International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 04 | Apr 2019 www.irjet.net p-ISSN: 2395-0072

An Experimental Study On Mechanical Properties Of Paver Blocks With Partial Replacement Of Cement With Metakaolin And Fine Aggregate With Red Soil

Amala Sebastian[1], Jashir A[2], Prakash M[3], Chitharath L[4],Deepak Adishankar[5], T Karthikeyan[6]

[1, 2, 3 ,4 ,5] *B.Tech Students, Department of Civil Engineering, Achariya College of Engineering Technology Villianur, Puducherry, India*

[6]*Assistant Professor, Department of Civil Engineering, Achariya College of Engineering Technology Villianur, Puducherry, India*

Abstract - *This paper provides an overview of study on the use of paver block with partial replacement of cement with metakaolin and fine aggregate with red soil. concrete paver blocks are ideal material which is used for easy laying of footpath, better look and finish. The use of supplementary like metakaolin is now widely accepted by the construction industry for technical and environmental reason. From the recent research work using metakaolin it is evident that it is very effective pozzolanic material and effectively enhances the strength parameters of concrete. The work was conducted on M35 concrete. In this paper metakaolin was used to replace in four different proportion of 5%, 10%,15% and 20% and red soil by 5%,10%,15%,20%,25% and 30%. The concrete is cured in 7 and 15 days.*

Key Words*: *Metakaolin, Red soil, Compressive strength, Flexural strength, Split tensile strength

1.INTRODUCTION

Concrete is most commonly used in construction industry. Concrete is a mix of cement, fine aggregate ,coarse aggregate and water. Cement and water form a gel or paste which coat the sand and aggregate. The paste bind the aggregates together. Now a days paver blocks are increasing in day by day, interlocking concrete pavements are used in a number of countries like India, china, japan etc.

Metakaolin is in widespread in all over the world in concrete industry. The advantage of metakaolin are not only the many concrete performance benefits, both in mechanical and durability properties ,but also the environmental benefits metakaolin usage helps in developing high performance and high strength in concrete. Researchers all over the world today are focusing on ways of utilizing either the industry or agriculture waste as source of raw material for industry.

The replacement of cement with metakaolin and fine aggregate with red soil was used in replace in four different proportion of 5%,10%,15% and 20% and red soil by 5%,10%,15%,20% and 30%. Finally the mechanical properties of the concrete mix specimens obtained from the addition of these materials is compared with control concrete mix.

1.1 MATERIALS USED

The material used:

i. Cement
ii. Metakaolin
iii. Fine aggregate
iv. Coarse aggregate
v. Red soil

CEMENT

Ordinary Portland 53 grade of cement is used for the work. It is the basis requirement used in concrete, mortar and paste.

TABLE 1: Properties of cement

S.NO	TEST	VALUES ONTAINED	STANDARD VALUES
1	Specific gravity	3.11	3.15
2	Initial testing time	45 mins	< 30 mins
3	Final setting time	10 hrs	>60 mins

1.2 METAKAOLIN

Metakaolin is a unhydrous calcined form of clay mineral kaolinite. It is effective pozzolanic materials. Metakaolin in concrete tends to reduce the size of pore which leads to obtains more strength and resistance to acid.

TABLE 2: Chemical Properties Of Metakaolin

Chemical composition	Percentage%
Sio_2	54.3
Al_2o_3	38.3
Fe_2o_3	4.28
Cao	0.39
MgO	0.08
Na_2o	0.12
K_2o	0.50

TABLE 3: Metakaolin Test

S.NO	CHARACTERISTICS	VAUE OBTAINED
1	Specific Gravity	2.7
2	Water absorption	3.06%

FINE AGGREGATES

Manufacture sand is used in this study.sand is sieved in 4.75mm sieve for used in concrete.

TABLE 4: Properties of fine aggregate

Test	Vaues	Standard values
Specific gravity	2.6	2.73
Fineness modulus	3.37	4.66
Water absorption	1.2%	1.6%

COARSE AGGREGATE

In this work coarse aggregate of sieze 20mm are used.

TABLE 5: Properties of coarse aggregate

SI NO	CHARACTERISTICS	VALUES OBTAINED	STANDARD VALUE
1	Specific Gravity	2.7	2.5-2.9
2	Water Absorption	1.1%	0.1-2%
3	Fineness Modulus	7.68	6.5-8

RED SOIL

In this study red soil is used for the partial replacement of fine aggregate.

TABLE 6: Chemical composition of red soil

Composition	Percentage%
Iron	3.61
Aluminium	2.92
Organic matter	1.01
Magnesium	0.70
Lime	0.56
Potash	0.24

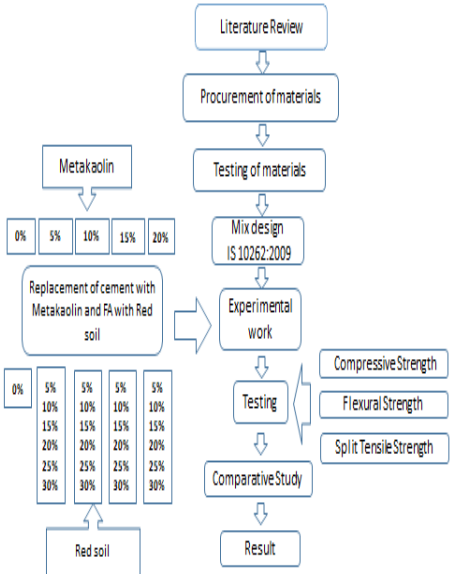
Soda	0.12
Phosphorous	0.09
Nitrogen	0.08

TABLE 7: Properties of red soil

S.NO	CHARACTERISTICS	VALUE OBTAINES
1	Specific gravity	2.5
2	Fineness modulus	2.76

2. METHEDOLOGY

Methedology explain how the project had been carried out in a step by step manner.



Compressive strength test was carried out for paver blocks at 7 and 15 days. flexural strength test for paver blocks also casted and tested at 15 days. split tensile strength test of paver block specimen were also casted and tested at 15 days for each mix specification following the standard test procedures:

4. RESULTS AND DISCUSSION

Compressive strength

The result of compressive strength were listed above table 8. The test were carried at 7 and 15 days.

Table 8: Compressive strength

MIXES	PARTIAL REPLACEMENT		COMPRESSIVE STRENGTH OBTAINED (N/MM^2)	
	CEMENT BY MK %	F.A BY RED SOIL%	CURING PERIODS	
			7 DAYS	15 DAYS
CC	0%	0%	29	35
M1	5%	5%	34.65	38.5
M2	5%	10%	31.4	38.07
M3	5%	15%	30.5	37.35
M4	5%	20%	27.4	33.31
M5	5%	25%	25.9	31.40
M6	5%	30%	24.5	29.74
M7	10%	5%	30.42	36.88
M8	10%	10%	29.61	35.91
M9	10%	15%	28.06	34.02
M10	10%	20%	26.81	32.51
M11	10%	25%	25.71	31.17
M12	10%	30%	24.73	29.98
M13	15%	5%	29	35
M14	15%	10%	32.34	39.2
M15	15%	15%	31.51	38.2
M16	15%	20%	31.01	37.59
M17	15%	25%	31.40	38.07

M18	15%	30%	30.91	37.5
M19	20%	5%	30.81	37.35
M20	20%	10%	32.64	39.57
M21	20%	15%	31.60	38.31
M22	20%	20%	31.51	38.2
M23	20%	25%	31.2	37.83
M24	20%	30%	31.01	37.59

Chart-1 Compressive Strength of Paver Blocks (M1 to M6)

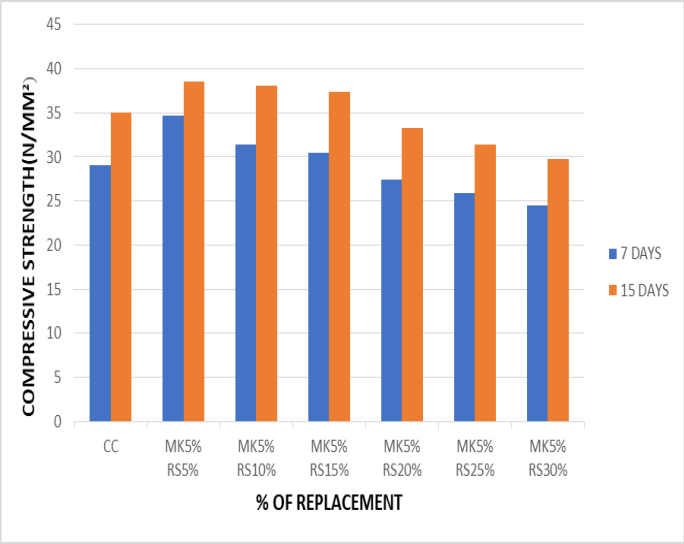


CHART -2 Compressive Strength of Paver Blocks (M6 to M12)

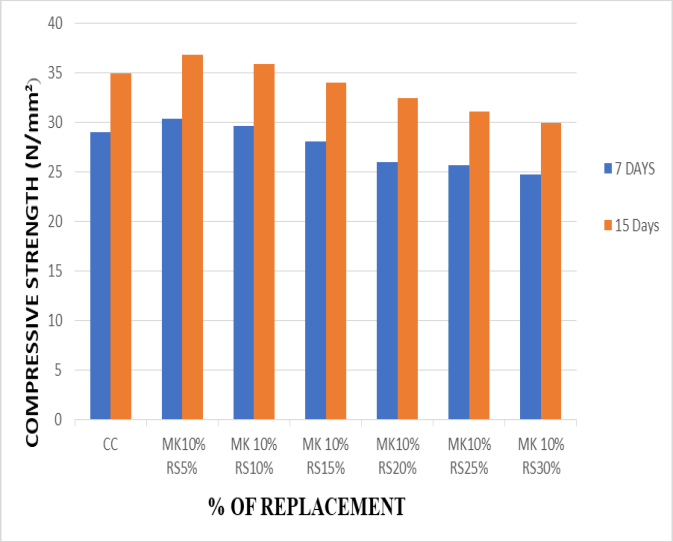


Chart -3 Compressive Strength of Paver Blocks (M13 to M18)

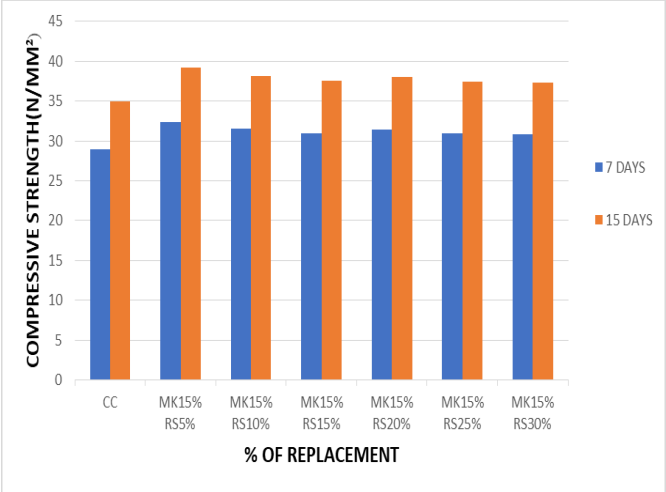


Chart -4 Compressive Strength of Paver Blocks (M18 to M24)

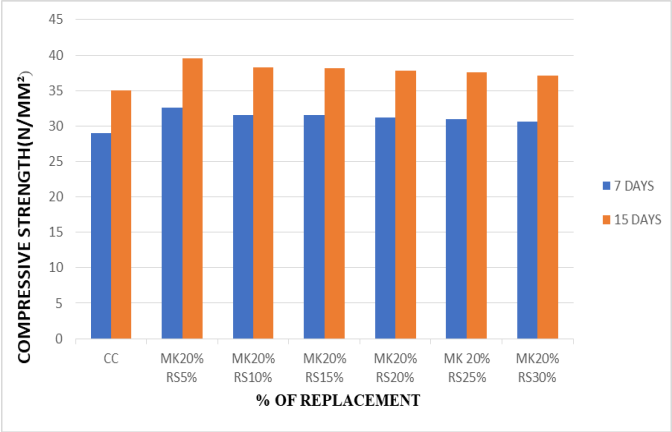
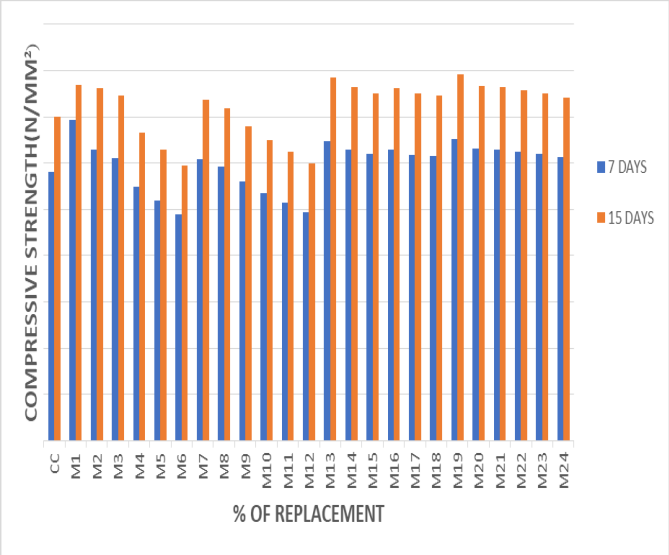


Chart -5 Compressive strength of paver blocks (M1 to M24)

M19	20%	5%	4.4
M20	20%	10%	4.42
M21	20%	15%	4.32
M22	20%	20%	4.31
M23	20%	25%	4.32
M24	20%	30%	4.26



From the Chart 1,2,3,4 and 5 it is clear that the compressive strength increases at 20 % replacement of metakaolin and 5% of Red soil where then it goes on decreases. Where the minimum value of compressive strength is 29.74 N/mm². The compressive strength of the concrete decreases with increase in metakaolin and red soil content after 15% of replacement. Therefore the optimum replacement of metakaolin and red soil concrete is found to be 20% and 5%.

Flexural strength

Split tensile strength of paver blocks are listed above 10. The test are carried out at 15 days.

Table 9: Flexural strength

MIXES	PARTIAL REPLACEMENT		FLEXURE STRENGTH OBTAINED (N/mm²)
	CEMENT BY MK %	F.A BY RED SOIL %	CURING PERIOD
			15 DAYS
CC	0%	0%	4.06
M1	5%	5%	4.34
M2	5%	10%	4.31
M3	5%	15%	4.27
M4	5%	20%	4.03
M5	5%	25%	4.0
M6	5%	30%	3.98
M7	10%	5%	4.24
M8	10%	10%	4.2
M9	10%	15%	4.08
M10	10%	20%	4.0
M11	10%	25%	3.9
M12	10%	30%	3.82
M13	15%	5%	4.38
M14	15%	10%	4.32
M15	15%	15%	4.29
M16	15%	20%	4.31
M17	15%	25%	4.28
M18	15%	30%	4.27

Chart 6- flexural strength of paver blocks (M1 to M12)

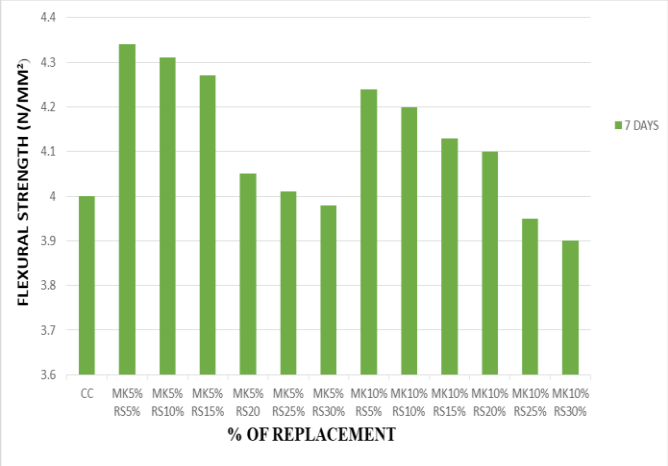


Chart 7- Flexural strength of paver blocks (M13 to M24).

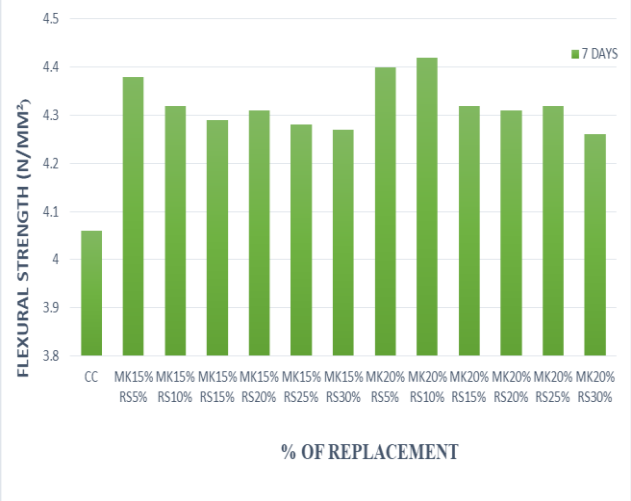
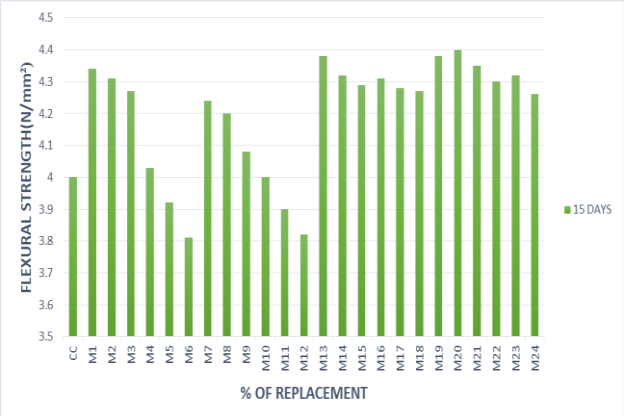


Chart 9 - Flexural strength of paver blocks (M1to M24)



From the above. Chart, it is clear that the flexural strength increases at 20% replacement of metakaolin & 10% of red soil and then it goes on decreases. Where the minimum value of flexural strength is 3.82 N/mm^2. The flexural strength of the concrete decreases with increase in metakaolin and red soil after 20% of replacement. Therefore, the optimum replacement of metakaolin & red soil in concrete for flexure is found to be 15-20%.

Split tensile strength

Split tensile strength of paver blocks are listed above 10. The test are carried out at 15 days.

Table 10: split tensile strength

MIXES	PARTIAL REPLACEMENT		SPLIT TENSILE OBTAINED(N/mm²)
	CEMENT BY MK %	F.A BY RED SOIL %	CURING PERIOD
			15 DAYS
CC	0%	0%	3.4
M1	5%	5%	3.86
M2	5%	10%	3.78
M3	5%	15%	3.4
M4	5%	20%	3.39
M5	5%	25%	3.38
M6	5%	30%	3.37
M7	10%	5%	3.74
M8	10%	10%	3.64
M9	10%	15%	3.54
M10	10%	20%	3.40
M11	10%	25%	3.33
M12	10%	30%	3.24
M13	15%	5%	3.91
M14	15%	10%	3.84
M15	15%	15%	3.79

M16	15%	20%	3.78
M17	15%	25%	3.93
M18	15%	30%	3.33
M19	20%	5%	3.84
M20	20%	10%	3.20
M21	20%	15%	3.84
M22	20%	20%	3.81
M23	20%	25%	3.79
M24	20%	30%	3.76

Chart 10 – Split tensile strength (M1 to M12).

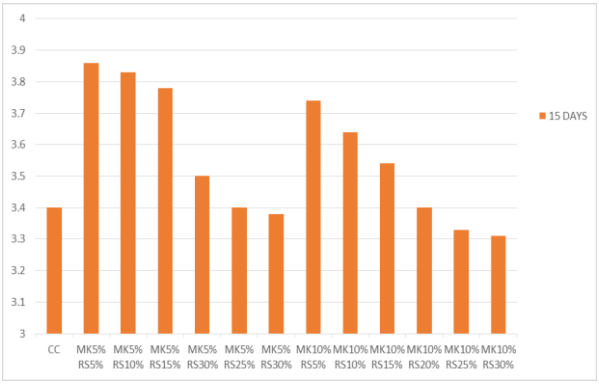


Chart 11- Split tensile strength of paver blocks (M13 to M24)

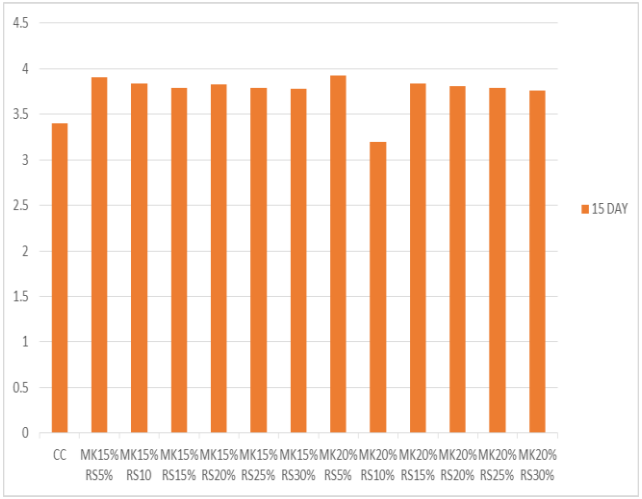
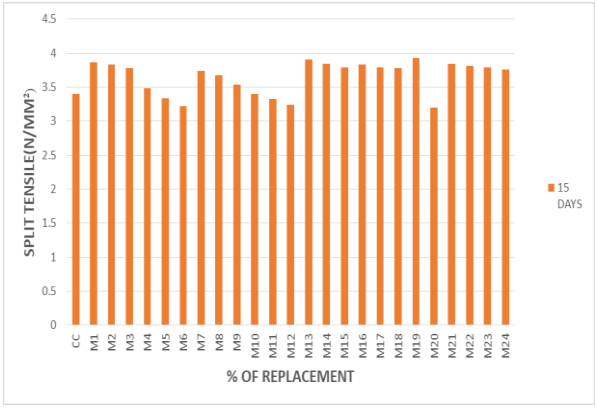


Chart 12- Split tensile strength of paver blocks (M1 to M24)



The above chart shows the increase and decrease of split tensile strength with gradual increase in percentage of Metakaolin and red soil as a replacement for fine aggregate. From the above table, it is clear the split tensile strength increases at 20% replacement of metakaolin & 5% of Red soil and then it goes on decreases. Where the minimum value of split tensile strength is 3.20 N/mm^2. The split tensile strength of the concrete decreases with increase in metakaolin content after 20% of replacement. Therefore, the optimum replacement of metakaolin and red soil in concrete for split tensile is found to be 20%and 5%.

3. CONCLUSION

It has been observed from the literatures the partial replacement of Metakaolin with up to 15% in concrete gains strength and the replacement of Red soil with fine aggregate up to 20% also gains strength.

Combining these two replacement together as per our thesis objective and after testing the concrete specimens, the following have been predicted:

1 .There is constant increase in strength if we increase the percentage of Metakaolin up to 20% but there is a fall of strength if we increase the percentage of Red soil.

2. The replacement of Metakaolin and red soil shows increase in compressive strength up to 20% to 5% of replacement. The maximum strength being 39.57 N/mm^2 is achieved for M35 grade of concrete at 15 days.

3. There is an immerse gain in split tensile strength has been observed from M14 to M19 and maximum strength is found at 20% of metakaolin and 5% of red soil that is 3.93 n/mm^2.

4. By comparing the strength gained by the combination of 20% of Metakaolin with 5%, 15%, 20%, 25% and 30% of red soil attain more strength than conventional concrete.

5. Maximum flexural strength being 4.42N/mm^2 is observed for the combination of 20% of metakaolin and 10% of red soil.

6. The results indicates that the increasing the percentage replacement of cement by metakaolin and fine aggregate by red soil over a certain percentage has resulted in reduction of compressive ,flexural and split tensile strength.

7. Current study concluded that Metakaolin and red soil can replace fine aggregate up to 20% to 5% as optimum replacement.

REFERENCE

1. Bharatkumar BH, Narayan R, Raghu Prasad Bj and Ramachandramurthy DS (2001) Mix proportioning of high performance concrete. Cement concrete composites.23, 71-80.
2. Ramesh Rathod, D.Memade (2017) Evaluation of the properties of Red soil concrete.
3. Debaiky AS, Green MF, Hope BB (2002) Carbon fiber-reinforced polymer wraps for corrosion control and rehabilitation of reinforced concrete columns.
4. Francis A Qluokun (1994) Fly ash concrete mix design and the water cement ratio law.ACI material J.362-367
5. Kedar S. Shinge, Bhagyashree Wasd, Shreyans B, Ratho D and Sandheep s (2015) Partial replacement of cement mortar by using red soil and rice husk ash.
6. Anhad Singh Gill, Rafat Siddique (2018) Durability properties of self-compacting concrete incorporating metakaolin and rice husk ash.
7. Singh, M., Mehla, P. and Kumar, A., (2015) An Experimental Investigation on Precast Cement Concrete Paver Blocks using Fly ash, pp: (395-402).
8. M.C.Nataraja and Lelin Das(2011) A study on the strength properties of paver blocks made from Construction of Interlocking Concrete Pavement Blocks (ICBPs) Using Super plasticizer ,volume.3 pp02-08
9. R.C.YeoleM. B.Varma (2014) Comparison of Mix Designs of Paver Blocks using Waste Rounded Steel Aggregates and Rubber, Volume4 pp73-79.
10. Sudhir (2013) an experimental study on flexural strength evaluation of prestressed concrete beams with partial replacement of cement by metakaolin and fly ash.
11. G.R.vijaya Shankar, (2014), static and cyclic behaviour of high performance concrete beams using metakaolin and partial replacement with quarry dust.
12. G. Nava. Venkateswara Rao (2014) Experimental Investigation on Properties Concrete Paver Block with the Inclusion of Natural fibres