ISSN 2286-4822
www.euacademic.org

EUROPEAN ACADEMIC RESEARCH
Vol. V, Issue 1/ April 2017

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

The role of gypsum addition to the soil on the relation of wet bulk density with shearing strength and penetration resistance

HUSAMULDEEN A. TAWFEEQ[1]
Agricultural Researchers Directorate
Ministry of Science & Technology, Baghdad, Iraq
MUSTAFA Z. ABD ALHAMEED
State of Forests and Desertification
Ministry of Agriculture, Baghdad, Iraq
ABDULWAHAB A.R. AL-KAYSSI
Tikrit University, College of Agriculture. Tikrit, Iraq

Abstract:

A laboratory experiment was conducted to test the role of gypsum addition rates on the relation between soil wet bulk density with shearing strength and penetration resistance. Soil samples with S_0*(0),* S_1*(100),* S_2*(200),* S_3*(300),* S_4*(400) and* S_5*(500) g gypsum* kg^{-1} *soil were prepared by mixing materials from surface soil (non gypsifesous) layer with pure with different gypsum content were samples were wetted at 50% of field capacity water contents 11.69 , 10.86, 10.39, 8.44 and 8.20% for soil samples* S_0*,* S_1*,* S_2*,* S_3*,* S_4 *and* S_5 *respectively. Soil samples were incubated for 60 days in plastic bags with continual daily mixing. After the incubation period, Soil samples were air dried, grinded and sieved through 2mm sieve. Soil sample were packed into a standard rings to a bulk density of 1.25 Mg* m^{-3}*. Wet. Shear strength and soil penetration resistance were determined at o, 33, 100, 300, 500 and 1000 kpa. Results shows that both soil shear strength and penetration resistance were increased with increasing soil moisture tension. On the other hand wet soil bulk density was decreased by increasing moisture tension.*

[1] Corresponding author: husam59@yahoo.com

Key words: Gypsum content, Shear strength, penetration resistance

INTRODUCTION:

Soil bulk density values changes, when soil moisture content varies, due swelling and shrinkage. These two processes occurred in soil system when soil moistening and drying happens alternatively special in soil which have 1:2 clay minerals (Dianqing etal.,2004). Rossignol and Debayle (2002) reported that wet soil bulk density increased when soil water content increased by 13% due to soil porosity decreasing and soil particles compression. Almost there were an inverse relationship between wet soil bulk density and soil water content because of soil particle becomes more closer when soil moisture decreased (Aimrun etal.,1986 and Reichert etal.,2004). Soil shearing strength had a correlating relationship with gypsum content in soil, Al-Qaissy (1989) reported that the increasing in gypsum content up to 38% causing remarkable decreasing in soil shearing strength. Ayers (1987) concluded that shearing strength increased with increasing soil bulk density barring from this the sandy soils.

Soil penetration resistance is an a soil physical character which reflect soil physical agricultural condition (Meek etal.,1992). Almost soil penetration resistance increased by decreasing soil moisture content in sandy loam and loamy sand soils (Ohu et al., 1987) . As well Rossignol and Debayle (2002) founds that soil plasticity becomes more rigid when soil moisture content decreases so that penetration resistance increases. In general soil penetration resistance was affected by many soil physical characteristics such as bulk density water content, texture, organic matter content and soil structure (Lai and Shulkla,2004).

MATERIALS AND METHODS:

Soil sample was collected from a soil profile located at Tuwaitha site 40Km south of Baghdad at 33^0 20 north latitude and 44^0 52 east longitude. The soil was classified as calcareous and city clay loam textured. Table 1 shows some physical and chemical soil characteristics. Air dried soil sample was sieved through a 2 mm sieve.

Table 1: Some soil physical and chemical characteristics.

Character		Value
Sand Silt Clay	g kg^{-1}	191.70 422.40 385.90
Texture		Silt Clay Loam
Bulk Density	Mg m^{-3}	1.30
Ec_e	dS m^{-1}	4.00
pH		7.20
$CaCO_3$	g kg^{-1}	4.50

Different content of gypsum soil samples was prepared through mixing soil sample with different amounts of gypsum as fellow: S_1(100) ,S_2(200), S_3(300),S_4 (400) and S_5(500) g gypsum kg^{-1} Soil. The sample were wetted to a half of field capacity water content with 11.7, 10.9, 10.4, 8.4, 8.4 and 8.2% for S_0, S_1, S_2, S_3, S_4 and S_5 respectively. Soil samples were incubated for two months in plastic bags with daily mixing after that soil samples were air dried, grinded and sieved through a 2mm sieve. Soil samples with different gypsum content, volumetric water content was estimated by using pressure plate apparatus according to Black (1965).

Soil shearing strength was estimated at different moisture content at 33, 100, 300, 500 and 1000 kpa by using electrical shearing strength apparatus model MI.SO-1038 according to Tiwari and Marui (2005). Soil penetration resistance was determined at different moisture content ranged between 33- 1000 kpa using pocket penetrometer model El-700.

Soil wet bulk density was calculated for soil samples through the relation between wet weight and total bulk volume as:

$\ell_{bw} = M_{moist} / V_t$............(1)

where:

ℓ_{bw}: wet bulk density(Mg m^{-3}).

M_{moist}: Soil sample wet weight (Mg).

V_t: Soil total bulk volume (m^3).

Soil particle size analysis determined using pipette method as indicated in black (1965). Soil electrical conductivity and pH were determined according to standard methods as mentioned in Page et al.,(1982).

RESULTS AND DISCUSSIONS:

Soil wet bulk density and shearing strength

Figure 1 shows the relation between soil wet bulk density and soil shearing strength at different gypsum content . Negative logarithmic relationship with r^2 values ranged from 0.85-0.97 was found between them at 0, 100, 200, 300, 400 and 500 g gypsum kg^{-1} soil. It is clearly appeared that soil shearing strength were increased by decreasing of wet bulk density with increasing soil moisture tension at all gypsum percent content.

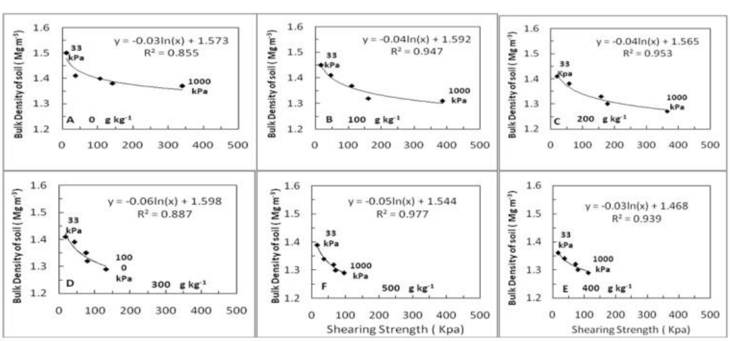

Fig. 1 : Relation between wet soil bulk density and soil shearing strength .

This behaviorism was due to decreasing in soil voids values (Table 2) to a range between 14.75 to 24.50% by increasing gypsum content from 0-500 g gypsum kg^{-1} soil, because the settlement of fine gypsum particles in soil pores causing a decreases in soil voids and increasing in soil shearing strength (Al-Qaissy 1989). Also figure 8 (A,B,C) shows a markable increasing in shearing strength by increasing of the tension from 33 to 1000 kpa as well as decreasing in wet soil bulk density. Decreasing parentage in wet soil bulk density reaches to 8.6 and 9.9% for soil samples with 0, 100 and 200g gypsum kg^{-1} soil respectively. Slight increasing in shearing strength were found in soil sample with 300, 400 and 500g gypsum kg^{-1} soil (Fig. 8 D, E and F). Schmertmann (1975) and Mulgueen etal. (1977) founds that soil shearing strength criteria increases with soil bulk density increasing and this depends on soil type and gypsum content.

Table 2: Effect of soil gypsum content on soil voids value at different moisture tensions.

Moisture tension (kpa)	**soil Gypsum Content (g kg⁻¹)**					
	0	**100**	**200**	**300**	**400**	**500**
33	1.22	1.12	1.12	1.12	1.04	1.00
100	1.22	1.17	1.12	1.08	1.04	0.92
300	1.22	1.12	1.12	1.08	1.08	1.04
500	1.22	1.17	1.12	1.12	1.00	0.96
1000	1.22	1.12	1.12	1.17	1.08	0.96

Soil wet bulk density and soil penetration resistance

Figure 2 shows there were a negative logarithmic relationship between wet soil bulk density and soil penetration resistance at different gypsum content (0, 100, 200, 300, 400 and 500 g gypsum kg^{-1} soil) .

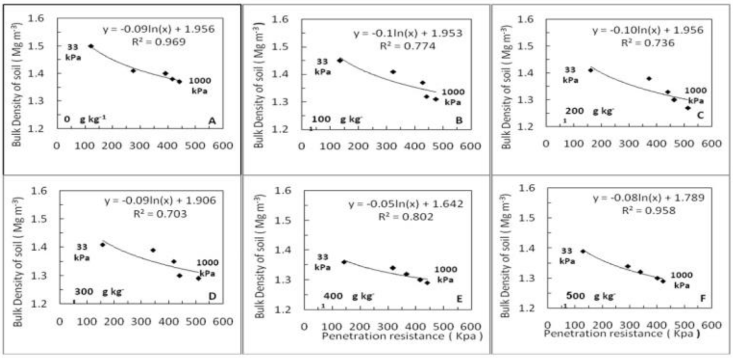

Fig. 2: Relation between wet soil bulk density and soil penetration resistance.

There were noticeable increasing in penetration resistance with decreasing in wet soil bulk density values by increasing moisture at all levels of gypsum content. This increasing in soil penetration resistance can be explained due to increasing in cohesion force and joining degree between soil particles with decreasing in soil moisture content also the reduction in water coating films around soil particle which decreasing the slipping forces between soil particles (Manuwa and Olaiya,2012).

Results in Fig. 8 indicates a huge increasing in soil penetration resistance when moisture tension increases from 33 to 1500 kpa, this increasing reaches up to 124, 140 130, 119, 124 and 126% at gypsum content treatments 0, 100, 200, 300, 400 and 500 g gypsum kg^{-1} soil respectively. This behavior can be explained that the soil at 33kpa is semi saturated soil but at 1500 kpa is dry soil and there were a noticeable decreasing in water holding capacity (table 3).

Table 3: Soil volumetric water content at different levels of gypsum content and moisture tensions.

Moisture tension (kpa)	soil Gypsum Content ($g\ kg^{-1}$)					
	0	**100**	**200**	**300**	**400**	**500**
0	0.55	0.54	0.54	0.53	0.51	0.51
33	0.27	0.26	0.24	0.21	0.21	0.20
100	0.22	0.21	0.21	0.16	0.16	0.15
300	0.18	0.16	0.15	0.14	0.13	0.12
500	0.17	0.15	0.14	0.13	0.13	0.11
1000	0.16	0.14	0.13	0.13	0.12	0.11

REFERENCES:

1. **Aimrun, W., Amin, M.and Eltaib, S., 2004.** Effective porosity of paddy soils as estimation of it's saturated hydraulic conductivity. Malaysia. Geoderma, 121:197-203.
2. **Al-Qaissy, F. F.,1989.** "Effect of gypsum content and its migration on compressibility and shear strength of the soil, M.Sc. Thesis, Building and Construction Department, University of Technology.
3. **Ayres, P. D., 1987.** Moisture and density effects on soil shear strength parameters for coarse soils. TRANSACTIONS of ASAE., 30(5): 1282-1287.
4. **Black, C.A., Evans, D.D., White, J.L., Ensminger, L.E., Clark, and F.E. (Eds.), 1965.** Methods of Soil Analysis. Part I. Agron. Monogr. 9. ASA, Madison, WI.
5. **Dianqing, L. S.,Mongon, H. Robert, and Chunping,L.,2004.** Effect of changing bulk density during water desorption measurement on soil hydraulic properties. Soil Science. 169. 5:319-329.
6. **Lal, R. and Shulkla, L., 2004.** Principles of Soil Physics. Ohio State University, Columbus, Ohio , U.S.A.
7. **Manuwa, S. I. and Olaiya, O. C., 2012.** Evaluation of shear strength and cone penetration resistance behavior

of tropical silt loam soil under uni-axial compression. Open J. Soil Sci. 2: 95-99.

8. **Meek, B. D., Rechel, E. R., Carter, L. M. and De Tar, W. R .,1992.** Bulk density of a sandy loam : Traffic , tillage , and irrigation-method effects . Soil Sci. Soc. Am. J., 56: 562-565 .
9. **Mulqueen, J., Stafford, J. V. and Tanner, D. W., 1977.** Evaluation of penetrometers for measuring soil shear strength. J.Terra mechanics, 14(3): 137-151.
10. **Ohu, J., Ayotamuno, M. M. and Folorunso, O. A.,1987.** Compactioncharacteristics of prominent agricultural soils in Borno state of Nigeria. ASAE., 30 (6) :1575-157.
11. **Page, A. L., Miller, R. H. and Keeney, D. R.,1982.** Methods of Soil Analysis. Part 2. Chemical and Microbiological properties, 2nd edition, Am. Soc. Agron. Inc. publisher, Madison, Wisconsin, USA.
12. **Reichert, J. M. d., Silva, V. R. and Renert, D. J.,2004.** Soil moisture, penetration resistance, and least limiting water range for three soil management systems and black beans yield. Soil Department, Federal University of Santa Maria, Santa Maria-RS, Brazil.
13. **Rossignol, J. and Debayle C. 2002.** Relationships between mechanical properties, penetration resistance and bulk density in reconstituted Anthroposols. Institut National d'Horticulture, 2 rue LeNotre,Angers,France. Available:http://www.cababstractsplus.org/google/abstract.asp?AcNo=20033038363 [9/21/2007]
14. **Schmertmann, J. H., 1975.** Measurement of in situ shear strength. proceedings of the conference on in situ measurement of soil properties Vol. (2). Pp. 57-138. Cited in Ayres, P.D. 1987. Moisture and density effects on soil shear strength parameters for coarse soils. Trans. ASAE., 30(5): 1282-1287.

15. **Tiwari, B., and Marui, H., 2005.** A new method for the correlation of residual shear strength of the soil with mineralogical composition. J. Geotech. Geoenviron. Eng. 131 (9): 1139–1150.