Study on Behavior of Soil using Gypsum

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***Abstract*- There are several places in the world particularly middle East Asia and Africa has problem of gypsum contaminated soil known as gypsiferous soil. Gypsiferous soils cover approximately 100 million hectors in the world.**

Gypsum not only dissolve in presence of water it also changes geotechnical properties of soil. In the current study effect of gypsum on Atterberg limits and compaction character tics of soil was studied.

Different percentage of gypsum was added with a soil from Raipur to simulate the conditions of Gypsiferous soil. Laboratory test were conducted to determine effect of gypsum content on liquid limit, plastic limit and compaction characteristics of soil. It was noted that with increase in gypsum content liquid limit and plastic limit of soil decreased.

The Maximum Dry Density (MDD) was noted to decrease continuously on increasing gypsum content. Although, some deviation was noted, in general a trend of increasing Optimum Moisture Content (OMC) was noted with increase in gypsum content.

***Index Terms*- Soil, Gypsum, Atterberg Limit, OMC/MDD, CBR.**

INTRODUCTION

There are several places in the world particularly middle East Asia and Africa has problem of gypsum contaminated soil known as gypsiferous soil.

The origin of sulphate ions in the soil solution is in some circumstances due to the presence of sulphur-rich minerals such as pyrite in the parent material. By weathering and oxidation, the sulphur in these minerals is transformed into sulphuric acid which in calcareous soils reacts with CaCO3 to form gypsum.

On irrigated land, leaching of saline soils containing sulphate and calcium in the soil solution leads in some circumstances to the precipitation and accumulation of gypsum in the subsurface horizon.

The formation of gypsum may result from replacement of NaCl by CaSO4 when the irrigation water contains a substantial amount of calcium and sulphate. But it could be also a result of a partial leaching of salts from the soil because NaCl is much more soluble than CaSO4. It has been observed in the Euphrates Basin, that gypsum is recrystallized and redistributed in the soil profile after leaching of other, more soluble, salts.

Gypsiferous soils cover approximately 100 million hectors in the world (Verheye and Boyagiev, 1997). Gypsum not only dissolve in presence of water it also changes geotechnical properties of soil.

Therefore detailed investigation is required to find out the change in geotechnical properties of gypsum contaminated soil. In soils with a recent accumulation of gypsum, the salt-affected horizon overlies the gypsic horizon. In the case of old or residual gypsum, the accumulation of soluble salts occurs either in the gypsic horizon or at lower depths.

RESULTS AND DISCUSSION

1. Variation of Swelling (Murram soil)

- Free swelling test was performed on Raipur soil by successive increment of percentage of gypsum by weight.
- Gypsum was added to the soil by 2, 4, 6, 8 and 10% by weight. It was noted that increase in gypsum content increases the swelling of soil.

Table 1 Variation of swelling of Murram due to increase in gypsum content

Gypsum content (in %)	Swelling in water		Swelling in kerosene	
	Initial	Final	Initial	Final
0%	11	12	11	11
2%	11	13	11	11
4%	11	13	11	11
6%	11	13.5	11	11
8%	11	14	11	11
10%	11	14	11	11

2. Variation of Atterberg limits (Murram soil)

Atterberg Limit tests are performed on Raipur soil by successive increment of percentage of gypsum by weight. Gypsum was added to the soil by 2, 4, 6, 8

and 10% by weight. The change in liquid limit and plastic limit due to increase in gypsum content is presented below. It was noted that with increase in gypsum content atterberg limits of soil decreased.

Table 2 Variations in atterberg limits (Murram soil)

Gypsum content	Liquid limit	Plastic limit	Shrinkage limit
0%	30	17.4	12.5
2%	27.5	16.5	11.8
4%	26.2	15.9	11.3
6%	25.4	15.4	10.9
8%	24.7	15	10.5
10%	24.1	14.3	10.2

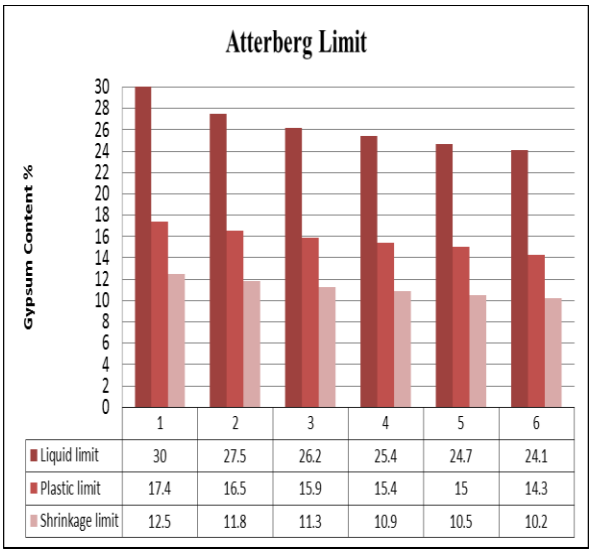

Fig. 1 showing variations in atterberg limits (Murram soil)

3. *Variation of Optimum Moisture content and Maximum dry density (Murram)*

Table 3 Variation of Optimum Moisture content and Maximum dry density (Murram)

Gypsum content (%) by weight	OMC (%)	MDD (gm/cc)
0	10.4	1.82
2	7.4	1.78
4	8.3	1.72
6	9.4	1.62
8	11.4	1.55
10	13.2	1.32

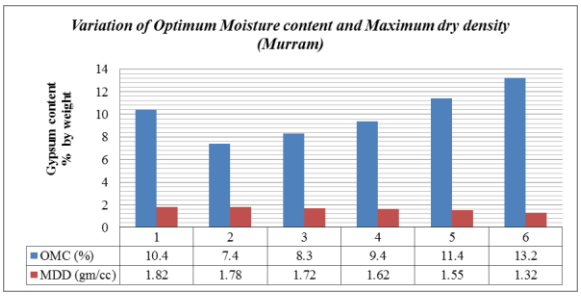

Fig. 2 showing variation of OMC and MDD (Murram)

4. Variation of Swelling (Black Cotton Soil)

- Free swelling test was performed on Raipur soil by successive increment of percentage of gypsum by weight.
- Gypsum was added to the soil by 2, 4, 6, 8 and 10% by weight. It was noted that increase in gypsum content increases the swelling of soil.

Table 4 variation of swelling of Black cotton soil due to increase in gypsum content

Gypsum content % by weight	Swelling in water		Swelling in kerosene	
	Initial	Final	Initial	Final
0%	11	12.5	11	11
2%	11	13.2	11	11
4%	11	13.8	11	11
6%	11	14	11	11
8%	11	14.5	11	11
10%	11	14.8	11	11

5. *Variation of Atterberg Limits (Black Cotton Soil)*

Atterberg Limit tests are performed on Raipur soil by successive increment of percentage of gypsum by weight. Gypsum was added to the soil by 2, 4, 6, 8 and 10% by weight. The change in liquid limit and plastic limit due to increase in gypsum content is presented below. It was noted that with increase in gypsum content atterberg limits of soil decreased.

Table 5 Variations in atterberg limits

Gypsum content % by weight	Liquid limit	Plastic limit	Shrinkage
0%	52	20.1	9.5
2%	48.5	18.7	8.8
4%	46.5	16.3	8.3
6%	42	15.5	7.7
8%	40.7	15	7.1
10%	39.1	14.6	6.7

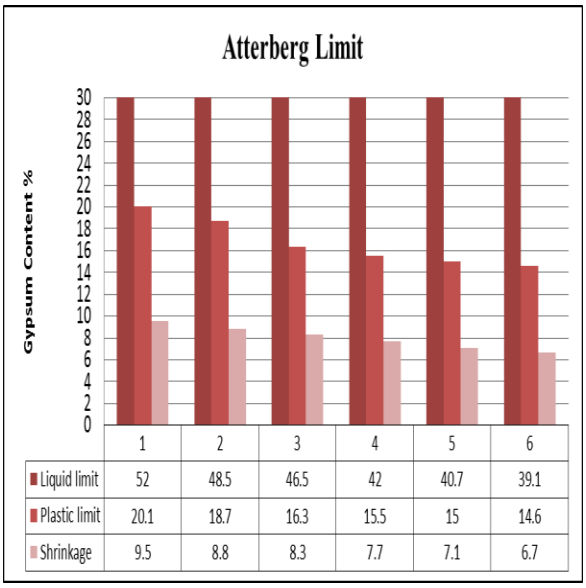

Fig. 3 showing variations in atterberg limits

6. *Variation of Optimum Moisture content and maximum dry density (Black cotton soil)*

Table 6 variation of optimum moisture content and maximum dry density (black cotton soil)

Gypsum content (%) by weight	OMC (%)	MDD (gm/cc)
0	12	2.5
2	10.9	2.13
4	11.4	1.78
6	12.2	1.34
8	13.3	1.25
10	13.2	1

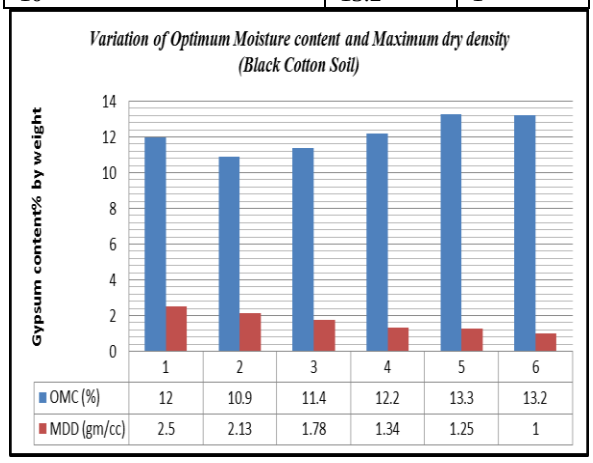

Fig. 4 showing variations in OMC and MDD (black cotton soil)

7. *CBR Test (Murram)*

Table 7 CBR test variation with gypsum (Murram)

S. No.	DIAL GAUGE Reading	PROVING RING Reading Gypsum					
		0%	2%	4%	6%	8%	10%
1	0	0	0	0	0	0	0
2	0.5	4.5	4.1	3.9	3.5	2.9	1.9
3	1	8	6	5.4	4.9	4.3	3.9
4	1.5	11.9	10.5	9.8	8.6	7.8	6.5
5	2	13	12.3	11.5	10.8	9.7	8.9
6	2.5	14.9	13.8	12.3	11.8	10.2	9.6
7	3	15.2	14.2	12.5	12.7	12.9	10
8	4	15.5	14.5	13	13.4	13.1	11.5
9	5	15.7	14.6	13.4	12.4	13.3	14.5
10	7.5	20	19.2	14.8	13.5	13.4	14.1
11	10	27.5	25	22.4	21.5	20	19.8
12	12.5	35.2	33	31.5	29	27	26.5

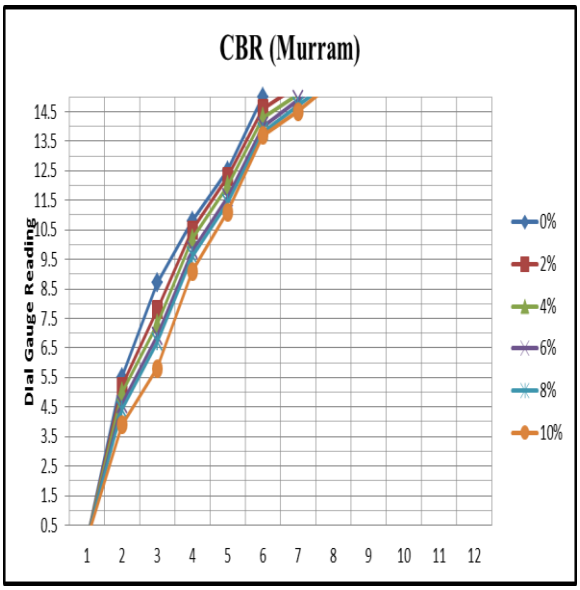

Fig. 5 showing variations in CBR (Murram)

8. *CBR Test (Black cotton soil)*

Table 8 CBR test variation with Gypsum (Black cotton soil)

S. No.	DIAL GAUGE Reading	PROVING RING Reading Gypsum					
		0%	2%	4%	6%	8%	10%
1	0	0	0	0	0	0	0
2	0.5	5.5	5.2	5	4.6	4.4	3.9
3	1	8.7	7.8	7.3	6.9	6.7	5.8
4	1.5	10.8	10.5	10.2	9.8	9.6	9.1
5	2	12.5	12.3	12	11.6	11.4	11.1
6	2.5	15	14.6	14.3	14	13.8	13.7
7	3	15.6	15.4	15.1	14.9	14.7	14.5
8	4	16.3	16.2	16	15.8	15.6	15.5
9	5	17.1	16.9	16.5	16.2	16	15.6
10	7.5	20.3	19.9	19.4	19	18.8	18.7
11	10	26.8	26.1	25.8	25.5	25.1	24.7
12	12.5	34.6	34	33.7	33.1	32.6	31.9

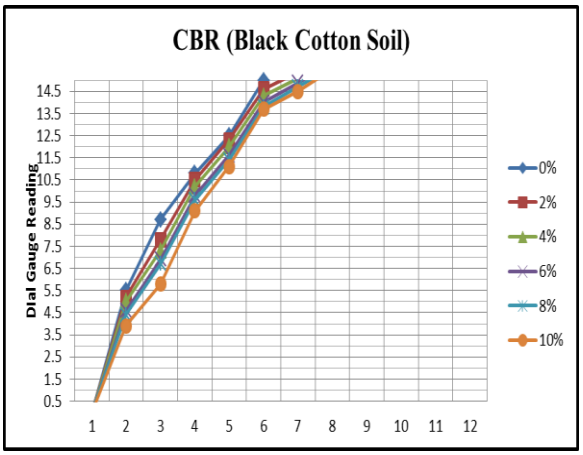

Fig. 5 showing variations in CBR (Black Cotton Soil)

CONCLUSIONS

Based on the laboratory tests carried out on Murram and Black cotton soil from Raipur, the following conclusions can be drawn.

- The Atterberg limits of soil were found to decrease with increase in the percentage of gypsum content.
- The Maximum Dry Density (MDD) was noted to decrease continuously on increasing gypsum content.
- California Bearing Ratio value (CBR value) decreases with increase in Gypsum content.
- From this we eventually conclude that if gypsum is present in the soil, it affects the properties of soil.
- Although, some deviation was noted, in general a trend of increasing Optimum Moisture Content (OMC) was noted with increase in gypsum content.

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