EFFECT OF MOISTURE CONTENT OF COHESIVE SUBGRADE SOIL

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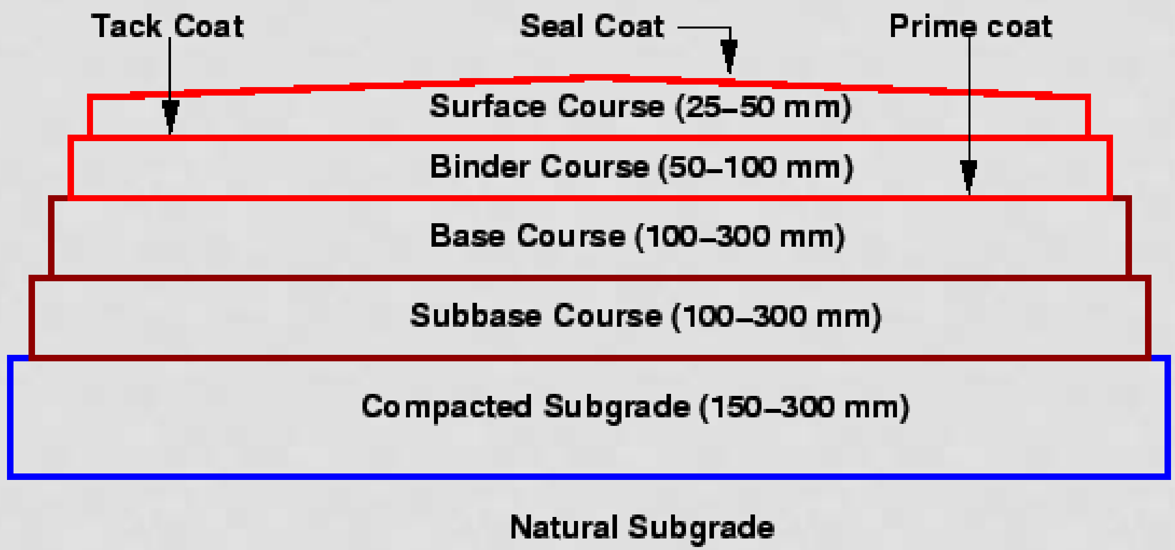
INTRODUCTION

- Subgrade soil is a very important material to support highways. The performance of the pavement is affected by the characteristics of the subgrade.



Typical cross section of flexible pavement (Mathew, 2009)

INTRODUCTION

- Resilient modulus is used to characterize pavement materials under loading conditions that will not result in failure of the pavement system. Stiffness is the most important fundamental property of pavement materials and it is explain by resilient modulus (Buchana, 2007).
- Resilient modulus means the ability of the material to return to its original form after being loaded at certain level of stress.
- Soil is a very variable material, it's related with soil texture, moisture content, density and strength. Moisture content has a significant influence on the resilient modulus for fine grained soil.

Disturb soil used in this study is Batu Pahat clay taken from the Research Centre of Soft Soil (RECESS)- UTHM

Soil Characteristic	value
Natural water content (%)	92.88
Liquid limit (%)	55.54
Plastic limit (%)	24.58
Plastic index (%)	30.96
Spesific gravity	2.61
Particles : Gravel fraction, percent retained above sieve 4,75 mm (%) Coarse fraction, percent retained above sieve 0.075 mm (%) Fine fraction, percent passing sieve 0.075mm (%)	0 5.87 94.13
USCS / AASHTO Classification	CH / A-7-6
Optimum water content (OMC) (%)	28%
Maximum Dry Density (MDD) gr/cm^3	1.85

METHODS

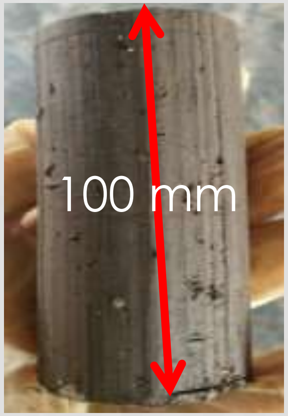
- A standard proctor test is used to determine the maximum dry density (MDD) and optimum moisture content (OMC).
- Each sample has been compacted at five different moisture contents (OMC-10%OMC, OMC-20%OMC, OMC, OMC+10%OMC, OMC+20%OMC) before the test of resilient modulus (M_R).
- The resilient modulus test was conducted on fine materials as per the standard AASHTO T.307 using the machine Load Trac II (Geocomp).
- The soil sample was prepared with a 50 mm diameter and height of 100 mm.
- The cyclic axial stress using a haversine-shape consists of a 0.1 second load pulse followed by a 0.9 second rest period.

Testing sequence for subgrade soil (Type II). (AASHTO T-370)

Sequence No.	Confining Pressure (S_3)		Max.Axial Stress (S_{max})		Cyclic Stress (S_{cyclic})		Constant Stress (0.1 S_{max})		No. of Load Application
	kPa	psi	kPa	psi	kPa	psi	kPa	psi	
0	41.4	6	27.6	4	24.8	3.6	2.8	0.4	500-1000
1	41.4	6	13.8	2	12.4	1.8	1.4	0.2	100
2	41.4	6	27.6	4	24.8	3.6	2.8	0.4	100
3	41.4	6	41.4	6	37.3	5.4	4.1	0.6	100
4	41.4	6	55.2	8	49.7	7.2	5.5	0.8	100
5	41.4	6	68.9	10	62	9.0	6.9	1.0	100
6	27.6	4	13.8	2	12.4	1.8	1.4	0.2	100
7	27.6	4	27.6	4	24.8	3.6	2.8	0.4	100
8	27.6	4	41.4	6	37.3	5.4	4.1	0.6	100
9	27.6	4	55.2	8	49.7	7.2	5.5	0.8	100
10	27.6	4	68.9	10	62	9.0	6.9	1.0	100
11	13.8	2	13.8	2	12.4	1.8	1.4	0.2	100
12	13.8	2	27.6	4	24.8	3.6	2.8	0.4	100
13	13.8	2	41.4	6	37.3	5.4	4.1	0.6	100
14	13.8	2	55.2	8	49.7	7.2	5.5	0.8	100
15	13.8	2	68.9	10	62	9.0	6.9	1.0	100

Moisture content for soil testing

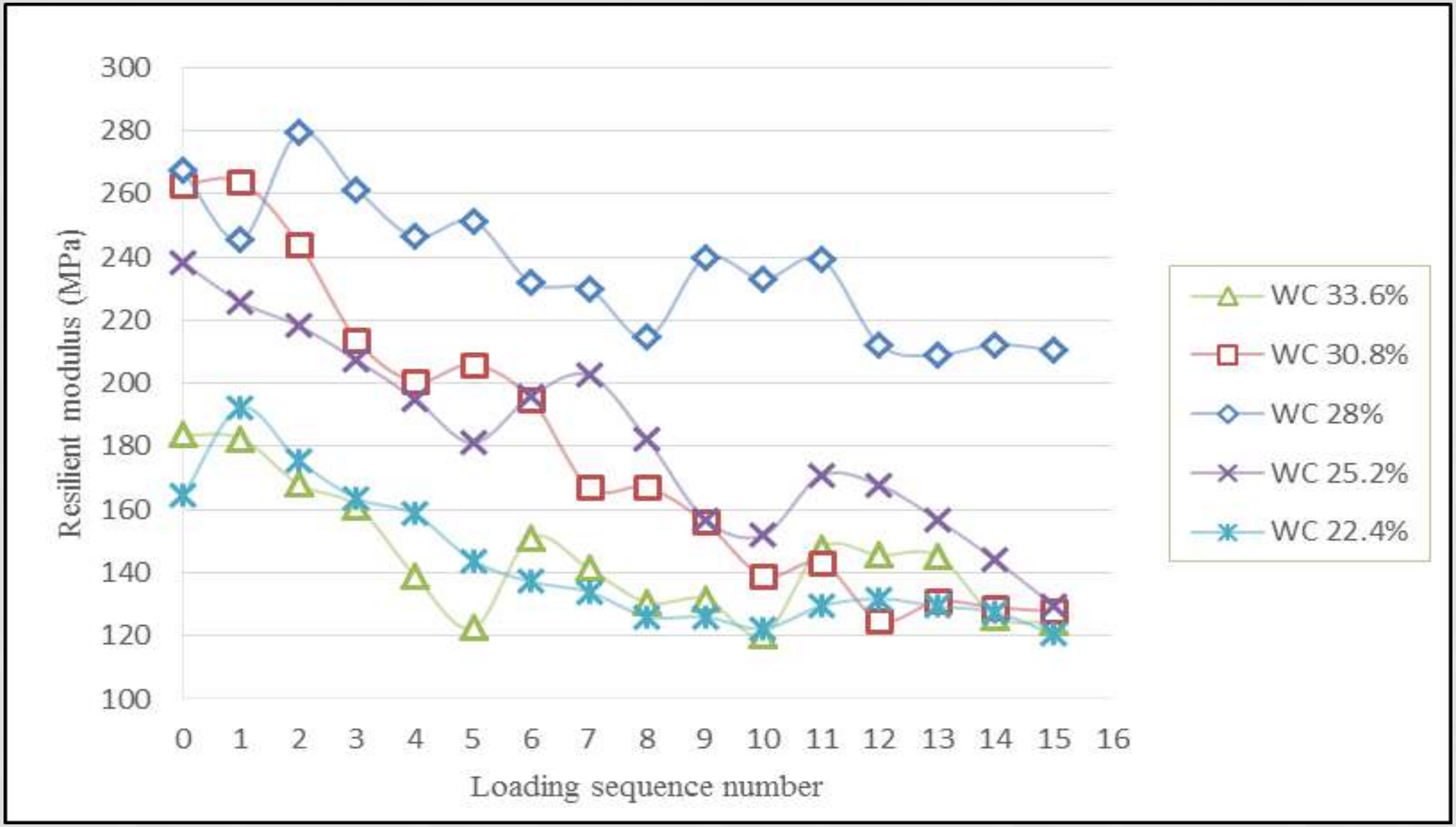
Target moisture content (%)	Moisture content of M_R test (%)	Moisture condition
22.4	21.87	OMC- 20%*(OMC)
25.2	24.65	OMC- 10%*(OMC)
28	27.85	OMC
30.8	30.23	OMC+ 10%*(OMC)
33.6	33.34	OMC+ 20%*(OMC)



Soil samples for resilient modulus test


Geocomp LoadTrac II testing machine for resilient modulus test

RESULT

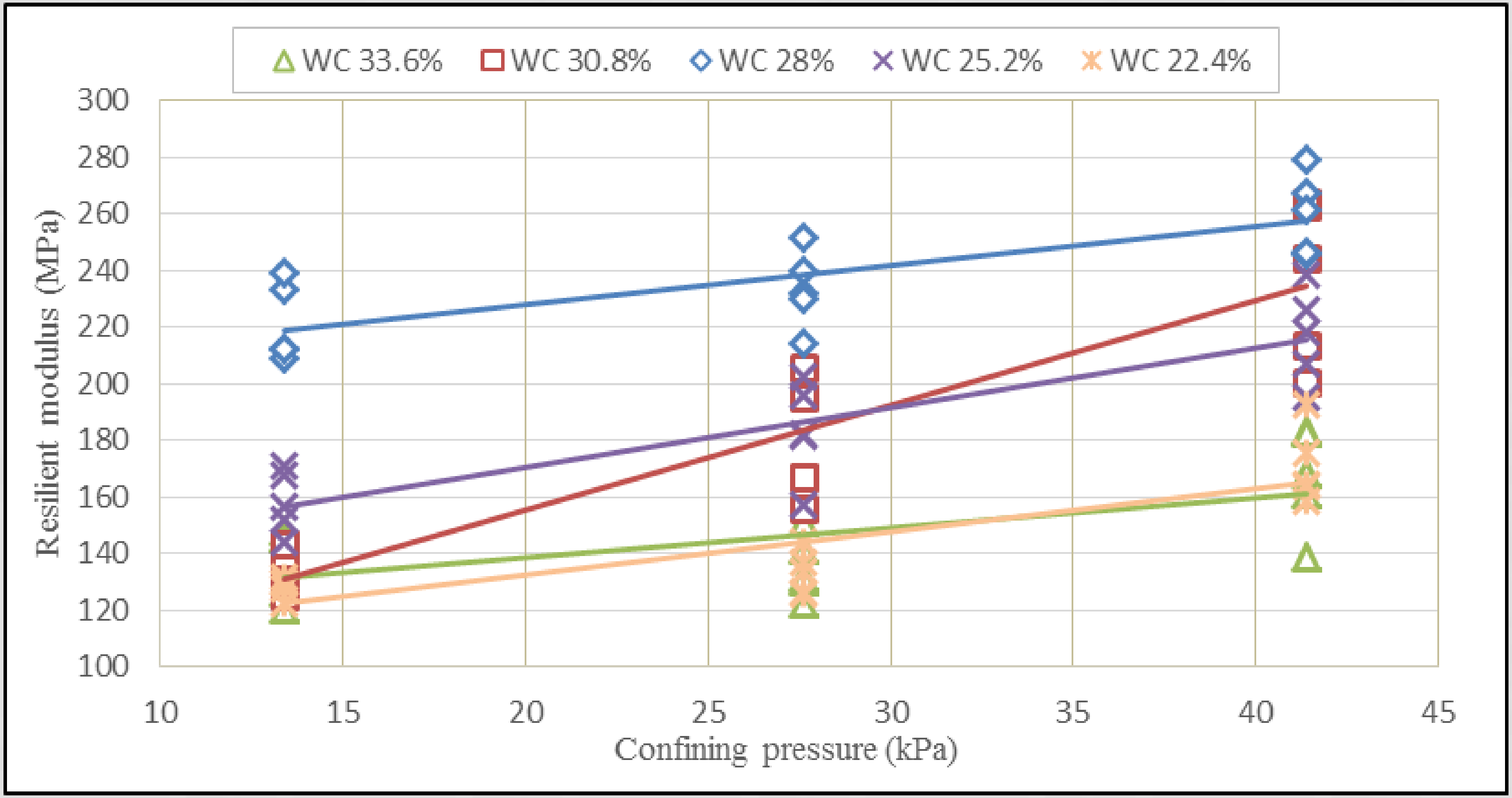


Resilient modulus value of various of moisture content for each loading sequence number

RESULT

- The influence of the moisture content on the mechanical strength of soil.
- The highest resilient modulus (M_R) value is at the OMC condition. According to the OMC-MDD curve, this can be explained when the sample is not at the optimum moisture content (OMC) point, and the dry density of soil is not at the maximum dry density (MDD) condition but at a position lower than the maximum dry density.
- Addition of more water soil can produce its saturation and it’s very difficult to compact, also if compaction is for soil with low water content

RESULT

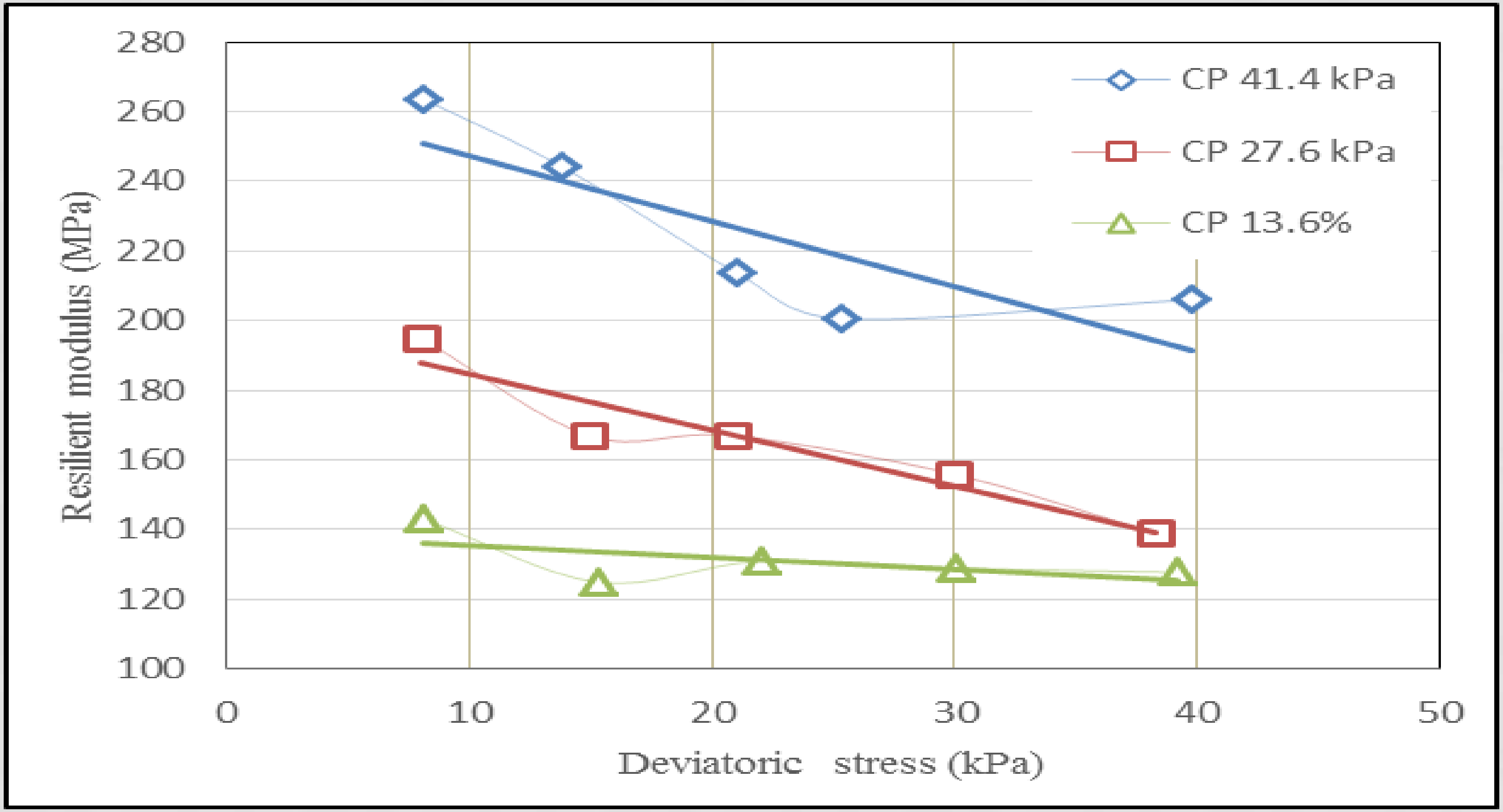


Resilient modulus vs confining pressure at various water content

RESULT

- The resilient modulus (M_R) value changes when the moisture content increases or decreases from the optimum moisture content.
- When the water content increases by 10% of OMC (+2.8%) and decreases by 10% of OMC (-2.8%), the M_R value respectively decreases by 24% and 22%.
- When the water content increases by 20% of OMC (+5.6%) and decreases by 20% of OMC (-5.6%), the M_R value respectively decreases by 39% and 40%.

RESULT



Resilient modulus vs deviatoric stress for 30.8% of moisture content

RESULT

- The influence of the deviator stress on the resilient modulus of cohesive subgrade showing that the decrease of the resilient modulus as the deviator stress increased at a constant confining pressure.
- The resilient modulus increases with the increase of confining stress and decreases slightly as the deviator stress increases

CONCLUSION

- Resilient modulus of subgrade is one of the key material properties that is required for pavement design and analysis. Cyclic repeated load that is used on the resilient modulus test is used to simulate the traffic load condition.
- The resilient modulus of subgrade is not strength but stiffness where a subgrade can support a high amount of load applied with very slight deformation.
- Moisture content has a significant effect on cohesive soil type on the dry-wet conditions, this causes the decrease of resilient modulus.
- The resilient modulus increases due to an increasing moisture content until it reaches the optimum moisture content, the increase of water content next will cause a decrease on resilient modulus.
- Clay has a high sensitivity to moisture content variation that very significanly affects the changes of the resilient modulus (M_R) value.

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THANK YOU