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Strength and Durability Properties of Concrete with Partial Replacement of Cement with Metakoalin and Marble Dust

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Abstract: Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The amount of the Co2 released during the manufacture of OPC due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced. Attempts are made to reduce the use of Portland cement in concrete are receiving much attention due to environment-related. In the present study Metakaolin and marble duat used as a partial replacement for cement. Metakaolin is a calcinied clay and It is a Dehydroxylated form of the clay mineral Kaolinite. Stone having higher percentage of Kaolinite are known as china clay or kaolin was traditionally used in the manufacture of porcelain ceramic material. The particle size of Metakaolin is smaller than cement particles and where as Marble dust is obtained from cutting and manufacturing industries of marble. In India near about 3500 metric tons of marble dust slurry per day is generated. So, Marble dust is very easily available with very less cost. Kaolinite is also called as green pozzolana because it emits less co2. In this project an experimental work is been performed to determine mechanical properties of concrete with metakaoline and marble dust is replaced with cement with the known percentages such as 0%,10%,11%,12%,13%,14%,15% for the grade of M20.

I. INTRODUCTION TO CONCRETE

Concrete is a very strong and versatile mouldable construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the whole mix together. The initial hardening reaction usually occurs within a few hours. It takes some weeks for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many years..

A. Why replacement of Concrete Making Materials are being Done?

The life-cycle assessment of concrete includes information on the production of raw materials for concrete, the manufacturing of concrete, the use of supplementary materials such as fly ash and ground-granulated, blast-furnace slag, chemical admixtures, and on the recycling of concrete. Lowering the environmental impact of concrete by using partial replacement of cement, improving cement production, the development of alternative binders, recycling waste byproducts, and the enhancement of durability is presented.

B. Introduction to Marble Dust and Metakoalin

1) *Marble Dust:* Marble dust is a waste product formed during the production of marble. A large quantity of powder is generated during the cutting process. ... It is a solid waste material generated from the marble processing and can be used either as a filler material in cement or fine aggregates while preparing concrete. Marble has been commonly used as a building material since the ancient times. Consequently, Marble waste as a by-product is a very important material which requires adequate environmental disposal effort. In addition, recycling waste without proper management can result in environmental problems greater than the waste itself. Marble dust is a waste product formed during the production of marble. A large quantity of powder is generated during the cutting process. The result is that about 25% of the original marble mass is lost in the form of dust. Leaving these waste materials to the environment directly can cause environmental problems such as increases the soil alkalinity, affects the plants, affects the human body etc. Marble powder can be used as an admixture in concrete, so that strength of the concrete can be increased. It is a solid waste material generated from the marble processing and can be used either as a filler material in cement or fine aggregates while preparing concrete

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Table 1: Chemical composition of Marble Dust

Oxides compound	Percentage
CaO	42.45
Al2O3	0.520
SiO2	26.35
Fe2 O3	9.40
MgO	1.52

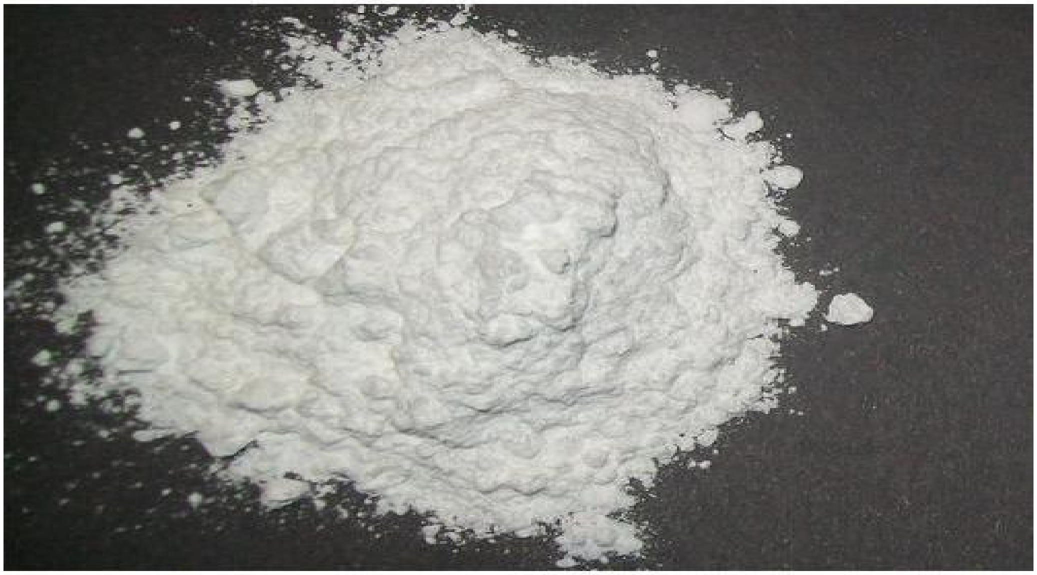

Fig:a Image of Marble Dust

2) *Metakoalin:* Metakaolin is the anhydrous calcined form of the clay mineral kaolinite. Minerals that are rich in kaolinite are known as china clay or kaolin, traditionally used in the manufacture of porcelain. The particle size of metakaolin is smaller than cement particles, but not as fine as silica fume. Considered to have twice the reactivity of most other pozzolans, metakaolin is a valuable admixture for concrete/cement applications. Replacing portland cement with 8–20% (by weight) metakaolin produces a concrete mix that exhibits favorable engineering properties, including: the filler effect, the acceleration of OPC hydration, and the pozzolanic reaction. The filler effect is immediate, while the effect of pozzolanic reaction occurs between 3 and 14 days. The increase in metakaolin content improves the compressive strength, split tensile strength and flexural strength upto 15% replacement. The result encourages the use of metakaolin, as pozzolanic material for partial cement replacement in producing high strength concrete.

Components	SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	K_2O	MgO	TiO_2	P_2O_5	L.O.I
Metakaolin	51.85	43.87	0.99	0.20	0.01	0.12	0.18	1.74	0.03	-
Cement	22.42	4.68	3.68	63.2	0.25	0.75	3.63	-	-	0.45
Silica Fume	93.16	1.13	0.72	-	-	-	1.6	-	-	1.58

Table 2 Chemical Composition of Metakoalin

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Fig: b Image of Metakoalin

II. LITERATURE REVIEW

A.V.S.Sai. Kumar, Krishna Rao B Concrete a composite material made from cement, water, fine aggregate and coarse aggregate. But present researchers are in interest of finding new cement materials by waste materials or waste products produced from industries which are harmful to environment. The present paper deals with partial replacement of cement with quarry dust and metakaolin which are having silica used as admixture for making concrete. First quarry dust is made partial replacement of cement and found that 25% of partial replacement is beneficial to concrete without loss of standard strength of cement. Making 25% partial replacement of cement with quarry dust as constant, 2.5%, 5.0%, 7.5%, 10.0%, 12.5% metakaolin was made in partial replacement of cement and results were found that quarry dust and metakaolin usage in partial replacement to cement can be made.

G. AshaLakshmi, P. Sai Pravallika Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. The amount of the Co2 released during the manufacture of OPC due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced. Attempts are made to reduce the use of Portland cement in concrete are receiving much attention due to environment-related. In the present study Metakaolin and marble duat used as a partial replacement for cement. Metakaolin is a calcinied clay and It is a Dehydroxylated form of the clay mineral Kaolinite. Stone having higher percentage of Kaolinite are known as china clay or kaolin was traditionally used in the manufacture of porcelain ceramic material. The particle size of Metakaolin is smaller than cement particles and where as Marble dust is obtained from cutting and manufacturing industries of marble. In India near about 3500 metric tons of marble dust slurry per day is generated. So, Marble dust is very easily available with very less cost. Kaolinite is also called as green pozzolana because it emits less co2. This paper presents results of an experimental program to determine mechanical properties of concrete with metakaoline and marble dust is replaced with cement with the known percentages such as 0%,5%+5%,7.5%+7.5%,10%+10%,12.5%+12.5%,15%+15% for the grade of M30.

CH Jyothi Nikhil1* and J D Chaitanya Kumar Among many mineral admixtures available, Metakaolin (MK) is a mineral admixture, whose potential is not yet fully tested and only limited studies have been carried out in India on the use of MK for the development of high strength concrete. MK is a supplementary cementetious material derived from heat treatment of natural deposits of kaolin. MK shows high pozzolana reactivity due to their amorphous structure and high surface area. The experimental work has been carried out as partial replacement of cement with MK in M70 grade of concrete at 0%, 10%, 15%, 20%, 25% and 30% of replacements. The mix design was made making the use of Erntroy empirical Shacklock's method. Cubes are tested for durability studies with H2SO4 and HCL of 0.5% and 1% concentrations. Cubes, cylinders and prisms are tested for temperature study at 15% replacement. The specimens were heated to different temperatures of 100oC, 200oC, 300oC, 400oC and 500oC for three different durations of 1, 2 and 3 h at each temperature.

J. Thivya , M. Arivukkarasi Concrete a widely used construction material, consumes natural resources like lime, aggregates, water. In concrete the composite materials are replaced with Metakaolin and Granite powder. Metakaolin used as a partial replacement of cement which was treated as economical and due to its pozzolonic action increases strength and durability properties of concrete. Granite powder is a waste material from the polishing industry not disposed properly into the land used in the concrete replaced for sand. The test results obtained indicate that granite powder of marginal quantity as partial sand replacement has beneficial effect on the mechanical properties such as compressive strength, split tensile strength, modulus of elasticity..

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P. Jaishankar and Vayugundlachenchu Eswara Rao Concrete is that pourable mix of cement, water, sand, and gravel that hardens into a super-strong building material. Supplementary cementing materials (SCM) have become an integral part of concrete mix design. These may be naturally occurring materials, industrial wastes or, by products or the ones requiring less energy to manufacture. Some of the commonly used SCM are fly ash, silica fume (SF), GGBS, rice husk ash and metakaolin (MK), etc. Metakaolin is obtained by the calcination of kaolinite. It is being used very commonly as pozzolanic material and has exhibited considerable influence in enhancing the mechanical and durability properties of concrete. M-sand is crushed aggregates produced from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency to be used as a substitute of river sand. Usage of M-Sand can overcome the defects occurring in concrete such as honey combing, segregation, voids, capillary, etc. In this project, experimental study was carried out on M-30 grade of concrete. In this concrete mixes sand was replaced by M-sand by a constant percentage and cement was replaced by metakolin in various percentages such as 5%, 10%, 15% and 20%. Concrete specimens containing metakaolin were studied for their compressive, split tensile and flexural strengths according to Bureau of Indian standards. The results thus obtained were compared and examined with respect to the control specimen

M. Jagadeesh Naik and S.M. Gupta Concrete is a Composite material made from cement, Fine aggregate, Coarse aggregate and water. The worldwide production of cement has greatly increased since 1990 and this production of cement results in lot of environment pollution as it involves the CO2 gas. So alternative supplementary cementitious materials like Metakaolin, Fly-ash, GGBS, Rice Husk etc.. are used as partial replacement of cement. Metakaolin is a dehydroxylated aluminum silicate and having pozzolanic action. With increased depletion of Natural Construction material, alternative means must be sought for replacement of the same in the concrete mixes. The paper presents the partial replacement of cement with Metakaolin (0%, 5%, 10%, 15% and 20%) and Natural Sand with ROBO SAND (50%). The Mechanical properties of concrete i.e. Compressive strength, Split tensile strength and Flexural strength are studied of concrete made with partial replacement of MK-RS and compared with conventional concrete.

M. Devi The utilization of well graded, fines free quarry dust has been accepted as a building material in the construction industry in recent years and it has been used as an alternative material to river sand for fine aggregate. The use of supplementary cementitious materials such as fly ash, silica fume, slag and metakaolin in concrete improves workability, reduces the heat of hydration, minimizes cement consumption and enhances strength and durability properties by reducing the porosity due to the pozzolonic reaction. Metakaolin is a highly pozzolanic and reactive material. In this paper emphasize has been given to metakaolin as partial replacement of cement at 5%, 10%, 15% and 20% by weight of cement in concrete having quarry dust as fine aggregate. The effect of metakaolin on the strength properties was analyzed by conducting compressive, split tensile and flexural strength tests and durability properties were evaluated by impressed voltage measurement, rapid chloride penetration test (RCPT) and gravimetric weight loss measurement in addition to water absorption and bulk density analysis. The optimum percentage of metakaolin replacement was also determined.

Zubair Ahmad Khan, V S Sagu Concrete is the most extensively used construction material in the world, which consumes natural resources like lime, aggregates and water. The worldwide production of cement has greatly increased, due to this production environmental pollution increases with emission of CO2 gas. To reduce this effect cement was replaced by some supplementary materials like Metakaolin, Fly ash, Bottom Ash, Ground Granulated Blast Furnace Slag (GGBS) and Rice Husk etc.. In this content Metakaolin was a pozzolanic material used in wide range in replacement of cement. Metakaolin is dehydroxylated aluminum silicate, due to its pozzolanic activity the strength properties and durability properties of concrete increases and reduction in Porosity and Permeability also. Now-a-day's availability of natural sand is constraint, so alternative material called ROBO Sand (having similar properties as that Natural Sand) is used in place of Natural sand to study the fresh and hardened properties of concrete. In this present investigation cement is replaced partially with metakaolin in varying percentage i.e. 0%, 5%, 10%, 15% and 20% and natural sand with 50% ROBO sand to get the different concrete mixes. The fresh and mechanical properties of concrete i.e. workability (slump test) and compressive strength, split tensile strength and flexural strength at 7 days, 28 days and 90 days are studied of the different concrete mixes and results are compared with conventional concrete.

III. PROBLEM IDENTIFICATION

On the basis of reading many research papers it was found that the compressive strength of concrete is more at 10%+10% replacement of metakaoline and marble dust. Due to increase of percentages of metakaoline and marble dust the strength of the concrete is reducing. The experimental test is done in many percentages but the percentage missing is 11%,12%,13%,14% which may give the best optimum percentage for dosage and also the concrete properties can be examined very thoroughly and minutely.

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IV. AIM OF THE STUDY

The main intension of this work is to know about the compressive strength of concrete with Metakoalin and Marble dust in a partial replacement of cement. Concrete is mainly used to bear the compressive load on structure, so it is necessary that it should be highly durable, less reactive, good workability and maximum load bearing strength.

Metakoalin and Marble dust is a waste material in India with a huge amount and they posses the cementitious properties , in this experimental work optimum dosage of admixtures(i.e. Metakoalin and Marble dust) were examined and also their effect is studied in concrete properties. Also the cost of cement is optimized for greater economy.

V. METHODOLOGY

From the study of all literature it is observed that, the partial replacement of cement with dolomite powder is beneficial for compression strength of concrete when mixed in optimum percentage. In this chapter will discuss about calculation, theory of materials and test procedure which is followed.

A. Tests On Different Components Of Concrete

1) Test on cement
2) Test on Coarse aggregate
3) Test on Fine aggregate
4) Calculation and Design procedure
5) Compression test

a) Test On Cement

i) Consistency Of Cement

Conclusion / Result

The normal consistency of a given sample of cement is 28%

Consistency =($weight\ of\ water\ added\ /weight\ of\ cement$) $X100$

S.No	Weight of cement (gms)	Percentage by water of dry Cement (%)	Amount of water added (ml)	Penetration from the bottom of vicat scale (mm)
1	300gm	26%	78ml	10mm
2	300gm	28%	84ml	7mm
3	300gm	30%	90ml	4mm

Table No -3 Consistency of cement

ii) Initial Setting Time Of Cement

Initial setting time of cement = 32min 18

S.No	Setting time in minute	Penetration in mm from the top vicat scale
1	28	2mm
2	3o	3mm
3	32	7mm

Table no.4 Initial setting time of cement

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iii) Fineness Of Cement

Conclusion

The average value of fineness of given sample of cement is 2 %

Fineness of cement = % of mass retained on sieve = $(M1/M)\,X100$

S.No	Weight of cement in gm (M)	Weight of cement retained on (M1)	Fineness of cement
1	100gm	2gm	2%
2	100gm	3gm	3%
3	100gm	2gm	2%

Table no. 5 Fineness of cement

b) Test On Fine Aggregate

i) Sieve Analysis

Conclusion / Result

Fineness modulus of a given sample of fine aggregate is 2.86

The given sample of fine aggregate is belong to Grading Zones II

IS sieve (in mm)	Wt of fine agg. retained Determination No.				Wt Retained	Cumulativ e percentage retained	% passing	Permissible % passing as per IS:383
	I	II	III	Avg				
10	0	0	0	0	0	0	100	100
4.75	20	22	20	27	2.1	2.1	98	90-100
2.36	36	32	26	32	3.2	5.3	94.9	75-100
1.18	314	320	332	322	32.2	37.5	63.1	55-90
600	215	186	228	210	21.1	58.5	41.5	35-59
300	270	292	264	276	27.6	86.1	13.9	8-30
150	116	104	104	108	10.8	96.9	3.1	0-10
75	20	28	15	21	2.1	99	1	-
pan	4	10	6	7	0.7	99.7	0.3	-

Table no. 6 Sieve analysis of fine aggregate

ii) Specific Gravity Of Fine Aggregate

SNo.	Discription	Sample1	Sample 2	Sample 3
1	Wt of sample taken	2000gm	2000gm	2000gm
2	Wt of pycnometer+sample+water(A)	1826gm	1824gm	1825gm
3	Wt of pycnometer+water(B)	1516gm	1513gm	1514gm
4	Weight of saturated and surface dry sample(C)	500gm	500gm	500gm
5	Weight of oven dry sample(D)	496gm	490gm	494gm
6	Specific gravity = D/($C-(A-B)$)	2.61	2.55	2.62
7	Apparent specific gravity= $D/(D-(A-B))$	2.66	2.73	2.69
8	Water absorption % dry weight= $((C-D)/D)\,X100$	0.8%	2.04%	1.2%

Table no. 7 Specific gravity of fine aggregate

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c) Tests On Coarse-Aggregate

i) Sieve Analysi

IS sieve (in mm)	Wt of coarse agg. retained Determination No.				Wt Retained	Cumulativ e percentage retained	% passing	Permissible % passing as per IS:383
	I	II	III	Avg				
80	0	0	0	0	0	0	0	-
63	0	0	0	0	0	0	0	-
40	0	0	0	0	0	0	0	100
20	82	44	56	61	6.1	6.1	93.9	85-100
16	534	454	490	493	49.3	55.4	44.6	-
12.5	292	402	380	358	35.8	91.2	8.8	-
10	86	86	66	80	8	99.2	0.8	0-20
4.75	06	10	8	8	0.8	100	0	0-5
2.36	0	0	0	0	0	100	0	-
1.18	0	0	0	0	0	100	0	-
0.6	0	0	0	0	0	100	0	-

Table no. 8 Sieve analysis of coarse aggregate

ii) Specific Gravity Of Coarse Aggegate

Table no. 9 Sieve analysis of coarse aggregate

SNo.	Discription	Sample1
1	Wt of sample taken	1000
2	Wt of vessel+sample+water(A)	3076
3	Wt of vessel+water(B)	2428
4	Weight of saturated and surface dry sample(C)	1004
5	Weight of oven dry sample(D)	996
6	Specific gravity = D/($C-(A-B)$)	2.79
7	Apparent specific gravity= $D/(D-(A-B))$	2.86
8	Water absorption % dry weight= $((C-D)/D)\,X100$	0.8%

B. Mix Design Process And Calculation

1) Concrete Mix Design Grade M 20 (Ultra-Tech 53 grade cement) IS 10262-2009

Grade Designation -	M 20
Type of cement	Ultra-Tech 53 grade conforming to IS 8112
Maximum nominal size of aggregate	20 mm
Minimum cement content	300 kg/m^3 (Table 5 IS 456-2000)
Max water cement ratio	0.55 (Table 5 IS 456-2000)
Workability	75mm slump
Exposure condition	Mild (Table 5 IS 456-2000)
Method of concrete placing	Manual placing
Degree of supervision	Good
Types of aggregates	Crushed angular aggregates
Max cement content	450 kg/m^3 (IS 456-2000)

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2) Test Data For Materials

a) Cement used OPC- 53 grade conforming to IS 8112
b) Sp.gr of cement 3.15
c) Sp.gr of Coarse aggregate 2.750
Sp.gr of Fine aggregate 2.575
d) Water absorption Coarse aggregate 0.73 Fine aggregate 1.00%
e) Free surface moisture Coarse aggregate 0.13 Fine aggregate 0.62%
f) Sieve analysis

Sieve Analysis of Coarse Aggregates (Gravel) 5 kg (dry sample)

Sieve Size	Wt. of Sample Retained	Cum Wt. Retained	% Wt. Retained	% Passing
40 mm	0.0 kg	0.00	0.00	100
20 mm	2.646 kg	2.65	53.0	47
10 mm	2.043 kg	4.70	94.0	06
4.75 mm	0.311 kg	5.00	100	00

Sieve Analysis of Fine Aggregates (Gravel) 2 kg (dry sample)

Sieve Size	Wt. of Sample Retained	Cum Wt. Retained	% Wt. Retained	% Passing
4.75 mm	0.148 kg	0.148	7.40	92.60
2.36 mm	0.222 kg	0.570	18.50	81.50
1.18 mm	0.485 kg	0.855	42.75	57.25
600 µ	0.452 kg	1.307	65.35	34.65
300 µ	0.608 kg	1.915	95.75	04.25
150 µ	0.070 kg	1.985	99.25	00.75
Dust Collection	0.015 kg	--	--	--

Sand is of Zone – II

3) Target Strength For Mix Proportioning

$f'_{ck} = f_{ck} + 1.65\, s = 20 + 1.65 \times 4 = 26.6\ N/mm^2$
where , f'_{ck} = target average compressive strength at 28 days
f_{ck} = characteristics compressive strength at 28 days,
s = standard deviation
from Table 1 of IS 10262-2009 , s = 4 N/mm^2

4) Selection Of Water Cement Ratio

From Table 5 of IS 456-2000 , maximum water cement ratio = 0.55,

based on experience , adopt water cement ratio = 0.50
0.50 < 0.55 Hence O.K

5) Selection Of Water Content

From Table 2 of IS 10262-2009 , max water content = 186 lit for slump of 25mm-50mm , 3% water is to be added for every another 25mm .
186 + (186x3/100) = 191.58 lit

6) Calculation Of Cement Content

W/C ratio = 191.58 / 0.5 = 383.16 kg/m^3 .

From table 5 of IS 456-2000 , minimum cement content for ‘ mild ’ exposure condition is 300 kg/m^3 .

383.16 kg/m^3 > 300 kg/m^3 Hence O.K

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7) Mix Calculation Per Unit Volume

Volume of Coarse aggregate = 0.62

Volume of Fine aggregate = 0.38

a) Volume of Concrete = 1 m^3

b) Volume of Cement = (Mass of cement / Sp. gr. of cement) x (1/1000) = (383.16/3.15) x (1/1000) = 0.121m^3

c) Volume of water = (Mass of water / Sp. gr. of water) x (1/1000)

= (191.58/1)) x (1/1000) = 0.191 m^3

d) Volume of all in aggregates = [a – (b + c)] = 1 – 0.312 = 0.688 m^3

e) Mass of Coarse Aggregate – 0.688 x 0.62 x 2.75 x 1000 = 1173.04 kg/m^3

f) Mass of Fine Aggregate – 0.688 x 0.38 x 2.575 x 1000 = 673.20 kg/m^3

Table:19 Mix Proportion For M 20 Grade Of Concrete with 0% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	383.16 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:20 Mix Proportion For M 20 Grade Of Concrete with 10% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	344.844 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:21 Mix Proportion For M 20 Grade Of Concrete with 11% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	341.012 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:22 Mix Proportion For M 20 Grade Of Concrete with 12% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	337.180 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:23Mix Proportion For M 20 Grade Of Concrete with 13% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	333.349 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:24 Mix Proportion For M 20 Grade Of Concrete with 14% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	329.517 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:25 Mix Proportion For M 20 Grade Of Concrete with 15% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	325.686 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

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Table:26 Mix Proportion For M 20 Grade Of Concrete with 0% replacement by Metakoalin

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	383.16 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:27 Mix Proportion For M 20 Grade Of Concrete with 10% replacement by Metakoalin

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	344.844 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:28 Mix Proportion For M 20 Grade Of Concrete with 11% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	341.012 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:29 Mix Proportion For M 20 Grade Of Concrete with 12% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	337.180 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:30 Mix Proportion For M 20 Grade Of Concrete with 13% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	333.349 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:31 Mix Proportion For M 20 Grade Of Concrete with 14% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	329.517 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

Table:32 Mix Proportion For M 20 Grade Of Concrete with 15% replacement by Marble dust

Water	Cement	Fine Aggregates	Coarse Aggregates
191.58 lit	325.686 kg/m^3	673.20 kg/m^3	1173.04 kg/m^3
0.5	1	1.756	3.061

VI. RESULT & DISCUSSION

1) *Properties Of Cement:* Ordinary Portland cement confirming IS 8112:1989 was used thought the work. Cement used was dry and free from lump with SG = 3.35

PROPERTIES	RESULT
Fineness modulus	2%
Specific gravity	3.35
Consistency	28%
Initial setting time	32min
Final setting time	600min

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2) *Properties Of Fine Aggregate:* The fine aggregate used in this work was clean river sand and maximum size is 4.75 mm. Sieve analysis confirms to zone-II (according to IS: 383-1970).

PROPERTIES	RESULT
Zone	II
Water absorption	1.1%
Fineness modulus	2.86
Specific gravity	2.66

3) *Properties Of Coarse Aggregate:* Machine crushed aggregate of 20mm size is used. And it is separated by sieving size passing from 40mm and retain on 20mm.

PROPERTIES	RESULT
Size of C.A	20mm
Water absorption	0.8%
Fineness modulus	7.2
Specific gravity	2.79

4) *Properties of Metakoalin & Marble Dust*

a) *Property of Marble dust*

1)	Specific gravity	2.56
2)	Moisture content	4.21%
3)	Colour	White
4)	Bulk Density	1340kg/m^3
5)	Percentage of Void	46.58%
6)	Finess Modulus	3.38

b) *Property of Metakoalin*

1)	Specific gravity	3.28
2)	Moisture content	4.21%
3)	Colour	White
4)	Bulk Density	1005kg/m^3
5)	Percentage of Void	41.83%
6)	Finess Modulus	2.84

A. *Workability Test*

1) *Slump Test*

Result

a) The slump value in mm = 85 (0% MD & MK)
b) The slump value in mm = 83.48 (10% MD & MK)
c) The slump value in mm = 83.1 (11% MD & MK)
d) The slump value in mm = 82.34 (12% MD & MK)
e) The slump value in mm = 80.98 (13% MD & MK)
f) The slump value in mm = 80.01 (14% MD & MK)
g) The slump value in mm = 78.94 (15% MD & MK)

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Table: Compression test on different percentage of Marble Dust added to concrete

SL.NO	GRADE OF CONCRETE	% Replacement(MD)	Characteristics Compressive Strength after 28 Days (N/mm^2)		
			7 Days	14 Days	28 Days
1	M20	0%	13.5	18.12	19.98
2	M20	10%	17.1	18.23	27.24
3	M20	11%	17.01	18.48	27.14
4	M20	12%	17.54	18.44	26.42
5	M20	13%	16.91	18.01	26.92
6	M20	14%	16.3	17.42	26.44
7	M20	15%	16.01	17.2	26.23

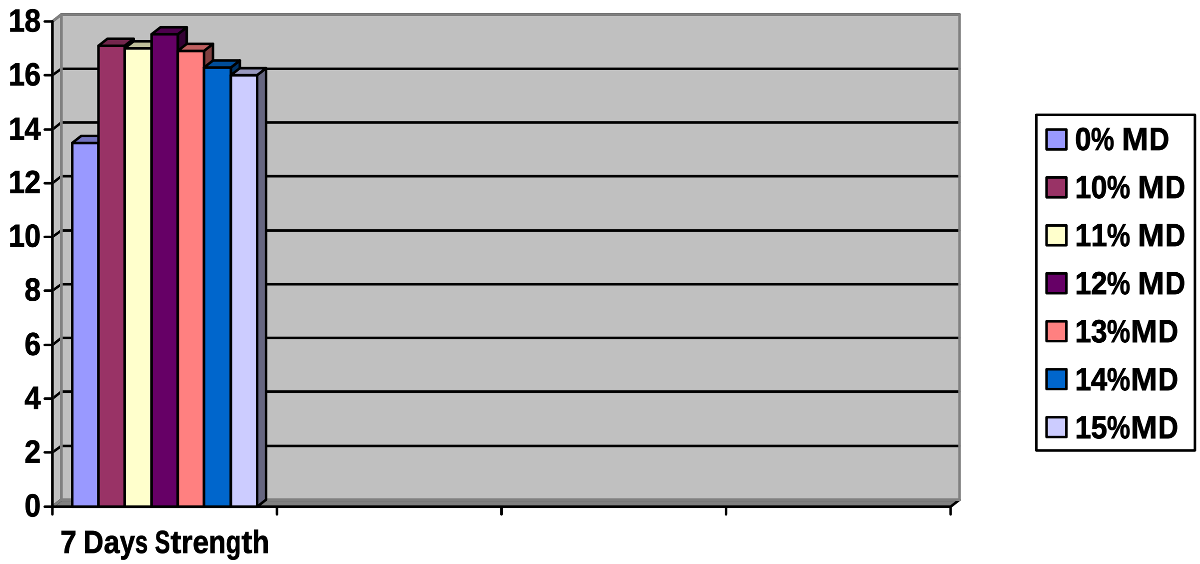

Fig : 14 Graphical representation of 7Days Compressive strength with different % replacement of MD

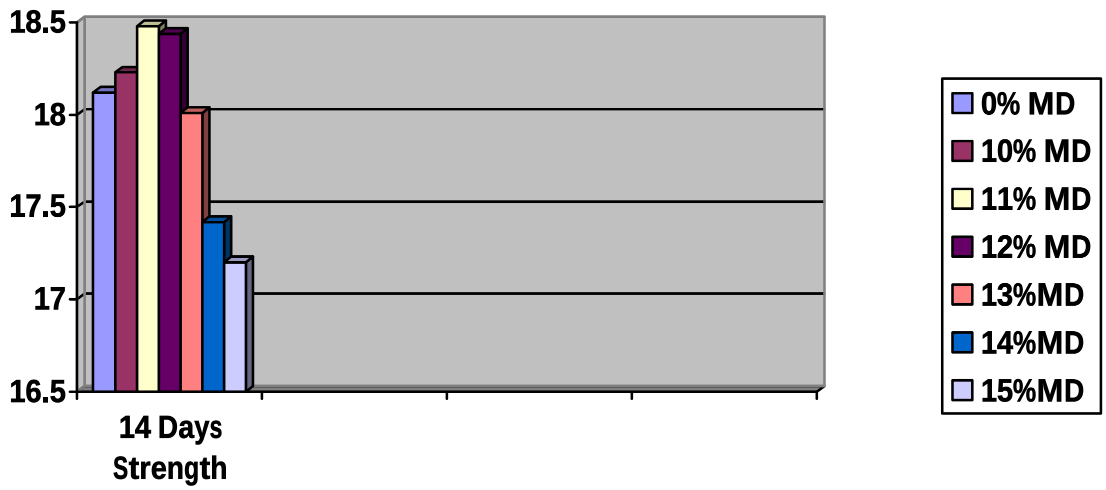

Fig :15 Graphical representation of 14 Days Compressive strength with different % replacement of MD

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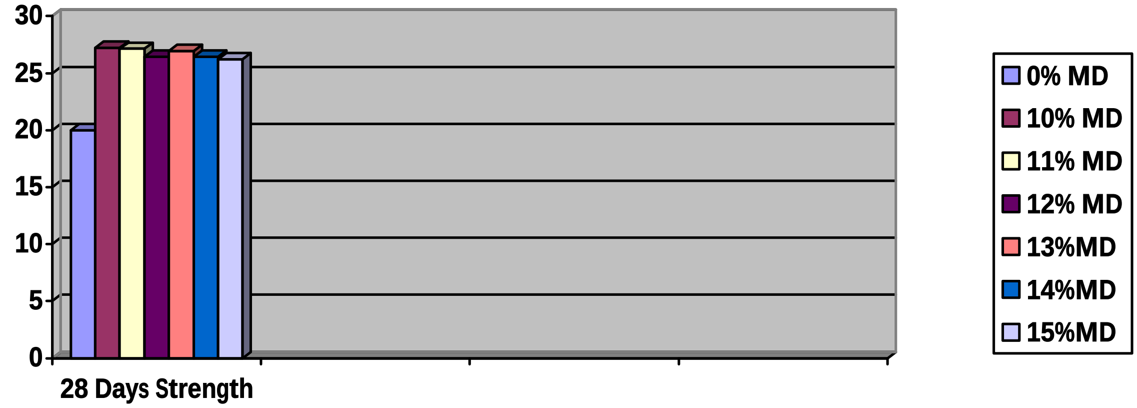

Fig : 16 Graphical representation of 28 Days Compressive strength with different % replacement of MD

The graphical representation above fig:14 says that when 12% replacement of MD is done then it will give the highest growth rate of Compressive strength after 7 days i.e. 17.54 N/mm^2 , Minimum strength rate growth is achieved when 0% replacement of MD is done .Again when 14 days strength is compared fig:16 the highest strength growth is in 11% replacement and lowest in 15% replacement of MD . 28 Days strength is maximum when 10% replacement of MD is made .So here replacement of MD with cement is worthy upto some extent and limit.

Table: Compression test on different percentage of Metakoaline added toconcrete

SL.NO	GRADE OF CONCRETE	% Replacement(MK)	Characteristics Compressive Strength (N/mm^2)		
			7 Days	14 Days	28 Days
1	M20	0%	13.5	18.12	20
2	M20	10%	16.51	18.00	27.1
3	M20	11%	17.11	18.98	27.99
4	M20	12%	17.01	18.01	26.89
5	M20	13%	16.52	17.68	26.32
6	M20	14%	16.01	17.33	26.23
7	M20	15%	16.03	17.43	26.52

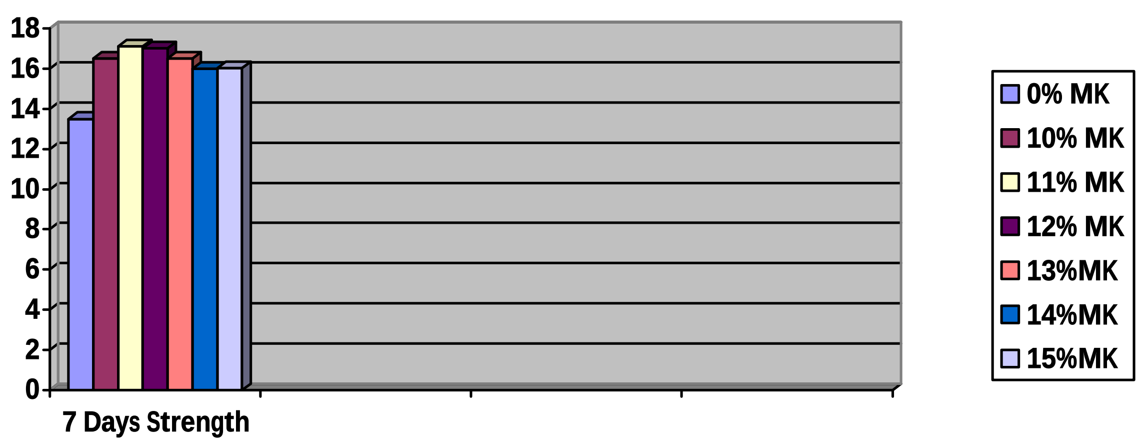

Fig :17 Graphical representation of 7 Days Compressive strength with different % replacement of MK

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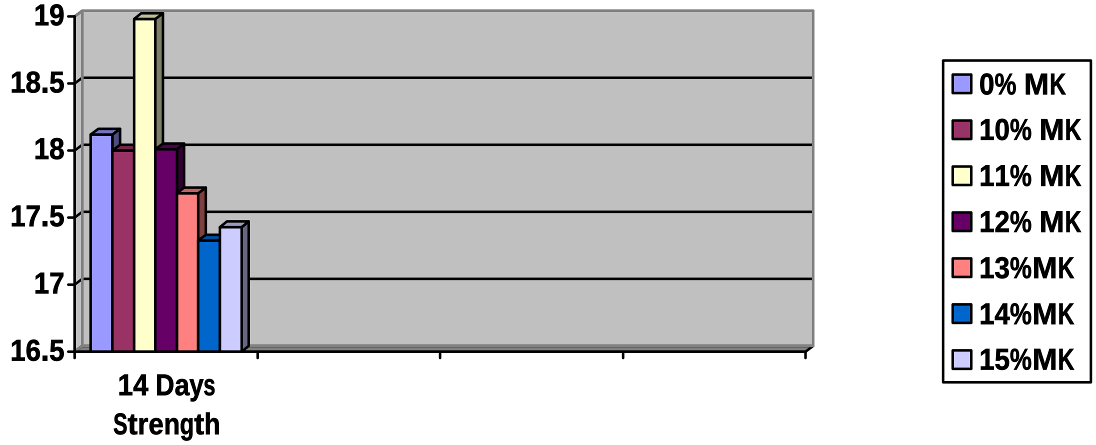

Fig : 18 Graphical representation of 14 Days Compressive strength with different % replacement of MK

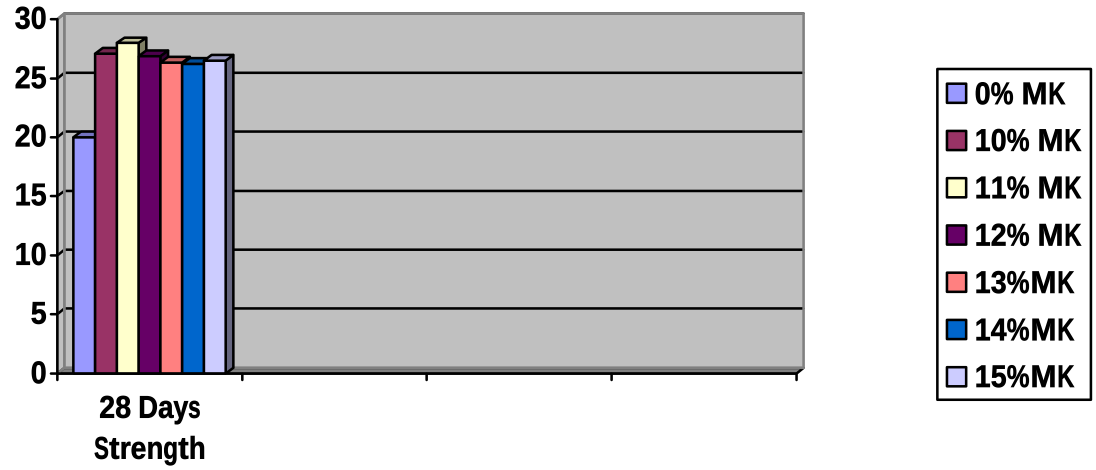

Fig :19 Graphical representation of 28 Days Compressive strength with different % replacement of MK

The graphical representation above fig: 17 says that when 11% replacement of MK is done then it will give the highest growth rate of Compressive strength after 7 days i.e. 17.11 N/mm^2 , Minimum strength rate growth is achieved when 0% replacement of MK is done .Again when 14 days strength is compared fig:19 the highest strength growth is in 11% replacement and lowest in 14% replacement of MK . 28 Days strength is maximum when 11% replacement of MK is made .So here replacement of MK with cement is worthy upto some extent and limit.

VII. CONCLUSION

A. From the Test results we find that metakaoline and marble dust can be use for partial replacement in concrete.
B. The compressive strength of concrete is more at 10% replacement of marble dust,11% replacement is also commendable
C. The compressive strength of concrete is more at 11% replacement of metakaoline
D. Due to increase of percentages of metakaoline and marble dust the strength of the concrete is reducing i.e. upto 13% it can be replaced but after it the strength rate of concrete decreases.
E. 11% replacement of MD and 12% replacement of MK can also be done.
F. Workability of concrete is also reducing due to increase in percentage of metakaoline and marble dust.
G. Strength and durability of concrete is increase.

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VIII. FUTURE SCOPE OF WORK

A. As in this work using Metakoaline and Marble Dust optimum dosage of this admixture is examined but this can be again re-tested using some chemical admixtures for futher increase in strength .

B. Next scholar can work for workability stream because workability is decreasing .

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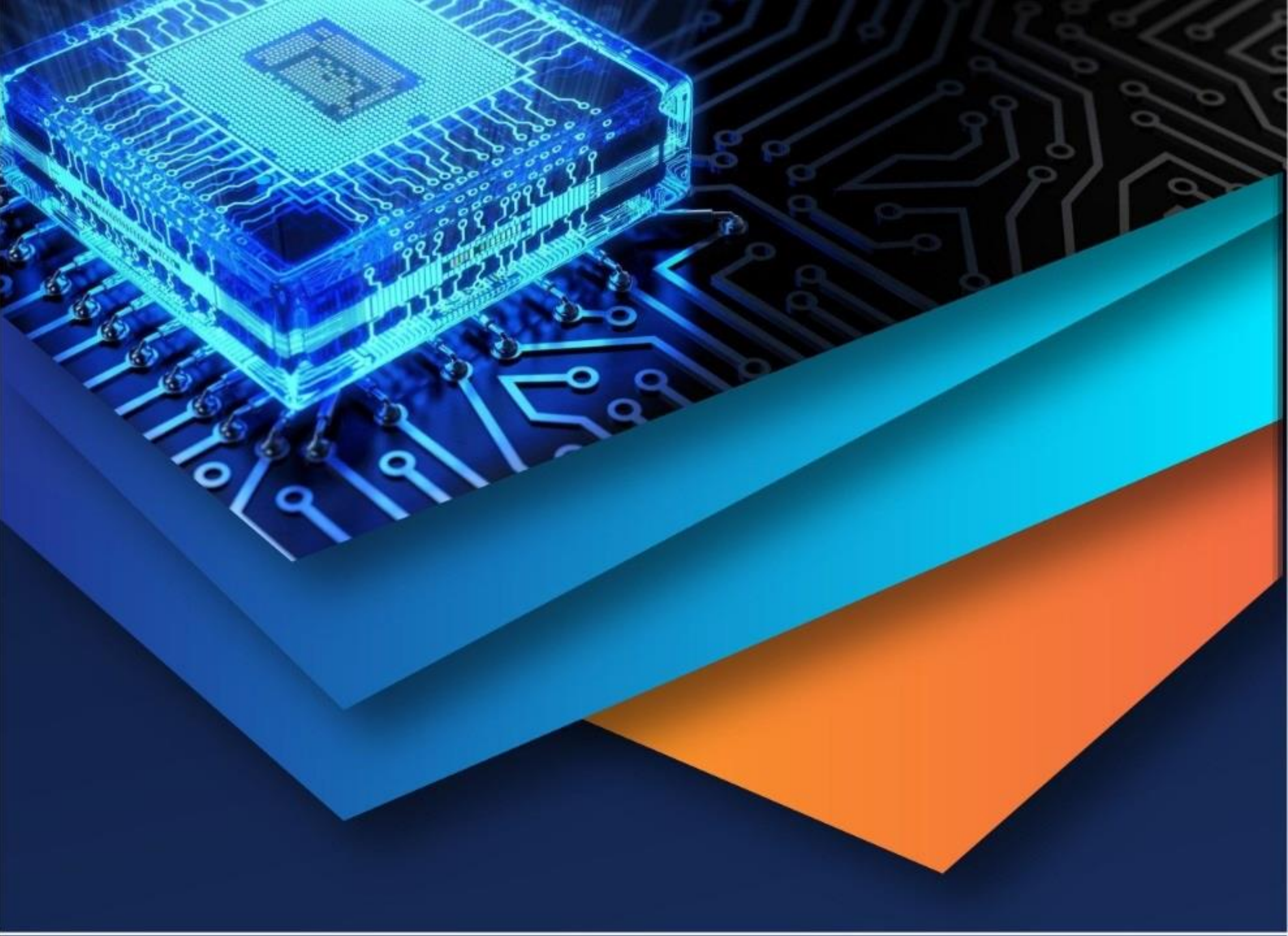

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