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SOIL STABILIZATION USING LIME, FLY ASH AND SODIUM SILICATE IN OPTIMUM PERCENTAGE

[1]Ravi Gupta
Research Scholar, Civil Engineering
Maulana Azad National Institute of Technology, Bhopal India

Abstract: **The substantial challenge on behalf of engineers specifically civil engineers are the scraping of industrial waste output and their storage. To protect environment from the dangerous effect the scrapsmaterial should be uses again and again. Theonly industrial scrap is Fly Ash which is produced throughout the country in every year. Fly ash is a dusty powder acquired from burning of coal through the production of electricity. Dumping of Fly ash is a big issue, to minimize the dumping of Fly ash into big area presently, an experimental survey was carried out to find out the strengthening properties of Fly ash with lime and Sodium silicate. Particularly some parameters like grain size distribution, liquid limit, OMC, MDD, Specific gravity and angle of internal friction of Fly ash were find out and then Fly ash was mixed with various percentages of lime (0-15%) and sodium silicate (1-4%). All the different proportions were tested to acquire optimum percentage of lime and sodium silicate. The difference in shear parameters like cohesion and angle of shearing resistance were practiced by conducting direct shear test. All the tests were completed afterwards a time period of 3hours from starting to the completion of preparation of sample. Every test is performed under the normal stresses of 0.5kg/cm2, 1kg/cm2, 1.5kg/cm2, 2kg/cm2 and 2.5 kg/cm2. The results are collected in a graphical manner to observe the trends for shear parameters. The conclusions show remarkable enhancement in strength characteristics for greater percentages of lime and sodium silicate.**

Index Terms - **Sodium Silicate, Shearing resistance, Specific Gravity, Direct Shear Test, Strength characteristics.**

I. INTRODUCTION

Fly Ash is a substantially inorganic ashes from flue gases of furnaces at pulverized coal power plants. The size ofthe large amount of particle percentage is smaller than 75µ. These elements consist primarily of silica, alumina and iron.In India, coal ash is produced about 70 million tons per year and from burning about of coal for electric power generation about 200 million tons per year. The handling of Coal-ash shows severe environment difficulties for India and requires a mission-mode approach. Considerable research and development work have been undertaken throughout the country towards constructing building and developing appropriate technologies for discarding and exploit of Fly Ash in construction industries.

Now a days only 10% Ash is used in Ash dykes construction and land filling and only about 3% Ash is used in other construction industries. Large portion of fly ash approx. 80% or more is used in developed countries for the frame of bricks, cellular concrete blocks, road construction, land fill application, ceramics, agriculture, insulating bricks, recovery of metals and dam constructions etc. Prevailing, for one metric tons of Ash discarding about one acre land is needed.

Use of Fly Ash in America is only about 30% of the Fly Ash produced according to the estimation reports of Malhotra and others in 2002. Two thirds concrete is used which has reached a maximum consumption figure. By pointing out that Israel would produce 1.3 mega tons of coal ash per annum by 2001 and that 0.6 mega tones could be used by the cement industry. Almost 50% of the Fly Ash produced is used in U.K whereas only 6% Fly Ash is used out of the total production in India.

Highway engineers are utilizing mass abundance of Fly Ash in embankments and road constructions. Only during the construction period, the Fly Ash lay down in very minute amount and not later. For high embankments low density is more fit. Fly Ash augmentation cementitious properties from lime stabilization due to the arrangement o silicate hydrates at the time of pozzolanic reaction. The strength of Fly Ash is exceeding for the stable sub-grade or sub-base because of the lime stabilization, due to lots of cementing properties. As compared to lime or un-stabilized Fly Ash sub-grade theCement stabilized Fly Ash has beat interpretation in load carrying volume and abatement of jack. The strength of Fly Ash can accelerate by mixing some additives such as sodium silicate.

I. METHODOLOGY

D S V Prasad et al. were studied about the performance of flexible pavement system. They used distinguishable type reinforcement materials in Fly Ash sub base courses laid on extensive soil sub grades. They conducted the test in the field which is cyclic load test by application of a circular metal plate on model flexible pavements. They achieved the maximum capacity of load with minor value of rebound deflection while using the geo grid reinforced elaborate followed by bitumen coated chicken mesh. Different materials are used such as, bamboo mesh stretch and waste plastic reinforced stretch. All these were laid on the system of flexible pavements.

Pradip D. Jadhao and P.B.Nagarnaik carried out from a study of Fly Ash mixtures on performance evaluation of fiber reinforced soil. In the study the relation of increment gain in ductility and strength was evaluated by conducting a series of unconfined compression strength tests (UCS). Specimens of soil –Fly Ash mixtures of were tested with 0, 0.5, 1and 1.5 percent polypropylene fibers with differentlengths of fibers. They concluded that inclusion of desultory distribution of fibers significantly raised UCS, residual and immersed energy of soil -Fly Ash mixes. The functions fiber content is escalate in values and length increase in fiber content increased residual strength, immersed energy and UCS. Escalate in fiber length deescalate UCS but escalate residual strength, immersed energy.

S Bhuvaneshwari et al. carried out an experimental research of expensive use Fly Ash on stabilization. They conducted tests with fly ash extension in various percentages to check the enhancement in the behavior of expansive soil. Laboratory and field tests have been carried out. They used these mixes for making an experimental embankment of 30m length by 6m width by 0.6m height. It was successfully invented and validate it is competent for construction of Ash dykes, filling low laying etc.

Snezana Heckman et al. Studied on influence of the chemical composition of fly ash on port land cement and fly ash mixture hydration mechanism. They focused in the stabilizer mixtures by using different amount of calcium oxide content. They tested the fly ash compounds influence on the strength of cement mixtures with special accent on the content of calcium oxide in the ash.

Hamid. Nikraz et al. studied on soil stabilization with the application of Lime and Fly Ash. The stabilization of soil by using lime and fly ash to find out the better binder to the soil in order to enhance the engineering properties of soils. They demonstrate to progression in workability and mechanical behavior of soil after stabilization by adding additives. These mixes were useful in chemical stabilization for further escalate in mechanical properties of soils such as strength, swelling, plasticity index and compressibility.

S bhattacharjee and K bandyopadhyay have worked on lime and cement stabilized Fly Ash. They determine stiffness and fatigue life characteristics determine flexural strength of these mixes and conducted flexural beam point load test to determine stiffness and fatigue life characteristics. They conducted the tests on these mixes at the curing periods of 56 days and 90 days.

II. RESULT AND DISCUSSION

Fly Ash was collected from GMR Power Plant in Raipur. The physical properties, Index and engineering properties of Fly Ash has been find out by the experimental research. The physical properties and chemical composition of Fly Ash are shown below.

Table No:3.0

Property	Values
Gravel (%)	0
Sand (%)	28
Fines (%)	72
a. Silt(%)	72
b. Clay(%)	0
Liquid Limit (%)	28
Plastic Limit (%)	NP
Specific gravity	2.1
IS Light Compaction	
Optimum moisture content (%)	30.0
Maximum dry density (g/cc)	1.28

3.1 Chemical composition of Fly Ash

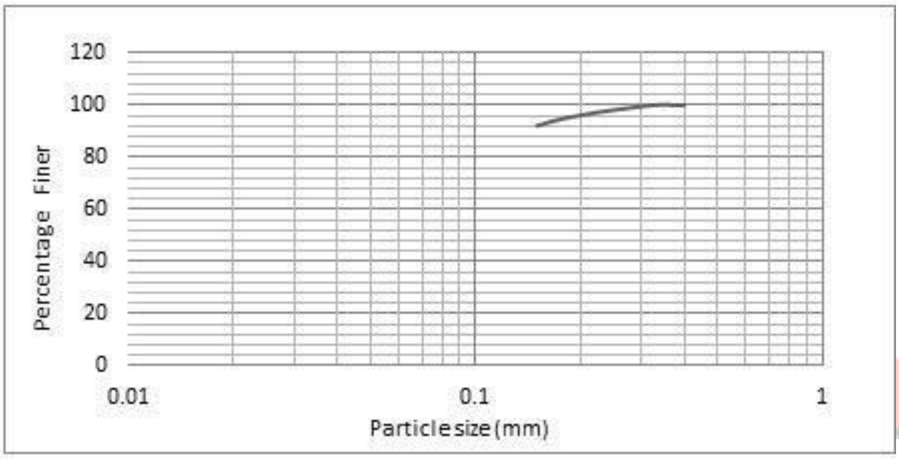
Table No: 3.1

Compound Formula	Percentage
SiO_2	55.85
Al_2O_3	24.98
CaO	2.54
MgO	1.14
TiO_2	6.91
V_2O_5	0.15

3.2 Grain Size Distribution

According to IS: 2720(part-IV) this test was conducted. According to IS: 2720 the sieve sizes are 4.75mm, 2.36mm,1.18mm, 0.6mm, 0.425mm, 0.3mm, 0.15mm and 0.075mm.

Fig: 3.1



Coefficient of uniformity: Cu = 28.89;

Coefficient of curvature: Cc = 2.13

3.3 Compaction Characteristics

3.3.1 Compaction Characteristics of Fly Ash Lime Mixes

As per IS: 2720 (part VII) – 1980 the Fly Ash tested for OMC and MDD with various percentages of lime and dry FlyAsh.

Table No: 3.3.1

LIME (%)	OMC (%)	MDD (g/cc)
0	30	1.28
2	31.4	1.26
4	31.8	1.24
6	34.3	1.23
8	36.4	1.21
10	37.3	1.18
12	38.2	1.16
15	38.3	1.14

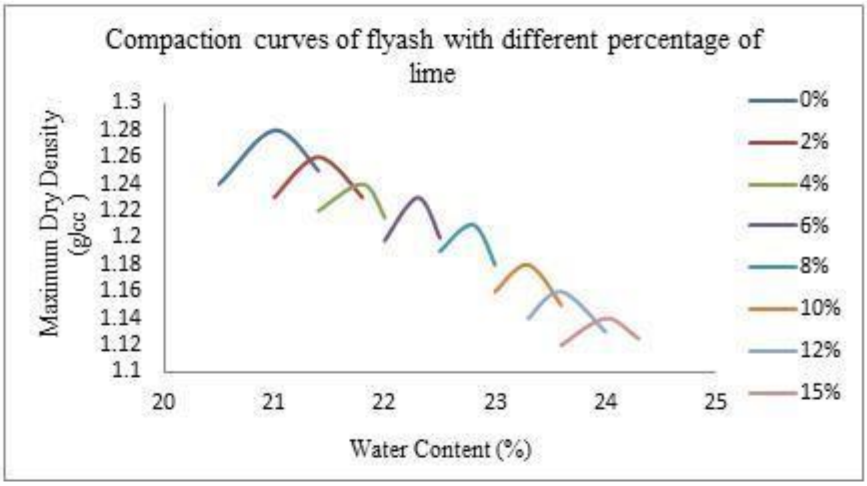


Fig: 3.3.1

The variation of maximum dry density (MDD) and optimum moisture content (OMC) of Fly Ash-Lime mixes shows in table No: 3.3.1 and fig No: 3.3.1. The MDD de-escalate significantly with escalate amount of Lime (0-15%) from 1.28 g/cc to 1.14 g/cc, and OMC escalate with escalate amount of Lime (0-15%) from 30-38.3%. The amount of water is increases if the lime content is increases because of the hydration process amount of water is required more that's why thevalue of OMC increases with increasing amount of lime content.

3.3.2 Variation in Ø Values for Different percentage additions of Lime

The interpretation in shear parameters was tested for Fly Ash samples at distinguishable percentages of water quantity. The samples were tested at Dry of optimum, OMC and Wet of Optimum conditions. The test was conducted under normalpressure of all water contents as 0.5kg/cm^2,1.0kg/cm^2 and 2.0kg/cm^2 respectively. After 3 hours of curing period each and every test was conducted. The samples were properly cured under cover so that the loss of water is inconsiderable.

Table No: 3.3.2

% OF LIME	OMC (-2)	OMC (-1)	OMC	OMC (+1)	OMC (+2)	OMC (+3)
0	25	28	30	29	26	24
2	27	30	31	30	28	26
4	29	31	32	31	30	27
6	30	32	34	33	31	29
8	31	33	36	34	32	30
10	32	35	37	35	34	31
12	32	35	38	36	34	31
15	32	36	38	37	34	31

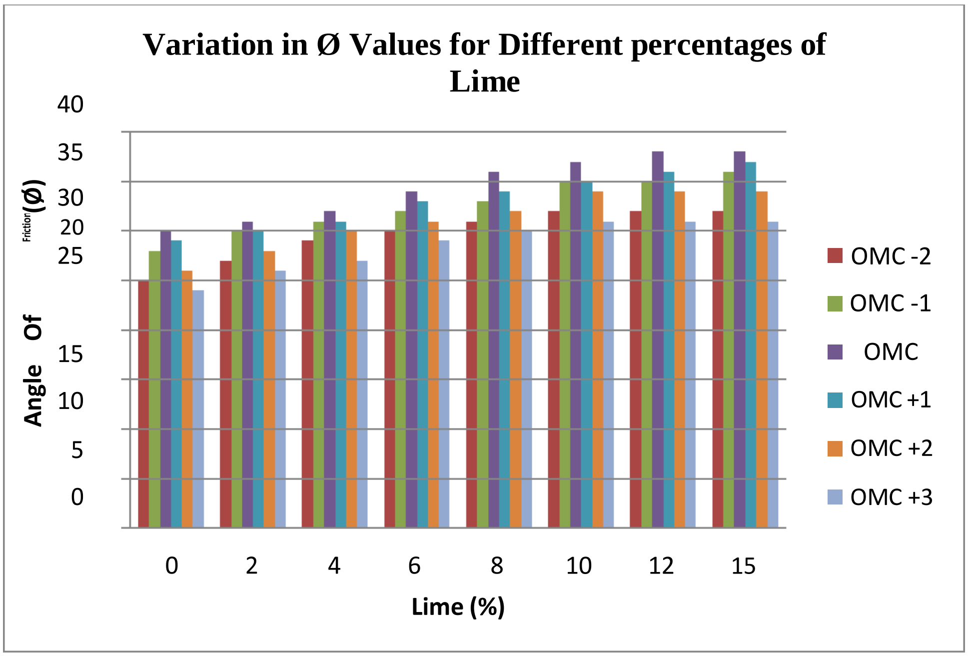


Fig No: 3.3.2

The friction of the particles is greater because the maximum values are obtained by mixing 15% of lime. The productivityis increases with the high percentage of lime when the flocculation is done in the mixes. The values of the friction are increased at OMC water content, farther the values decreased due to the high amount of water content which are responsible for the friction loss in between the particles. The amount of water is lesser in OMC than in Dry of Optimum conditions like OMC-2, OMC-1 because the water is not enough to form flocculated mixes in the structure.

3.3.2.1 Variation of Ø values with different water contents

The results observed in the shearing resistance values for different percentage of lime and for all water contents areshown below.

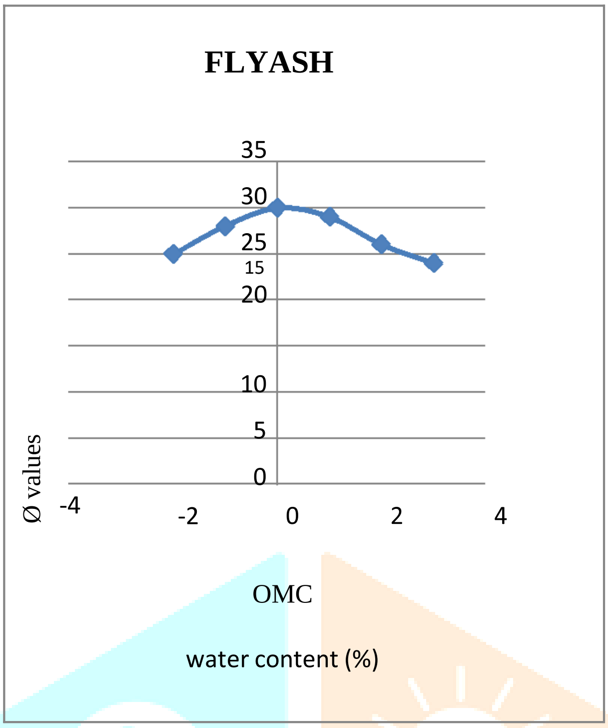


Fig No: 3.3.2.1(a)

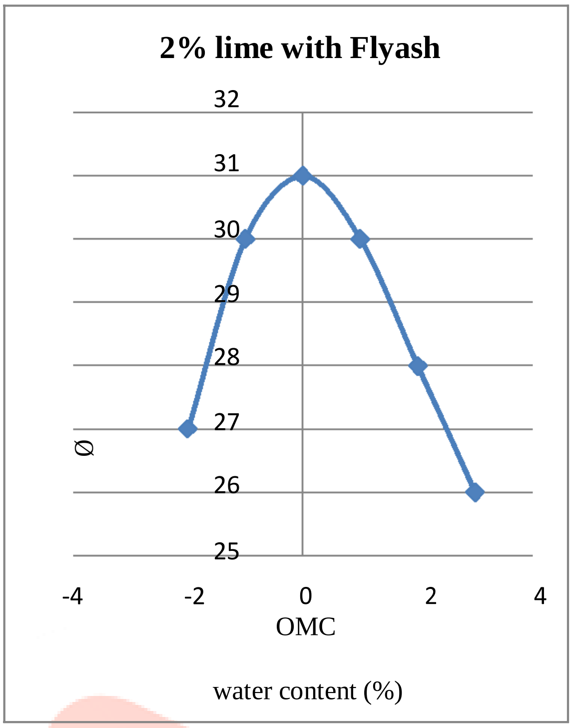
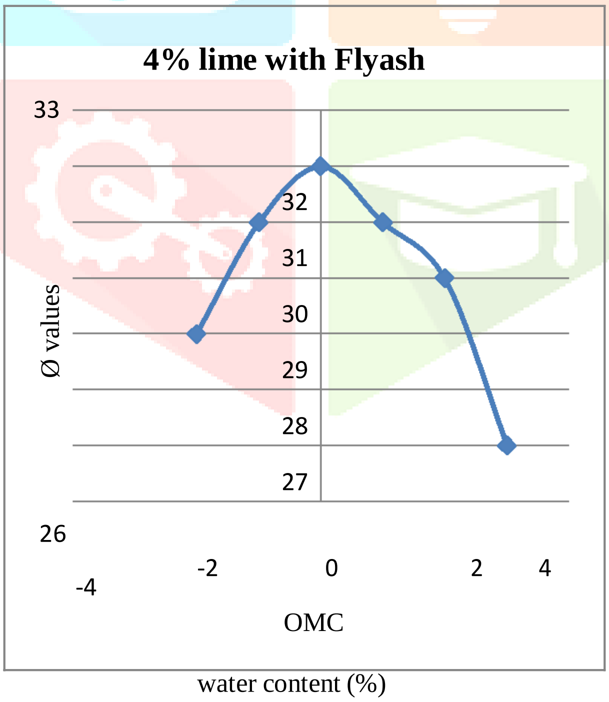


Fig No: 3.3.2.1(b)



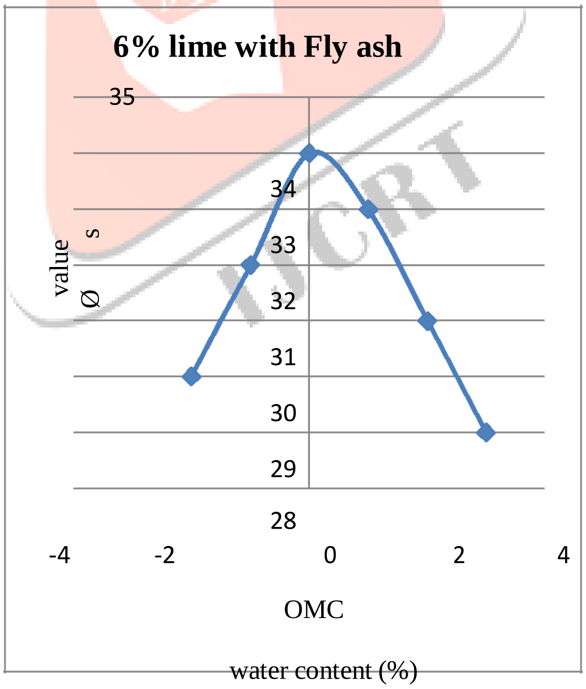


Fig No: 3.3.2.1(c)

Fig No: 3.3.2.1(d)

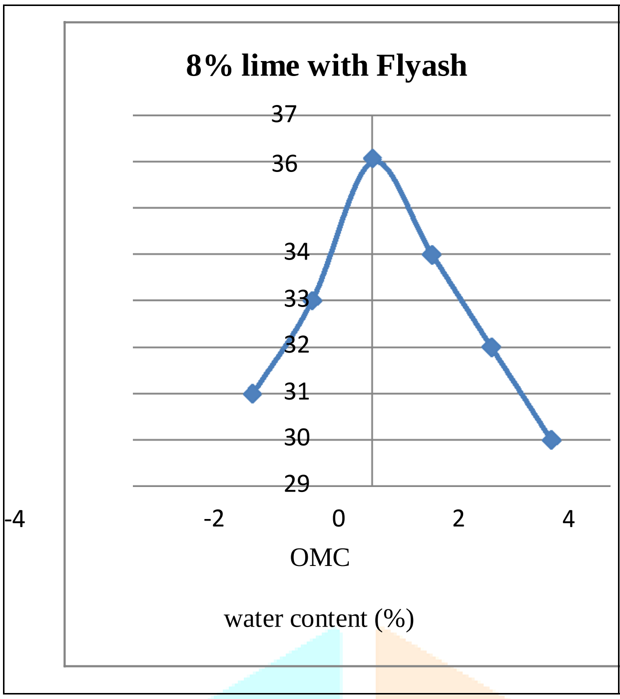


Fig No: 3.3.2.1(e)

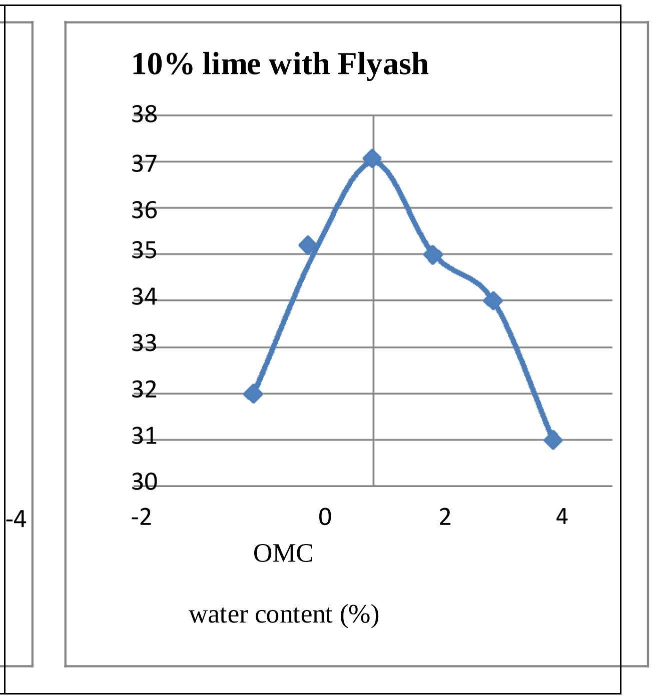


Fig No: 3.3.2.1(f)

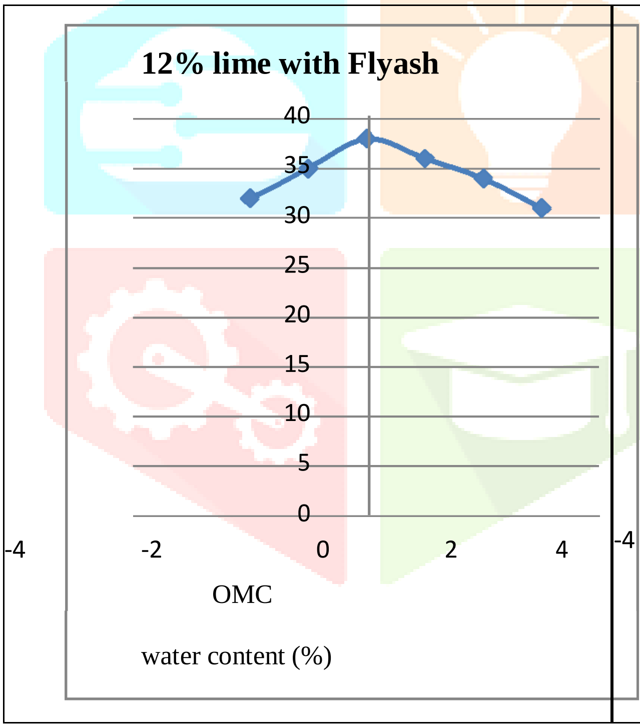


Fig No: 3.3.2.1(g)

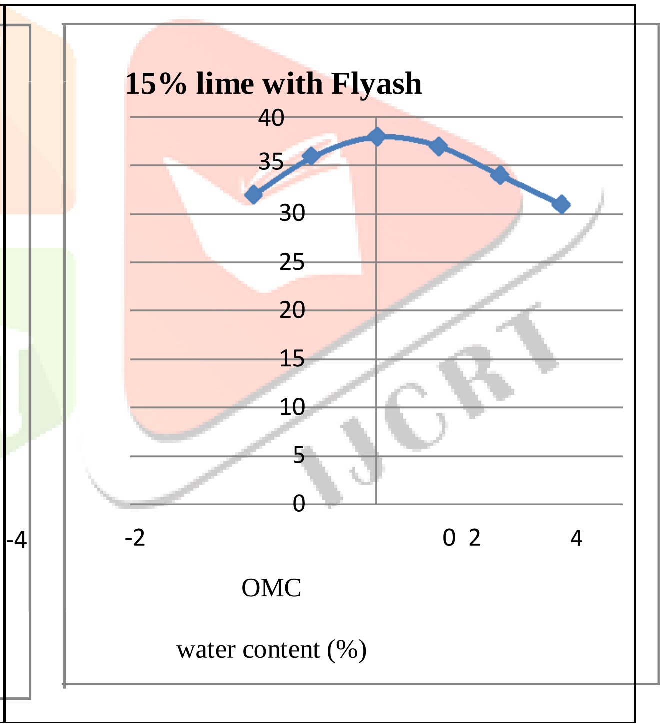


Fig No: 3.3.2.1(h)

The value of the shearing resistance is extended with the extend percentages of lime. The amount of calcium oxide is highif the lime content is increased because calcium oxide provides better resisting capacity of Fly Ash samples. The productive bonds are shown between the fly ash and lime particles so that the values are max at OMC. After OMC water content OMC (+1) have shown improved resistance against shear assimilate to other water contents like OMC (-1), OMC (-2), because of the functional participation of calcium oxides and aluminates present in the stabilized mixes. The water content is deescalating beyond OMC (+2) because further escalate in water content then the mix is scattered and weak. Due to the strong bond among the particles the OMC (-1) water content has provide improved results than OMC (-2) water content. This trend is almost equal for all percentage additions of lime. The values of the shearing resistance is totally proportional to the values of OMC and MDD, if the values of OMC and MDD are increased the shearing resistance are also increased and vice versa. According to the increased number of percentages of lime the values are also increased

It not only depends on the increased amount of calcium oxide but also due to the flocculated structure obtained in the mix. Chains are formed in the mix due to the flocculation process in the structure and strong bond is resulted in the mix, due to this technique of mixing it helps to increase the strengths.

III. CONCLUSION

From the study of Fly Ash stabilized with lime, cement and sodium silicate at compacted condition. The following conclusions have derived:

- The pozzolanic reaction developing between silica alumina with calcium formed calcium silicate gel. The maximum strength developed because gels are crystalline with time
- Flocculation has taken place because of additives like lime and sodium silicate with time.
- The maximum value of shearing resistance is shown by the addition of lime and sodium silicate of 15% and 4% respectively.
- Due to the dispersed structure the values are less in Dry of optimum and wet of optimum both.
- Due to the insufficient amount of water flocculated structure is formed and at OMC-2 all the values are less for all percentages of lime and sodium silicate.
- At OMC the values are maximum for all proportions in which the effective flocculation occurs.

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