RESİLİENT MODULUS TESTS FOR GEOGRİD REINFORCED CONSTRUCTION AND DEMOLOTION WASTE (CDW)

Talha Sarici
Inonu University, Civil Engineering Department, Malatya, Turkey

Bahadır Ok
Adana Science and Technology University, Civil Engineering Department, Adana, Turkey

Senol Comez & Aykan Mert & Muhammet Komut & Şenol ALTIOK
Republic of Turkey General Directorate of Highways, Ankara, Turkey

ABSTRACT

The use of construction and demolition waste (CDW) in construction constitutes a significant step towards a more sustainable society and also creates a new market opportunity to be exploited. In recent years, several cases studies have emerged in which CDW were used in geotechnical applications, such as filling materials and in unbound pavement layers. In this paper, the behavior of CDW, natural granular material (PMT) and the mixture of 50% CDW and 50% PMT investigated experimentally. The resilient modulus test device was used for this study. The main purpose of this work is to determine the influence of geogrid reinforcement on resilient modulus and permanent deformation. Cylindrical specimens with 15 cm diameter and 30 cm length were prepared with a vibratory proctor device for resilient modulus test. For this reason, a single layer geogrid was placed at depths of 7.5 cm of the test specimen. As a result of this study, it is seen that the use of geogrid in the CDW, PMT and mixture of 50% CDW and 50% PMT may be used for road base construction reduces the permanent deformation value. The maximum resilient modulus was observed in PMT specimen.

Key words: Demolotion waste, resilient modulus, geogrid, permanent deformation

1. INTRODUCTION

Construction and demolition waste (CDW) is one of the heaviest and most voluminous waste streams generated in the Turkey . Waste is consists of numerous materials, including concrete, bricks, gypsum, wood, glass, metals, plastic, solvents, asbestos and excavated soil, many of which can be recycled. CDW arises from activities such as the construction of buildings and civil infrastructure, total or partial demolition of buildings and civil infrastructure, road planning and maintenance waste.

The use of construction and demolition waste (CDW) in construction constitutes a significant step towards a more sustainable society and also creates a new market opportunity to be exploited. In recent years, several cases studies have emerged in which CDW were used in geotechnical applications, such as filling materials and in unbound pavement layers. In this paper, the behavior of CDW, natural granular material (PMT) and the mixture of 50% CDW and 50% PMT investigated experimentally.

2. MATERIALS

2.1 Granular base course material

A mixture of granular materials have different size was used in the base course layer. Particle size distribution of the mixture of granular materials is suitable for used in road according to Road Technical Specification of Republic of Turkey General Directorate of Highways (Figure 2). Large scale direct tests were performed to the granular material at normal stress levels which are 25, 50 and 75 kPa. In the result, friction angle of the granular material was found 62 degree. Properties of granular base course material are shown in Table 1.

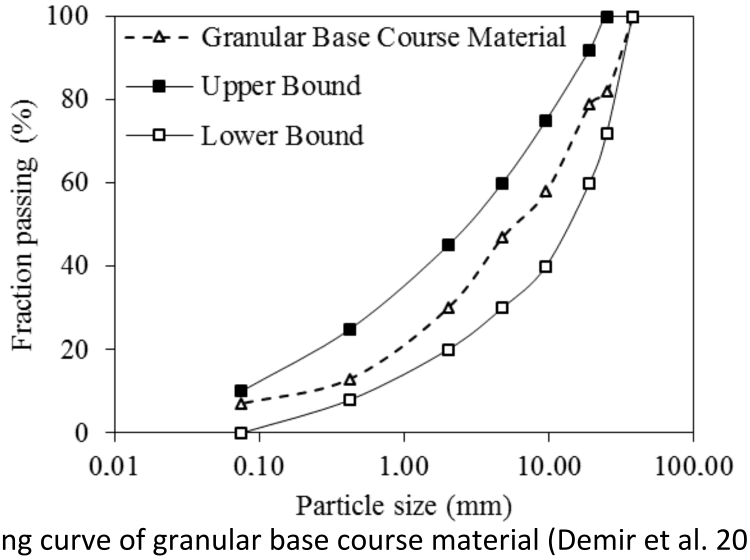


Figure 1. Grading curve of granular base course material (Demir et al. 2016)

Table 1. Properties of granular base course material.

Property	Unit	Value	
		Modified Compaction	Vibratory Compaction
Maximum Dry Density (γ_{kmax})	kN/m^3	22.48	23.45
Optimum Moisture Content (ω_{opt})	%	4.6	4.0
Liquid Limit (LL)	%	N.P. (Non-Plastic)	
California bearing ratio (CBR)	%	252-246	
Los Angeles Abrasion loss	%	30	
Water Absorption	%	0.82	
Methylene Blue Test	%	1.25	
Friction Angle	Degree	62.07	

Table 2. Construction and Demolition Waste (CDW) General Characteristics (Ok & Demir, 2018)

Property	*Unit*	*Value*
Coefficient of Uniformity (Cu)	%	41.87
Curvature Coefficient (Cc)	%	1.06
Flatness Index	%	11.68
California bearing ratio (CBR)	%	33.58
Grain Unit Volume Weight (γs)	kN/m^3	26.30^i-26.10^k
Water Absorption	%	6.82^i-4.06^k
Maximum Dry Density (γ_{kmax})	kN/m^3	20.77
Optimum Moisture Content (ω_{opt})	%	9.7
California bearing ratio (CBR)	%	99.98
^{i} Fine Grain (4.75 mm under sieve), Coarse Grain (4.75 mm over sieve)		

According to HTS (Highway Technical Specification, 2013), while the Los Angeles abrasion percentage, flatness index and CBR value of the construction debris waste material is suitable for use as filling material in the basic subbase fillings, the water absorption percentage is slightly higher. According to UCSC, the ground class GW of both CDW and NA aggregates is determined as “Uniform Grade Distributed Gravel”.

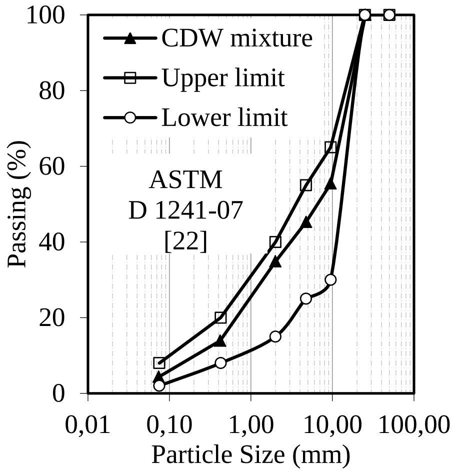


Figure 2. CDW Gradation and Border Gradations (Ok and Demir, 2018)

Table 3. General Properties of Natural Aggregate (NA) (Ok, 2018)

Property	*Unit*	*Value r*
Coefficient of Uniformity (Cu)	%	35.88
Curvature Coefficient (Cc)	%	1.89
Flatness Index	%	12.66
California bearing ratio (CBR)	%	23.40
Grain Unit Volume Weight (γs)	kN/m^3	26.90[i]-27.10[k]
Water Absorption	%	0.40[i]-0.36[k]
Maximum Dry Density (γ_{kmax})	kN/m^3	23.90
Optimum Moisture Content (ω_{opt})	%	6.0
California bearing ratio (CBR)	%	125.16
[i i] Fine Grain (4.75 mm under sieve), Coarse Grain (4.75 mm over sieve)		

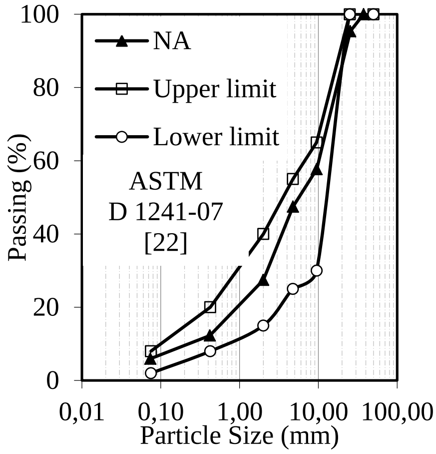


Figure 3. Natural Aggregate (NA) Gradient (Ok, 2018)

2.2 Geosynthetics

Triaxial geogrid were used to reinforce the base layer in the large scale cyclic plate load test sections. In addition, woven geotextile were used to separate the base layer from the weak soil. The physical and mechanical properties of geogrid and geotextile, as provided by the manufacturers, are listed in Table 4. Photographs of Geosynthetics are presented in Figure 4.

Table 4. Geosynthetics properties

Properties	Unit	Geogrid
Raw Material	-	Polypropylene
Aperture Type	-	Triangle
Aperture Dimensions	mm	40x40x40
Thickness	mm	1.1
Static Penetration Resistance	kN	-
Tensile Strength at 5% strain, md/cmd*	kN/m	300

* md/cmd: machine direction/cross machine direction

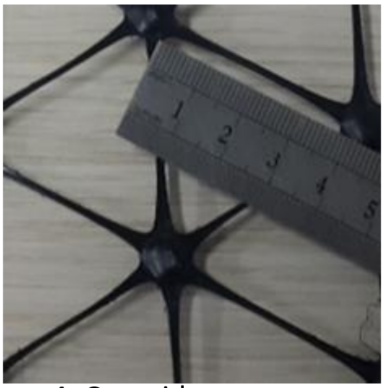
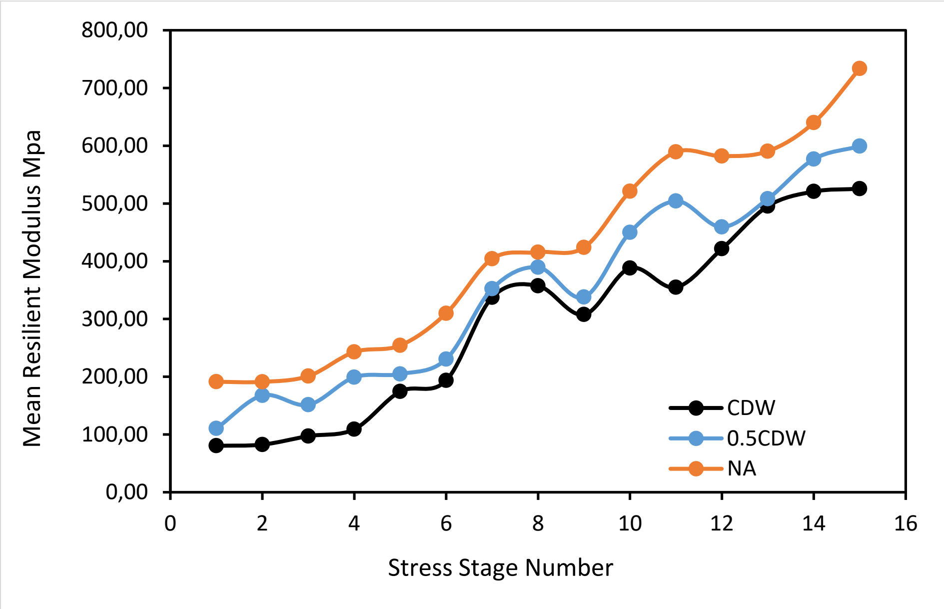


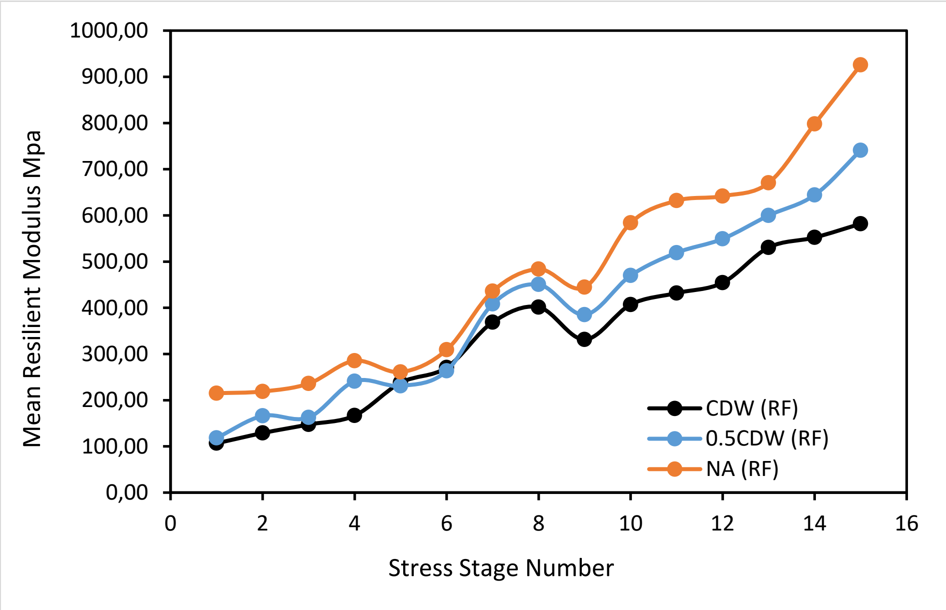
Figure 4. Geogrid

3. EXPERIMENT RESULTS

The resilient modulus test device was used for this study. The main purpose of this work is to determine the influence of geogrid reinforcement on resilient modulus and permanent deformation. Cylindrical specimens with 15 cm diameter and 30 cm length were prepared with a vibratory proctor device for resilient modulus test. For this reason, a single layer geogrid was placed at depths of 7.5 cm of the test specimen. As a result of this study, it is seen that the use of geogrid in the CDW, PMT and mixture of 50% CDW and 50% PMT may be used for road base construction reduces the permanent deformation value. The maximum resilient modulus was observed in PMT specimen.



Resilient modulus tests on pure samples (without reinforcement) (Construction and demolition waste: CDW; half-mix of construction and demolition waste with natural ground: 0.5CDW, natural ground: NA)



Resilient modulus tests of geogrid reinforced samples (without reinforcement) (Construction and demolition waste: CDW; half-mix of construction and demolition waste with natural ground: 0.5CDW, natural ground: NA)

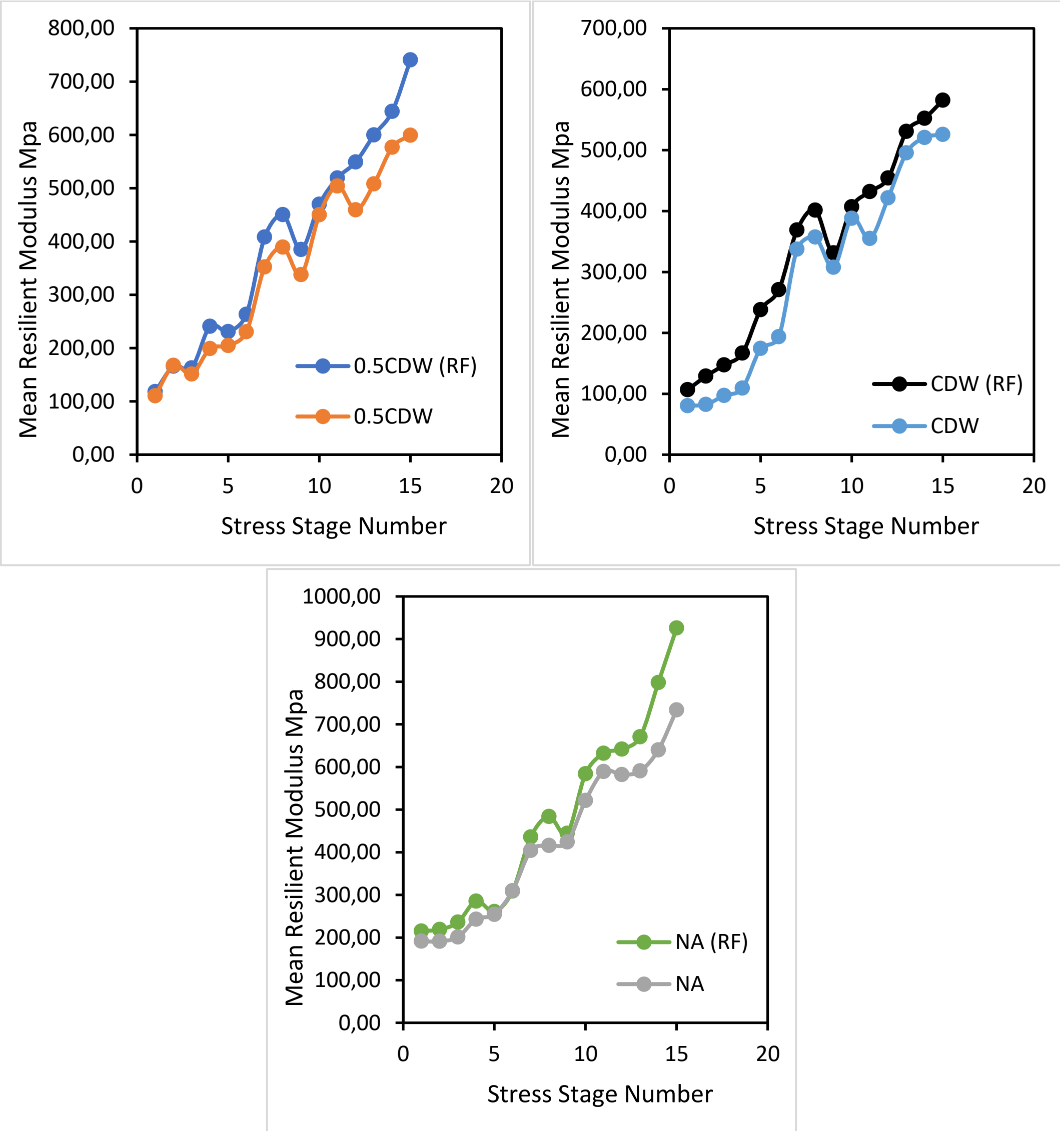


Figure 6. Comparison of experiments with and without reinforcement

4. RESULTS

The behavior of the aggregates under repetitive loads was investigated by fresilient modulus experiments.

As the loading step for each sample increased, the average resilient modulus value calculated for the step generally increased.

In the case of a Geogrid reinforcement, the values of the resilient modulus for each sample increased in general.

The best performance was obtained from experiments with natural aggregate as expected.

The elastic modulus values obtained from the resilient modulus test of the mixture of construction and demolition waste and natural aggregate were determined to be less than the natural aggregate more than construction and demolition waste.

The performance of construction and demolition waste is improved with natural aggregate. In addition, since the resilient modulus values of construction and demolition waste compared to natural aggregate are not very low, it can be said that it can be used only as a granular floor according to the resilient modulus test. However, in order to be able to make a clear statement for this, it has to be done in other traditional laboratory experiments.

5. REFERENCES

HTS (Highway Technical Specification) , 2013

Ok, B., Demir, A., 2018. Yapım Yıkım Atıklarının Yol Temellerinde Kullanılabilirliğinin İncelenmesi. Ömer Halisdemir Üniversitesi Mühendislik Bilimleri Dergisi, 7(1):224-236.

Ok, B. (2018). "Geosentetiklerle Güçlendirilmiş İnşaat ve Yıkıntı Atığı Dolguların Statik ve Tekrarlı Yükler Altındaki Davranışının İncelenmesi, Doktora Tezi, Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Adana.