2nd International Conference on Current Research Trends in Engineering and Technology
© 2018 IJSRSET | Volume 4 | Issue 5 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

# Effect of Different Proportion of Find Sand and Silt on Swelling Pressure of Expansive Clays

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## ABSTRACT

Expansive soils are highly problematic as they have tendency to increase in volume on absorption of water and to shrink on evaporation of water. The volume increase, if resisted by any structure resting on it; then vertical swelling pressure is exerted on structure. This pressure if not controlled may cause uplifting and distress in the structure. Due to this behavior, many civil engineering structures constructed on expansive soil get severely distress. In this study effect of fine clay and silt on swelling pressure of expansive clays would be studied by performing swelling pressure on Bentonite which is a resemblance of pure clay through consolidation apparatus method on addition of silt and find sand in different proportions.

**Keywords:** Swelling Pressure, Bentonite, Expansive clays, Fine Sand, Silt

## I. INTRODUCTION

Some of the partially saturated clayey soil are very sensitive to variation in water content and show excessive volume changes, such soil is classified as expansive soil and exist in many part of the world. Expansive soil derives their swelling potential mainly from montmorillonite minerals which is present in this soil they are residual soil formed by the weathering of the basaltic rocks under alkaline environment. Extended period of dry climate causes desiccation of the soil but rain causes swelling near ground surface the depth of swelling zone is not more than 5m inmost case. However active zone below which there are seasonal changes in moisture content, varies from 1.5m to 4m Any structure located on expansive clay may be subjected to large magnitudes of pressures due to development of swelling pressure when moisture content of clay increases. When moisture content of clay decrease settlement problem creates in structure due to differential settlement structure became damage. We can reduce economical loss by evaluating swelling characteristic of soil before starting the construction of important structure. Considerable amount of work has already been done in understanding the behavior of expansive soils. The parent materials associated with expansive soils are either basic igneous rocks or sedimentary rocks. Basic igneous rocks, it is formed by decomposition of feldspar and pyroxene and in sedimentary rocks, it is a constituent of rock itself in any case most expansive soils are rich in montmorillonite clay mineral. Bentonite clay comes under this montmorillonite clay group, which is having highly swelling and shrinkage properties. Depending on the dominant exchangeable cations present the clay may be referred to as calcium bentonite or sodium bentonite, the two varieties exhibiting markedly different properties and thus uses. The terms non-swelling bentonite and swelling bentonite are synonymous with calcium bentonite and sodium bentonite respectively. When mixed with water, swelling bentonite exhibit a greater degree of dispersion and better plastic and rheological properties than non-swelling bentonites.

## II. METHODS AND MATERIAL

The three most important groups of clay minerals are montmorillonite, Illite and kaolinite, which are crystalline hydrous alum inosilicates. Montmorillonite is the clay mineral that present in most of the expansive soil problem, these types of soils are generally resulting due to weathering of rocks. G. W. Donaldson (1969) classified the parent materials that can be associated with expansive soils in to two group; basic igneous rocks and sedimentary rocks. Bentonite clay comes in this montmorillonite group which is having highly swelling and shrinkage properties. Smectite is the essential and active component of bentonites on which their economic importance is based. The majority of commercial bentonite deposits contain Ca2+ and Mg2+ as the main exchangeable cations. However, smectite clay minerals become unstable with the increasing age, depth of burial, and digenesis, and alter to mixed-layer, illite-smectite clays, sometimes referred to a K- or meta- bentonites, in which their valuable properties have been largely destroyed. Consequently, pure smectite clay minerals are essentially absent in rock of pre mesozoic age. Whilst Jurassic bentonites are known, most economic deposits are Cretaceous or younger in age and this fact is an important exploration criterion. Most bentonites have formed alteration of igneous material. Such deposits are of two markedly different types: (i) those resulting from sub-aqueous alteration of fine-grained volcanic ash and (ii) those resulting from in situ hydrothermal alteration of acid volcanic rocks. Problem of expansive soils throughout the five continents results from a wide range of factors: (1) Shrinkage and swelling of clay soils resulting from moisture change. (2) Type of the clay size particles. (3) Drainage– rise of ground water or poor surface drainage. (4) Compression of the soil strata resulting from applied load. (5) Pressure of the backfill soil. (6) Soil softening, Weather (7) Vegetation and (8) The amount of aging (Lucian, 1996, Chen, 1988 and Day, 1999). Expansive soils are characterised by large clay fraction, very high liquid limit, high plasticity index and very small shrinkage limit. It exhibits high swelling pressure in presence of water due to increase in volume by adsorbed water. This behaviour alters at different fraction of non-cohesive finer- silt/fine sand. The present study aims at a parametric study to compare swelling behaviour of BENTONITE an expansive soil in present of varying percentage of silt & fine sand. It also aims at study effects of adding potentially low swelling soils. With all the presentation apart from grain size analysis, atterberge limit, standard proctor test, % free swell, swell pressure test carried out with different gradation SILT, FINE SAND, SILT+FINE SAND where prepare with different contents (0%,5%,10%,15%). All the test performed at 95%,100%,105% MDD. From the procured 3 sets of remolded sample with different gradation SILT, FINE SAND, (SILT + FINE SAND) prepared with different contents (0%, 5% , 10% ,

<table>
<tr><td rowspan="3">DRY SAND</td><td>Expansive soil</td><td>SILT<br>(5%, 10% ,15% )</td><td rowspan="3">MDD</td></tr>
<tr><td rowspan="2">0.9 expansive soil+<br>0.1 KAOLINITE</td><td>FINE SAND<br>( 5% , 10% ,15%)</td></tr>
<tr><td>SILT + FINE SAND<br>( 5% ,10% , 15%)</td></tr>
</table>

15%). Preliminary test carried out on sample in pure condition on Bentonite, Kaolinite & sand sample (atterberg limits, hydrometer, free swell). After classification of Soil sample standard proctor test is carried out to obtain optimum moisture content (OMC) and maximum dry density (MDD) of the collected sample. All the test performed at max. dry density (MDD) & at dry side of (95% of OMC), wet side of OMC (105% of OMC) and at OMC. Than swelling potential is evaluated using constant volume method

## III. RESULTS AND DISCUSSION

BENTONITE SOIL TEST READING

| | LL (%) | PL (%) | IP (%) | SL (%) | MDD (gm/ml) | OMC (%) | FREE SWELL (%) | SWELL PRESSURE (kg/cm$^2$) |
|---|---|---|---|---|---|---|---|---|
| Bentonite | 135 | 42.55 | 92.4 | 7.11 | 1.301 | 35.17 | 140 | 3.06 |
| B + 5%fs | 126 | 42.22 | 83.78 | 7.67 | 1.309 | 32.87 | 127 | 2.97 |
| B+ 10%FS | 119 | 38.59 | 80.41 | 12.83 | 1.332 | 31.37 | 113 | 2.54 |
| B+ 15% FS | 107 | 35.51 | 71.49 | 14.21 | 1.342 | 29.2 | 100 | 2.13 |
| B+K | 129 | 38.05 | 90.95 | 9.23 | 1.302 | 31.29 | 133 | 2.279 |
| B+K+ 5% FS | 118 | 37.61 | 80.39 | 10.01 | 1.322 | 30.08 | 127 | 2 |
| B+K+ 10%FS | 111 | 35.35 | 75.6 | 13.24 | 1.34 | 29.67 | 110 | 1.91 |
| B+K+15%FS | 102 | 31.9 | 70.1 | 14.34 | 1.351 | 27.18 | 81 | 1.72 |
| B+5%SILT | 123 | 41.14 | 81.86 | 14.21 | 1.31 | 31.65 | 127 | 2.16 |
| B+10%SILT | 115 | 38.68 | 76.32 | 14.54 | 1.327 | 29.54 | 120 | 2.03 |
| B+15%SILT | 107 | 35.51 | 71.49 | 15.52 | 1.346 | 28.7 | 100 | 1.706 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| B+10%K+5%SILT | 115 | 33.67 | 78.33 | 14.43 | 1.325 | 28..29 | 81 | 1.65 |
| B+10%K+10%SILT | 106 | 35.4 | 70.6 | 14.95 | 1.356 | 27.1 | 76 | 1.08 |
| B+10%K+15%SILT | 98.2 | 34.80 | 63.4 | 15.85 | 1.397 | 25.91 | 75 | 0.91 |
| B+5%(SILT+FS) | 115.5 | 39.73 | 75.77 | 12.14 | 1.313 | 32.84 | 113 | 1.65 |
| B+10%(SILT+FS) | 100 | 36.82 | 63.18 | 13.56 | 1.321 | 30.53 | 107 | 1.55 |
| B+15%(SILT+FS) | 88 | 35.07 | 52.93 | 14.18 | 1.343 | 28.26 | 93 | 0.82 |
| B+10%K+5%(SILT+FS) CC | 107.6 | 37.5 | 70.1 | 14.91 | 1.326 | 27.4 | 100 | 0.97 |
| B+10%K+10%(SILT+FS) | 96 | 34.9 | 61.1 | 15.3 | 1.358 | 25.45 | 93.3 | 0.89 |
| B+10%K+15%(SILT+FS) | 83 | 33.6 | 56.6 | 15.9 | 1.407 | 23.9 | 86.6 | 0.71 |

Table - bentonite total test reading (atterberge limit, MDD, OMC, %Free swell , swell pressure)

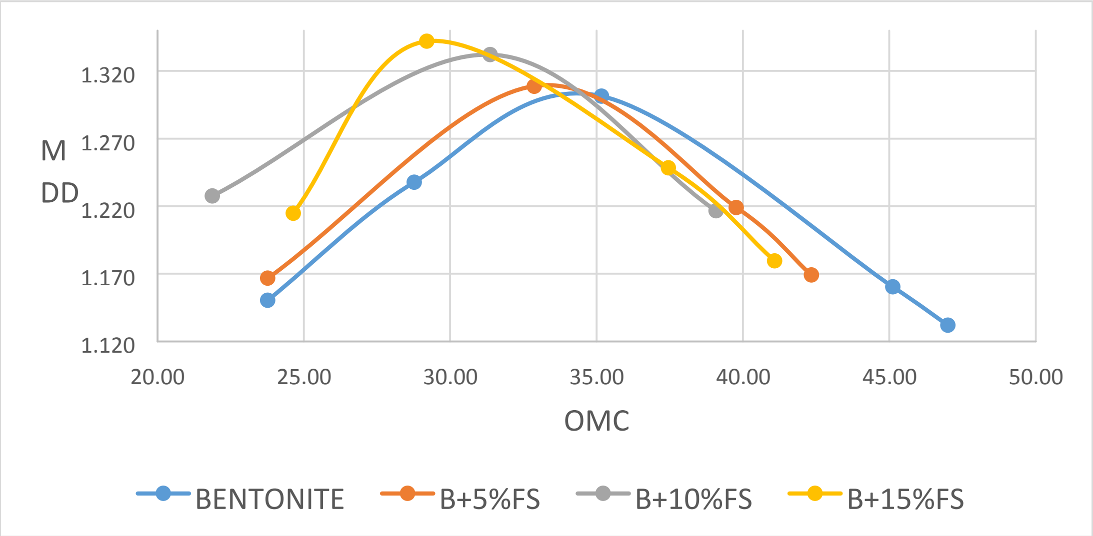


Fig. COMPACTION CURVE FOR BENTONITE+(0,5,10,15) %FS

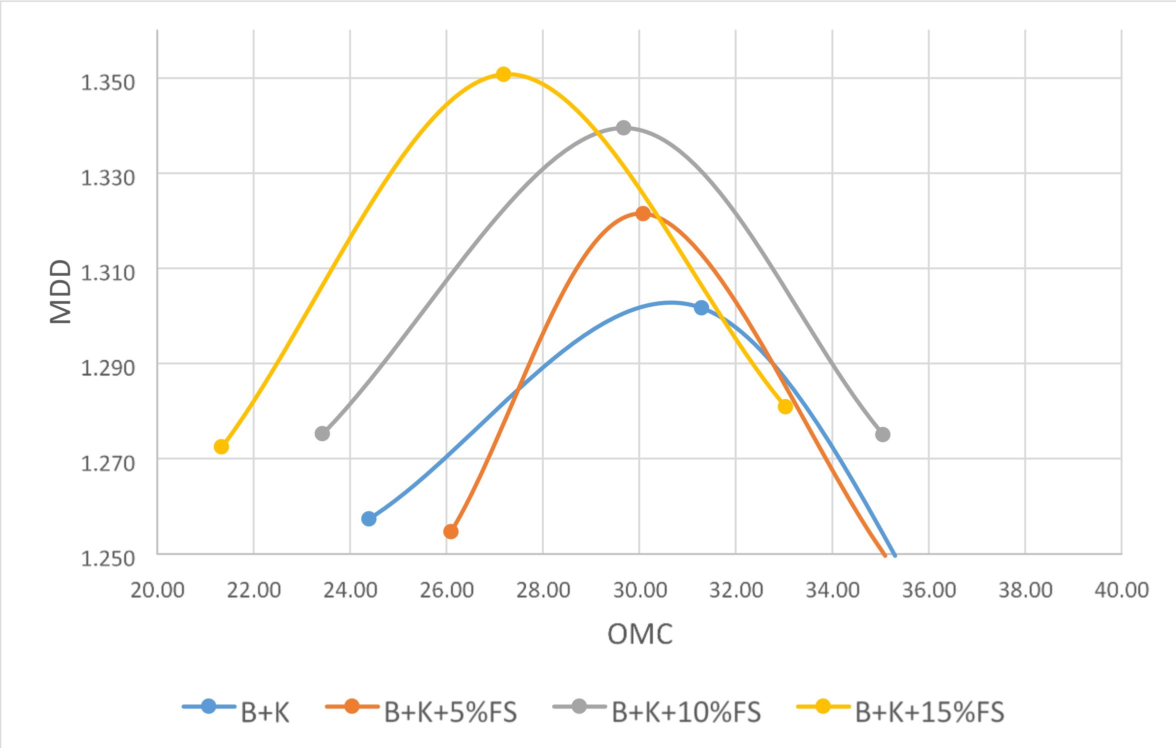


Fig. COMPACTION CURVE FOR B+K+(0,5,10,15) %FS

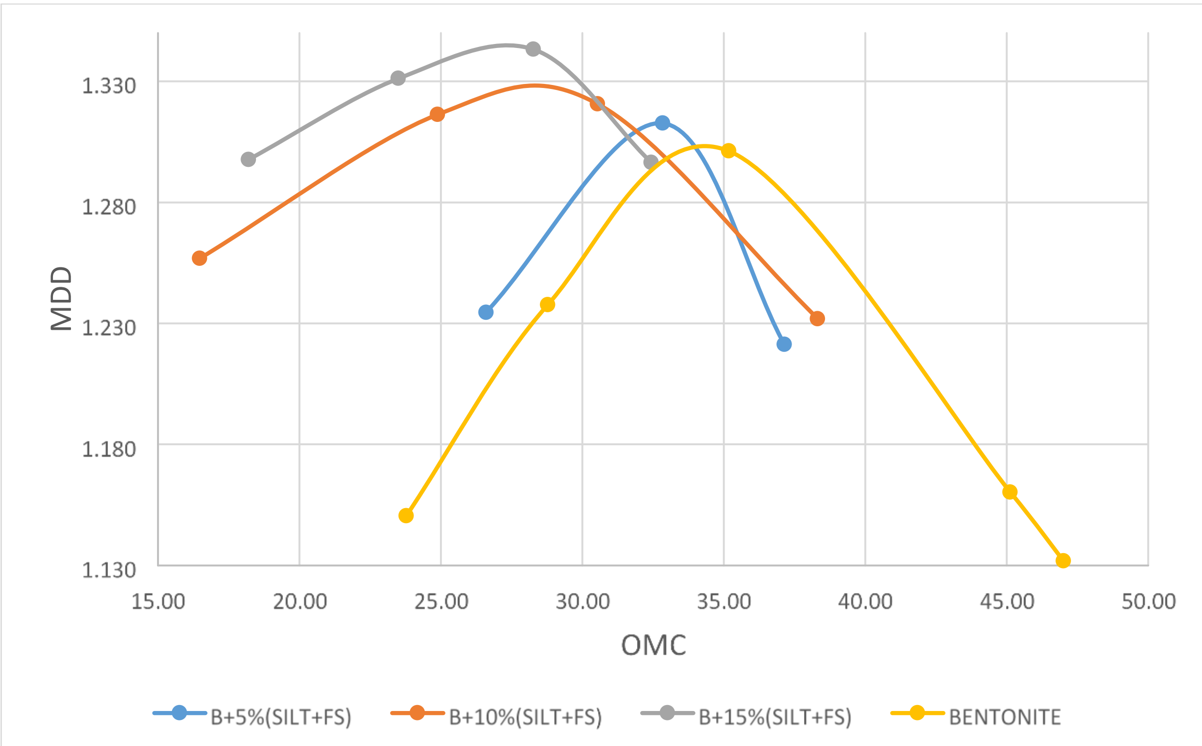


Fig. COMPACTION CURVE FOR BENTONITE+(0,5,10,15) %(SILT+FS)

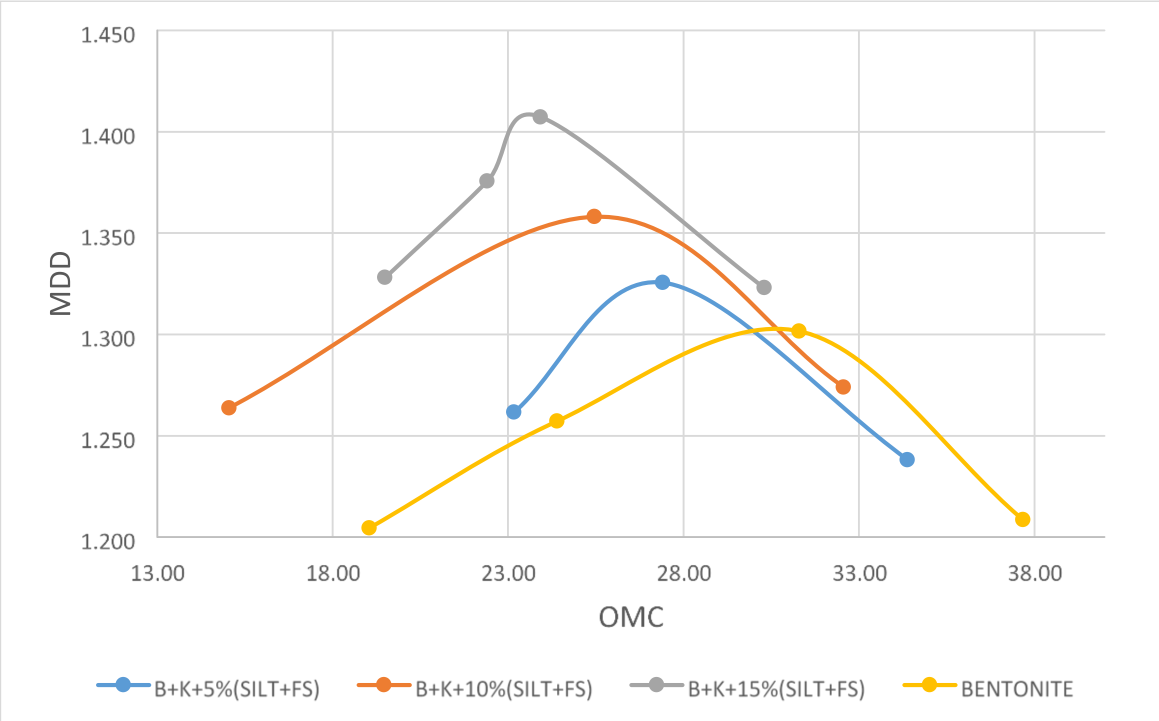


Fig. COMPACTION CURVE FOR BENTONITE+K+(0,5,10,15) %(SILT+FS)

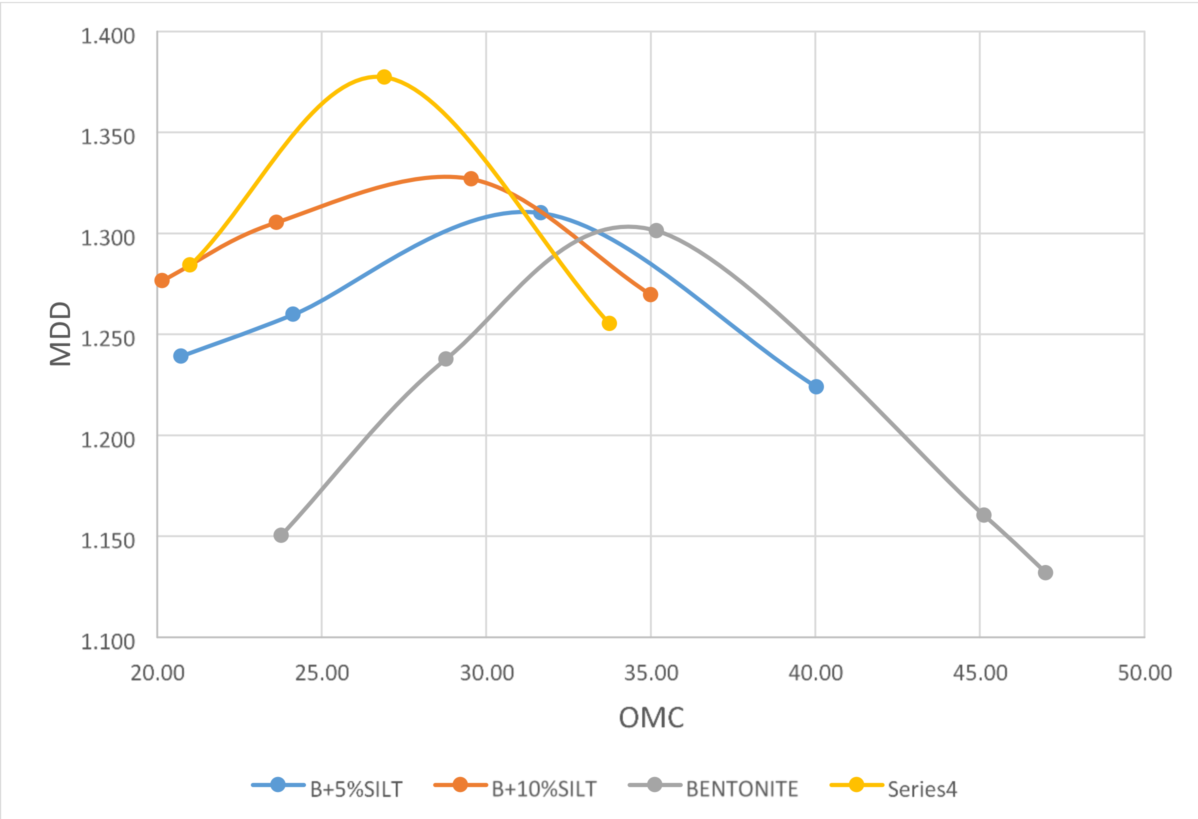


Fig. COMPACTION CURVE FOR BENTONITE+(0,5,10,15) %SILT

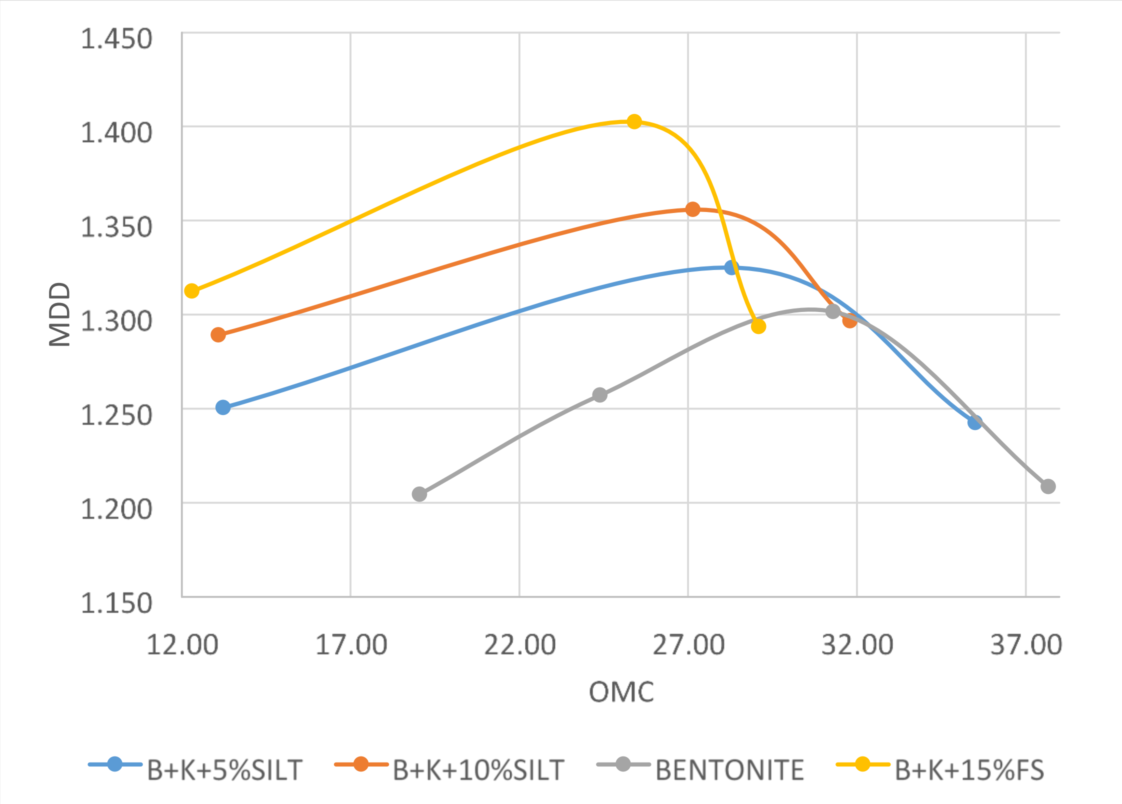


Fig. COMPACTION CURVE FOR BENTONITE+K+(0,5,10,15) %SIL

## IV. CONCLUSION

In this study to compare swelling behaviour of expansive soil in present of varying percentage of silt, fine sand, silt+fine sand.it also study effects of adding potentially low swelling soils. 1. On addition of (silt, fine sand, (silt+fine sand)) & kaolinite + (silt, fine sand, (silt+fine sand), the basic index properties, such as liquid limit and plasticity index was found to be decreasing & shrinkage limit was found to be increasing. 2.

Effect of addition of (silt, fine sand, (silt+fine sand)) & kaolinite + (silt, fine sand, (silt+fine sand) were also observed on compaction curves by increasing values of MDD and gradual decrease in OMC. 3. It was found that in bentonite adding 15%(silt+fine sand) reduce free swell & swell pressure93 & 0.82kg/cm2 & 10% kaolinite+ 15% of bentonite is replaced by (silt+fine sand) free swell & swell pressure respectively 86.6 & 0.71kg/cm2. 5. It was concluding that reduction of combine soil (silt+fine sand) is more than individual soil. & non expansive soil is more effective for reduction of swelling behavior of expansive soil instead of finer particles.

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