Proceedings of the XVI ECSMGE
Geotechnical Engineering for Infrastructure and Development
ISBN 978-0-7277-6067-8

doi:10.1680/ecsmge.60678

Field measurement of Poisson's ratio for municipal solid waste

Mesures de champ du coéfficient de Poisson des déchets usuels solides

V.G. Ofrikhter*[1], M.A. Bezgodov[1], A.B. Ponomaryov[1] and I.V. Ofrikhter[1]

[1] *Perm National Research Polytechnic University, Perm, Russia*
* *Corresponding Author*

ABSTRACT Poisson's ratio is used in engineering calculations. The results of this MSW property measurements are distinguished by a large scatter of results. In the summer of 2013 field measurements of the Poisson's ratio on the MSW landfill of 7.5 m in height were carried out by a well geophone method. A 3-D seismic pickup probe was installed in a drilled uncased borehole of 100 mm in diameter. Every meter along the hole depth was measured. When measuring the near-surface wave velocity the wave arrival time was determined by the first breaks in seismograms because phase loci, automatically determined by a control program, led to considerable errors. Estimation of the first brakes was done using MASW-survey (multichannel analysis of surface waves) of the MSW mass carried out at the same time.

RÉSUMÉ. Le coéfficient de Poisson est utilisé dans les calculs d'ingénieurs. Les mesures de cette caractéristique des déchets usuels solides se distinguent par la dispersion des résultats. En été 2013 on a éffectué les mesures de champ du coéfficient de Poisson sur le massif de 7 m par la méthode de carottage sismique direct. 3-D récepteur du type de sonde a été installé dans le forage non-tubé 100 mm de diamètre. Les mesures ont été éffectuées à chaque mètre en profondeur. Lors des mesures de la vitesse superficielle le temps de l'arrivée de l'onde a été déterminé par le début du train d'ondes sur les seismogrammes puisque les holographes des phases enregistrés automatiquement font erreurs. L'évaluation des débuts d'ondes faite en même temps a été basée sur les données de levé de l'analyse multicanale des ondes superficielles de ce massif.

1 SURVEYING

The Poisson's ratio investigation of MSW was carried out on a landfill in the suburb of Perm on the top of the aged MSW mass, about 3-7 years old and 7.5m in height, by a well geophone method in July 2013 (Figure 1). An uncased borehole of 100 mm in diameter and 6 m in depth was drilled on the top of the MSW mass (Figure 2). At short notice after the completion of drilling a 3-D seismic pickup probe was installed in the borehole (Figure 3 and 4).

Data were recorded with the sampling period of 0.25 ms and the record length of 4096 readings. 4-fold stacking was applied due to the low level of the ambient noise. External synchronization was provided by short circuit under the sensitivity equal to 1.

Figure 1. General view of waste mass.

A start-record signal was sent to the computer via the USB interface by a cable synchronization system.

Figure 2. Borehole drilling on the top of MSW mass.

Figure 3. Probe installation into the borehole.

Before the start of the field measurements after the installation of the probe into the borehole the assembled seismic system was tested by means of the operational software. The complete seismic system test included the control of the main seismic channel parameters, such as noise, a nonlinear distortion factor, geophone sensitivity and phase variation, crosstalk, in-phase rejection. The seismic cables test included a nonlinear distortion factor, a number of connected geophones, geophone resistance.

Figure 4. Surveying (vertical shot).

The measurements were carried out at 5 levels – 5.8 m, 4.5 m, 3.8 m, 2.8 m, 1.8 m. In each point the surveillance was done firstly when striking vertically (Figure 5) and then horizontally across the probe axis (left and right shots) and along the axis (forward and backward shots) (Figure 6). The shots were done straight near the wellhead and at the two offsets, of 2 and 4 m, respectively. During the measurements, the air-gas environment was monitored. The content of methane near the wellhead came to more then 2,81%, and that of hydrogen sulphide amounted 1,2% (Figure 7)

Figure 5. Set of equipment for vertical shot.

Figure 6. Set of equipment for horizontal shot.

Figure 7. Air-gas environment control. Readings displayed on the monitor: TKD (metane) – 2.81%, H_2S – 1.2%.

2 SURVEY RESULTS

As a result of observations seismic signals were registered and recorded in the host PC. Primary data processing and seismogram summation with the help of the control program were done directly during the measurements. The initial seismogram obtained at the depth of 5.8 m and the offset of 4 m when striking vertically is presented in Figure 8.

Seismogram analysis shows that when moving the source point away from the wellhead the quality of shear wave seismograms recorded through channels 2, 3 gets slightly better. At the same time, the quality of pressure wave seismograms (channel 1) when approaching the wellhead does not get worse. The influence of pressure waves on the seismograms of shear waves is also obvious. It complicates the determination of wave arrival time due to some distortions.

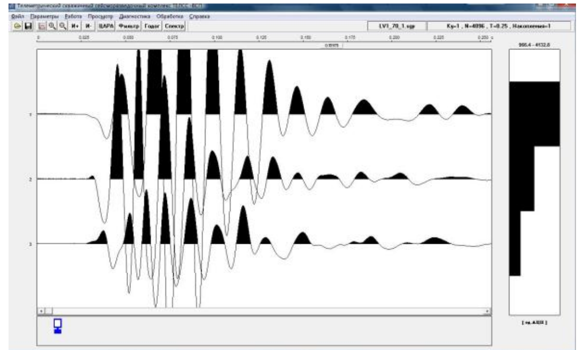

Figure 8. Initial downhole seismogram at vertical shot. Offset from the wellhead is 4 m. Depth is 5,8 m. Amplitude amplification – 4. Positive half-wave is coloured black. Channel 1 (from the top) is P-wave, channels 2, 3 are S-waves.

The results of seismic well lodging are listed in Table 1. They are rather depth nonuniform and show some horizontal anisotropy of MSW properties. This feature was firstly observed by Matasovic and Kavazanjian in 1998.

Table 1. Results of seismic well logging surveillance.

Depth	t_p	t_{s1}	t_{s2}	V_p	V_{s1}	V_{s2}	μ_1	μ_2
5,8	0,02638	0,04181	0,04144	219,9	138,7	140,0	0,17	0,16
4,5	0,02114	0,03581	0,03781	212,9	125,7	119,0	0,23	0,27
3,8	0,01631	0,0295	0,03153	233,0	128,8	120,5	0,28	0,32
2,8	0,01088	0,0186	0,02244	257,4	150,9	124,8	0,24	0,35

Comments to the table:

V_p is pressure wave velocity

V_s is shear wave velocity

$k = V_p^2 / V_s^2$

$\mu = (k-2)/(2k-2)$ is Poisson's ratio

The determination of the Poisson's ratio for the whole thickness of the waste seems to be more significant. For this purpose the probe must be installed in close proximity to the bottom boundary of the MSW mass (in the present case at the depth of 5.8 m).

The measurements made by the well-geophone method were estimated by the results of multichannel analysis of surface waves (MASW) survey, carried out at the same place a month earlier. The surface wave velocity V_R, measured during the survey was 110 m/s. The maximal ratio between the surface and shear waves is 0.915. Thus, the estimated shear wave velocity, calculated by the results of the MASW survey was equal to

$$V_s = V_R / 0.915 = 120 / 0.915 = 131\, m/s$$

which is close to the shear wave velocity, measured by the well geophone method at depth 5.8 m.

3 CONCLUSION

Field measurement of the Poisson's ratio for MSW confirmed the horizontal anisotropy of the MSW properties. The Poisson's ratio determination is more appropriate as an average value along the whole depth of the waste mass, because MSW is characterized by significant heterogeneity. The results of the MASW survey can be used for the estimation of the measured shear wave velocity.

REFERENCES

Matasovic, N. & Kavazanjian, E. jr. 1998. Cyclic characterization of OII landfill solid waste. *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, **124**(3), 197-210.