the difficulty in using Kanto loam soil for backfilling. Therefore, when Kanto loam soil is used for backfilling roadbeds, the compaction energy must be suitably adjusted.

The unconfined compressive strength increases to the maximum value at a compaction energy of approximately 300 (kJ/m^3), and this can be assumed to weaken with the application of higher compaction energy. Therefore, if Kanto loam soil is compacted at a compaction energy of approximately 300 (kJ/m^3), the optimum backfilling conditions can be achieved.

Table 3. Specifications of the mechanical rammer used in study

Engine	Two-cycle engine
Output (W)	3000
Strike number (times/s)	10
Weight (kg)	62
Strike plate	Steel

Table 3 shows the specifications for the mechanical rammer used in this study. According to George et al. (1993), when this rammer is used to compact sandy soil, the compacting energy per one rammer stroke is 66.4–75.5 (J). In addition, as shown in Figure 5, the definition of one compaction round is the up-and-back pass of a single round of compaction across an excavated trench. The actual time required for one compaction round when Kanto loam soil is used for backfilling an excavated trench of length 1.0 m and width 0.4 m and then compacting the soil surface, is approximately 60 s. For each compaction round, 600 rammer strokes with the mechanical rammer are required.

The compaction energy per unit volume absorbed by the roadbed soil can be calculated under the abovementioned conditions along with the bed layer thickness and the number of compaction rounds. Table 4 shows the calculation results for the compaction energy. For a bed layer thickness of 300 mm, the compaction energy increases up to 332.0–377.5 (kJ/m^3) per compaction round or per two compaction rounds if the bed layer thickness is 600 mm; this brings the roadbed soil relatively close to the optimum backfilling condition. However, if the bed layer thickness is significantly large, the compaction effect may not adequately reach the lower layers of the roadbed and only the surface layer may be excessively compacted. As a result, when a mechanical rammer is used for backfilling the Kanto loam soil used in this test, it would be most appropriate to compact the bed layer thickness to 300 mm with one compaction round.

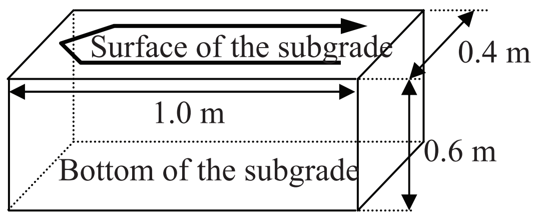

Figure 5. Backfill compaction method.

Table 4. Compaction energy of mechanical rammer

Exca-vation width (mm)	Layer thickness (mm)	Compaction number (times/layer)	Compaction energy (kJ/m^3)
400	300 (2 layers)	1	332.0~377.5
		2	664.0~755
		3	996.0~1132.5
	600 (1 layer)	1	166.0~188.8
		2	332.0~377.5
		3	498.0~566.3

3 CYCLIC LOADING TEST

A cyclic loading test is conducted to predict the amount of road surface subsidence due to cyclic traffic loading. In the past studies, the cyclic loading triaxial compression tests were conducted on soils to investigate the subsidence characteristics. However, it is thought that the lateral displacement is restricted in the backfill of the relatively small-scale road excavation works.

In this study, vertical stress loading is repeatedly applied to the same Kanto loam soil samples mentioned in the previous chapter with the lateral displacement is restricted. The relationships among the physical properties of the soil sample, magnitude and number of cyclic loading and amount of cumulative compressive strain in the sample are investigated.

3.1 Test Conditions

3.1.1 Preparation of Soil Samples

Table 5 shows the conditions for the preparation of the sample. The compaction test described in the previous chapter demonstrates that the unconfined compressive strength of compacted Kanto loam soil is dependent on the compaction energy and water content. In addition, for the maximum unconfined compressive strength, the degree of saturation is approximately 95%. Consequently, the water contents in the soil sample are adjusted to 90% (Case A), 100% (Case B) and 110% (Case C). The Kanto loam soil with adjusted amounts of water content is compacted in a steel cylindrical mold (inner diameter of 100 mm, height of 127 mm, and with the inner surface coated with silicon grease to reduce friction) so that it achieves a sufficiently compacted state with a degree of saturation of 95%.

3.1.2 Method of Loading

Figure 6 shows an overview of the device used in the cyclic loading test. Porous stones were mounted on upper and lower surfaces of the compacted samples so that the pore water and gases could be drained off from the samples. Vertical stress was repeatedly applied to the samples by using an electropneumatic transducer with a capacity of 980 kPa (Compression side: J813-004, manufactured by Moog Japan Inc.; Extension side: T6000-06U, manufactured by Fairchild Corporation).

Figure 7 shows the vertical stress loading sequence in the test. First, the vertical stress is monotonically increased upto $\sigma_{min} + (\Delta\sigma/2)$, and then the stress is repeatedly loaded and unloaded up to 100,000 times in a sinusoidal waveform at a frequency of 1 Hz for generating the minimum stress σ_{min} and the maximum stress σ_{max} values.

Table 5. Backfill compaction conditions

Case	A	B	C
Soil grain density (g/cm^3)	2.832		
Degree of saturation Sr(%)	95.0		
Dry density ρ d(g/cm^3)	0.767	0.707	0.660
Water content ω (%)	90.3	100.8	110.4

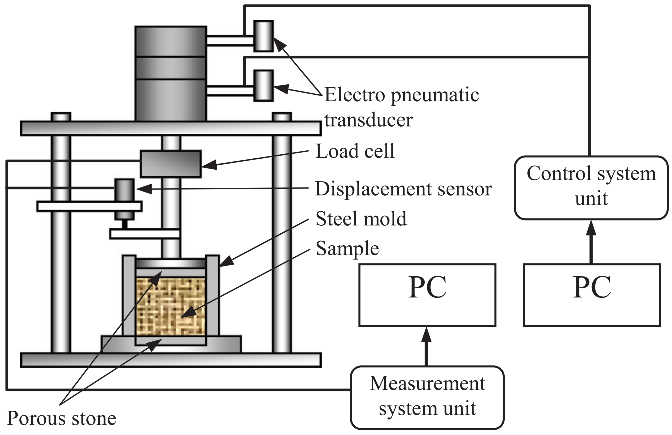

Figure 6. The device used for cyclic loading.

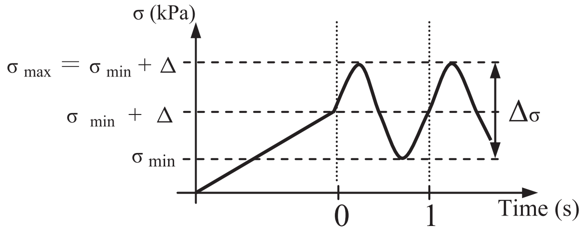

Figure 7. Cyclic loading method.

The minimum stress σ_{min} is a static soil overburden pressure of 9.2 kPa at a depth of 0.462 m corresponding to the average value of the vertical soil pressure on a typical pavement.

The maximum stress values of σ_{max} are 23.6 kPa, 62.5 kPa and 101.3 kPa, which are the maximum vertical stress magnitudes on the roadbed due to a rear wheel load of 39.3 kN.

A load cell (Capacity: 1000N, TCLZ-1000N manufactured by Tokyo Sokki Kenkyujo Co., Ltd.) is used to measure the magnitude of the acting load. In addition, an axial displacement gauge (Capacity: 30 mm, DDP-30A manufactured by Tokyo Sokki Kenkyujo) is employed to measure the vertical displacement Δl from the initial position at the top of the sample when the cyclic loading stress is $\sigma_{min} + (\Delta\sigma/2)$. As shown below in Eq. (2), the cumulative compressive strain ε is defined as the value of the measured displacement Δl divided by the initial height L of the sample.

$$\varepsilon = \frac{\Delta l}{L} \quad (2)$$

3.2 Compressive Strain of Compacted Sample

Figures 8, 9 and 10 show the relationships between the number of cyclic loadings and the cumulative compressive strain of the sample. The compressive strain increases sharply during the initial stage of loading; however, the amount of increase becomes

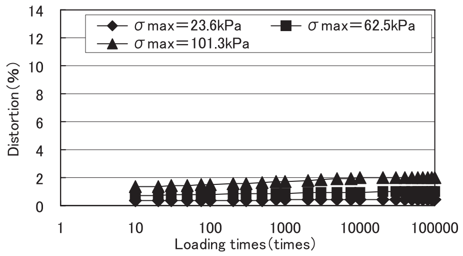

Figure 8. Relationship between the number of cyclic loading and compressive strain (Case A).

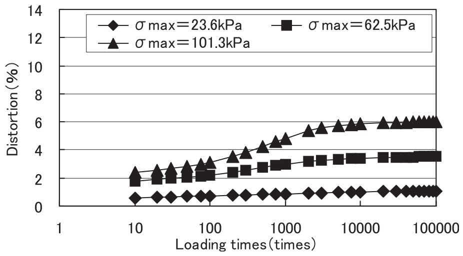

Figure 9. Relationship between the number of cyclic loading and compressive strain (Case B).

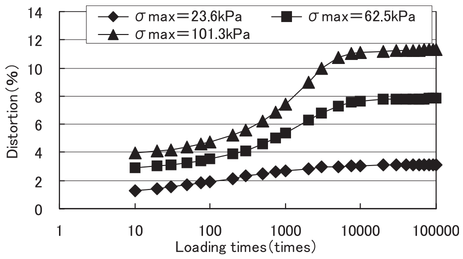

Figure 10. Relationship between the number of cyclic loading and compressive strain (Case C).

extremely small when the number of loadings reaches 10,000. Subsequently, it becomes almost constant. This implies that the magnitude of compressive strain beyond 10,000 loadings depends on the maximum value of the loading stress.

The relationship between the compressive strain for 100,000 cyclic loadings and the maximum value of stress σ_{max} is shown in Figure 11. This result shows that the compressive strain is almost proportional to the maximum vertical stress value σ_{max}.

4 PREDICTION OF SUBSIDENCE

Based on the results of the cyclic loading test described in Chapter 3, the amount of road surface subsidence due to cyclic loadings is predicted. Furthermore, a full-scale traffic loading experiment is conducted for roads backfilled with Kanto loam soil. The full-scale experimental results are compared with the predicted values.

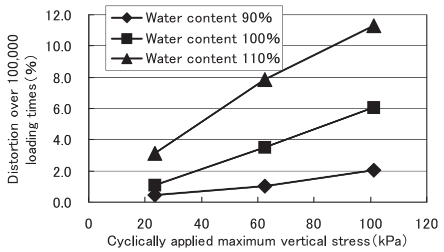

Figure 11. Relationship between the maximum vertical loading stress and compressive strain.

4.1 Prediction Method

4.1.1 Subsidence Mechanism

Figure 12 shows the mechanism assumed for the prediction of subsidence and the road model (a Type 35 asphalt-concrete mix). The amount of cumulative compressive strain due to cyclic traffic loading on the backfilled roadbed (roadbed thickness of 600 mm) is assumed to be the reason for the road surface subsidence. Since the compressive strain within the paving portion (paving thickness of 350 mm) is expected to be extremely small as compared to that induced at the roadbed portion, the paving portion is assumed to be a completely rigid body.

4.1.2 Vertical Stress Due to Traffic Loading

The vertical stress σ_z on the paving and roadbed, when the vehicles pass over the road surface is calculated as follows. By utilizing the relationship between the wheel loading and the tire air pressure *p*, Foster and Ahlvin (1954) analytically determined the vertical stress σ_z due to the wheel load by taking into account the fact that the tire air pressure *p* is evenly distributed over the contact area of a circle with radius *a*, as shown in Figure 13. The diagram in Figure 14 shows the contact radius *a*, depth *z* and vertical stress σ_z expressed in terms of the percentage of the tire air pressure *p* and distance *r* from the center of the tire. The vertical stress σ_z distributions at the wheel center (r = 0) due to a passenger vehicle (total weight 9.8 kN, rear wheel load of 3.9 kN) and a truck vehicle (total

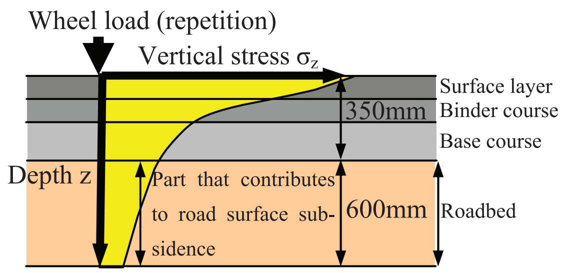

Figure 12. Stress distribution due to wheel loading.

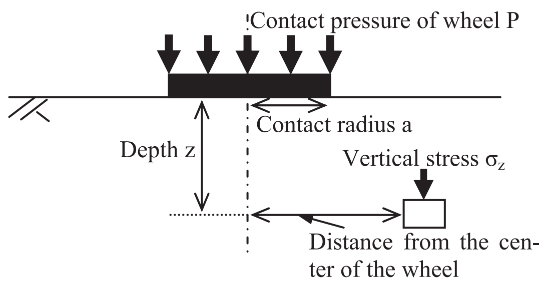

Figure 13. Contact pressure due to wheel loading.

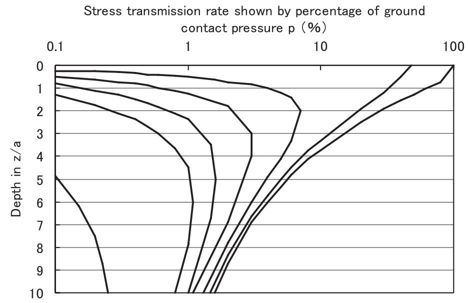

Figure 14. Relationship between vertical stress σ z and z/a (Foster and Ahlvin 1954).

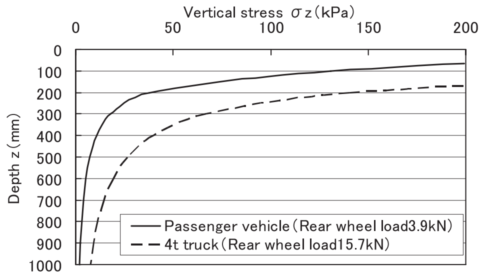

Figure 15. Relationship between the vertical stress σ z due to rear wheel loading and depth z.

weight 39.2 kN, rear wheel load of 15.7 kN) are obtained, as shown in Figure 15.

4.1.3 Prediction of Road Surface Subsidence

The subsidence of the road surface that was subjected to cyclic traffic loading and whose roadbed was backfilled with the Kanto loam soil used in the experiments in Chapter 2 and Chapter 3 was predicted. In the cyclic loading test described in Chapter 3, the compressive strain decreased significantly after the number of cyclic loadings exceeded 10,000. It is assumed that the roadbed had been sufficiently subjected to cyclic loadings when the number of cyclic loadings reached 100,000. The road surface subsidence under various conditions for water contents in the Kanto loam soil is obtained on the basis of the relationship between the maximum value of the loaded vertical stress shown in Figure 11 and the vertical stress and soil depth due to rear wheel loading shown in Figure 15, as follows.

The magnitude of road surface subsidence δ (mm) can be calculated by the integration of the compressive strain generated by cyclic traffic loading over subgrade thickness values ranging from 350 mm to 950 mm, as shown by the following Eq. (3).

$$\delta = \int_{340}^{950} \varepsilon(z)dz \tag{3}$$

in which $\varepsilon(z)$: compressive strain due to cyclic traffic loading at the depth z; z: depth from the surface (mm).

The relationship between the maximum vertical stress $\sigma_{max}(z)$ and the compressive strain $\varepsilon(z)$ obtained from the cyclic loading test described in Chapter 3 is shown in Figure 11. The linear approximate equations between $\varepsilon(z)$ and $\sigma_{max}(z)$ are obtained by using the least squares method for each water content, as follows:

$$\varepsilon_{w=90.3\%}(z) = 0.0189 \times \sigma_{max}(z) \tag{4}$$

$$\varepsilon_{w=100.8\%}(z) = 0.0582 \times \sigma_{max}(z) \tag{5}$$

$$\varepsilon_{w=110.4\%}(z) = 0.1161 \times \sigma_{max}(z) \tag{6}$$

where $\sigma_{max}(z)$: Maximum vertical stress (kPa) generated at depth z due to traffic loading.

The road surface subsidence prediction results are shown in Table 6. The roads traversed by passenger vehicles and truck vehicles experience road surface subsidence up to 14 mm, even when the water content of the Kanto loam soil is at relatively high levels of 110%.

In actual road construction, a relatively simple pavement is constructed immediately after the roadbed is backfilled and temporarily recovered. After vehicles are allowed to pass for a specific period, the final paving is reconstructed and recovered. According to the cyclic loading test results, the surface subsidence occurs during the initial stages of cyclic traffic loading and then remains at a fixed level. It is believed that (1) even during the temporary recovery stage, a compressive strain from the backfilled material accumulates in the roadbed due to cyclic traffic loading and a certain degree of subsidence occurs on the road surface and (2) after the main recovery, the amount of compressive strain that accumulates in the roadbed due to cyclic traffic loading is extremely small. This means that the road surface subsidence after the main recovery is further smaller than the amount of subsidence predicted.

From these results, it can be concluded that the subsidence calculated in this study is within an acceptable range for practical applications and that the backfilling using Kanto loam soil in this research is fully feasible for the roads, where the traffic loading level is within 39.2 kN.

4.2 Verification of the Subsidence Prediction Method

4.2.1 Full-scale Test for Traffic Loading

As shown in Figure 16, two excavated trenches are backfilled with Kanto loam soil and paved using the Type 35 asphalt-concrete mixture, which is most commonly used on the residential streets in Japan. Table 7 shows the full-scale test implementation conditions and soil physical properties for the Kanto

Table 6. Predicted results for the road surface subsidence

	Water content (%)		
	90.3	100.8	110.4
Loading conditions	Subsidence (mm) in cyclic loading in 100,000 times		
Passenger vehicle (9.8 kN)	0.6	1.9	3.8
Truck vehicle (39.2 kN)	2.3	7.1	14.1

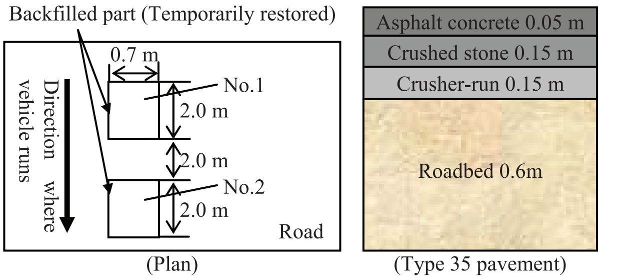

Figure 16. Full-scale test of traffic loading.

Table 7. Backfill conditions of full scale test

		No.1	No.2
Method of compaction	bed grade thickness (m)	0.3	0.3
	Compaction (round)	1	1
Soil physical properties	Name	Sand mixed with volcanic cohesive soil	
	Soil grain density (g/cm^3)	2.802	
	Plastic limit (%)	88.2	
	Liquid limit (%)	111.2	
	Design CBR (%)	0.8	
Compacted soil condition	Wet density (g/cm^3)	1.368	1.378
	Dry density (g/cm^3)	0.679	0.695
	Water content (%)	101.6	98.4
	Void ratio e	3.13	3.03
	Cone index (kPa)	521	747

loam soil used in backfilling (based on JGS 0051, JIS A 1202, JIS A 1203, JIS A 1205, JIS A 1211 and JIS A 1228). In addition, Figure 17 shows the grain size distribution curve (based on JIS A 1204). The thickness of each backfill material layer is 300 mm, and each layer is subjected to one round of compaction.

Vehicles pass over the center of the temporary recovery, as shown in Figure 16. Initially, 600 passes of a passenger vehicle of 9.8 kN are conducted and the road surface settlement is observed until no further increase in subsidence can be observed. Then, the same number of passes of a 39.2-kN truck vehicle over the temporary recovery locations is performed.

4.2.2 *Test Results*

Figure 18 shows the relationship between the number of passing vehicles and the amount of road surface subsidence observed from the full-scale traffic loading test. From the cyclic loading test performed in the laboratory, the full-scale test results confirmed a large amount of subsidence in the initial stages of loading. Although subsidence up to approximately 2 mm is observed due to the initial irregularities in the adjacent road surfaces after backfilling, the road surface settles monotonically with increase in the volume of traffic passage.

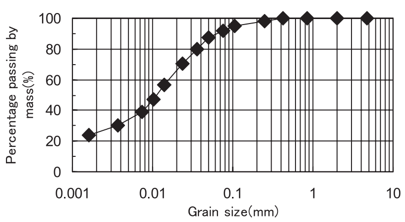

Figure 17. Grain size distribution curve.

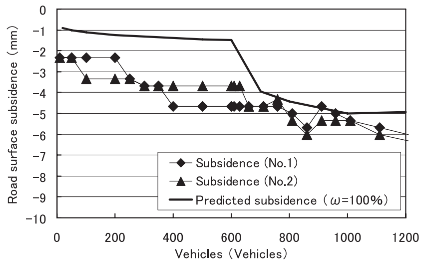

Figure 18. Relationship between the number of vehicles passing and road surface subsidence.

A difference of approximately 1 mm is observed between the observed surface settlement values at two locations (No.1 and No.2). It can be assumed that this difference results from the differences in compaction time or paving construction precision or measurement errors. Although the measured subsidence value increased by approximately 1 mm and then decreased by 1 mm for approximately 800–900 vehicle passes, it was concluded that this value must be a measurement error and therefore it was excluded from the experimental data.

4.2.3 *Comparison of Predicted Subsidence Value with Measurement Results*

The relationship between the amount of cyclic traffic loading and compressive strain (with water content of 100%) shown in Figure 9 is used to investigate the relationship among the number of passing vehicles, the maximum vertical stress value and the compressive strain. These relationships and the maximum vertical stress value for each roadbed soil depth obtained from Figure 15 are combined to predict the road surface subsidence in a full-scale test.

Figure 18 compares the predicted subsidence value with the measurement value. Comparing the measurement value from the full-scale test with the predicted subsidence value, subsidence of approximately 2 mm in the full-scale test due to the initial irregularities in the adjacent road surfaces is observed. Therefore, a difference of approximately 1–2 mm between the predicted value and measured value is observed. It is confirmed that the subsidence increases during the initial loading stage in every case, and thereafter tends to increase gradually with the number of passing vehicles. These results show that the proposed method can be used to predict subsidence due to cyclic traffic loading for road surfaces backfilled with Kanto loam soil within a reasonable range.

5 CONCLUSION

In this study, cyclic loading tests on compacted Kanto loam soils are conducted to investigate the subsidence characteristics by using a confined compression apparatus, and then the experimental results were employed to predict the amount of road surface subsidence due to cyclic traffic loading. A full-scale experiment was conducted to investigate the subsidence due to cyclic traffic loading on a road surface, which was backfilled with Kanto loam soil.

The values measured in the full-scale experiment were compared with the predicted subsidence values to verify the suitability of the subsidence prediction method. Consequently, good correlation is obtained between the amount of the predicted subsidence and the measurement results. The proposed method for predicting the road surface with the compacted Kanto loam soil can be used to predict the subsidence due to cyclic traffic loading for road surfaces backfilled with Kanto loam within a reasonable range.

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