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Marshall Properties of SDBC using Emulsion based Cold Mix Technology

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Abstract: ***Cold mix is a bituminous mixture containing mineral aggregate, water and binder (bitumen emulsion) mixed together at ambient temperature. There is an increasing trend for using cold mix design with bitumen emulsion all over the world because of several advantages such as elimination of heating of binder and aggregate while producing mixes, this helps in protection of environment and energy conservation. In the present study, the main objective is to study the behavior and effect of cold emulsion on semi dense bituminous concrete (SDBC) mix by the Marshall Method of mix design. The specimen was prepared with Cement and Ground Granulated Blast furnace Slag (GGBFS) as fillers. In the present investigation the Marshall properties of SDBC using cold emulsion have been studied and compared using both filler materials. Based on the present study it has been found that mix having GGBFS as filler has better results as compared to mix with cement as filler material.***
Keywords: Marshall Stability, Marshall Flow, volumetric properties

I. INTRODUCTION

Flexible pavements constitute 80% over total road network in India. In flexible pavement hot mixed bituminous materials are generally used for the construction of upper layers. The paving bitumen like VG30, VG40 is generally used as binder. These bituminous materials are either solid or semi-solid at the ambient temperature and converted into fluid either by heating or by adding of petroleum solvent or by emulsifying bitumen in water. Therefore high amount of energy consume for heating of aggregate and bitumen to prepare the hot mix .this causes high level of noise and air pollution. Cold Mix technology is field application of mix design based on cold mix binders without need of any heating in an environment-friendly manner. Cold mix therefore is the right solution for rural and other low volume roads. The main object and scope of the study is:

To prepare and test specimen of semi dense cold mix using emulsion by cold mix method using Marshall Equipment by conducting the laboratory study.

To evaluate the cold mix samples with emphasis on the coating, air curing period, Marshall Stability and volumetric properties.

Bitumen emulsion being liquid at room temperature, there is no need to heat or dry the mineral aggregate. Cold mix is useful in the areas, where there is long distance between the job site and plant and temperature of climate is low and moderate(<40°C). Further, the versatility of cold mix allows it to be mixed in-place at the job site as well as at a plant site and then subsequently transported to the job site. In this present study bituminous mix is prepared by using cold emulsion. The semi dense bituminous concrete is designed and prepared as per MORTH specifications. The Marshall properties of Semi Dense Bituminous Concrete by using GGBFS and cement as fillers are studied and compared.

II. MATERIAL AND METHODOLOGY

The coarse aggregate having nominal size10 mm; 6 mm and stone dust were used in appropriate proportion. The mineral fillers GGBFS or cement were used in the mix at 2% by the total weight of the mix. The aggregates were tested for impact value, Los Angeles Abrasion value, specific gravity, water absorption and crushing value as per IS 2386-1963. To prepare the SDBC specimen with cement filler and GGBFS filler each 2% and different percentage of cold bitumen emulsion at curing stage of the mix different emulsion contents by conducting Marshall Stability and their volumetric properties. The cold emulsion used in this study was purchased from Ooms polymer, Gurgaon, Haryana.

A. Mix Design Procedure of Sdbc by using the Cold Bituminous Emulsion

1) The dry aggregate was blended into 1200g batches by combining the different aggregate sizes to the desired gradation.
2) The aggregate was used cold (at room temperature)

3) The moisture content was added 3% to the aggregate and mixed thoroughly. The mix was left for 10-15 minutes at room temperature before adding bitumen emulsion.
4) The emulsion was added cold to the wet aggregate and mixed thoroughly for about 2 minutes. The suitability of the mix and degree of coating was then evaluated.
5) In my study done the compaction of the mixture by the Marshall Compaction hammer on each side of specimen 50 blows.
6) The prepared samples were extruded after 24 hours.

In my study took 7 to 10 percent of bitumen emulsion and add 2% additive i.e. cement and granulated grinded blast furnace slag (GGBFS) to all percentage of bitumen emulsion.

B. Aggregate Testing

The aggregates are tested as per IS 2386 for following properties.

1) Sieve analysis for coarse and fine aggregates
2) Specific gravity and water absorption of coarse aggregate
3) Specific gravity of fine aggregates
4) Aggregate impact value
5) Crushing Value
6) Specific gravity of cement and GGBFS

III. TEST RESULT ANALYSIS

The following test results of aggregates were obtained

A. Aggregate Test Result

Table 1: Aggregate test result

S No.	Tests	Value
1	Water Absorption	.449
2	Impact Test	14.20%
3	Los Angeles Abrasion	23.20%
4	Specific Gravity Of Aggregate	2.89
5	Crushing	18.83%

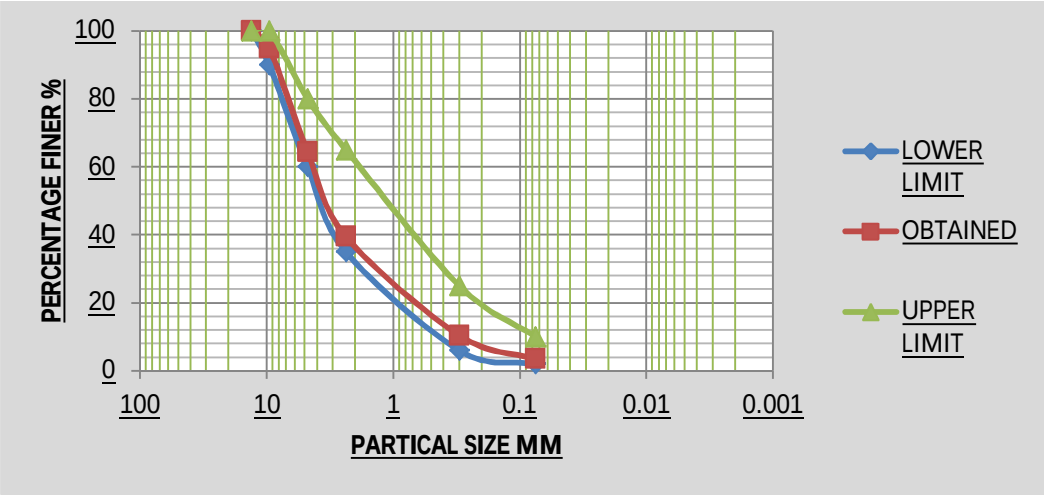
B. Job mix Formula

The combined aggregate grading for SDBC is shown in table 2 which falls well within the limits as per MORTH specification ranges.

Table 2: SDBC job mix formula

SDBC JOB MIX FORMULA							
SIEVE, MM	% BY WEIGHT PASSING				COMBINED GRADING	MORTH SPECIFICATION	
	10 MM	6 MM	DUST	FILLER	.28A+.30B+ .40C+.02D	LOWER LIMIT	HIGHER LIMIT
	A	B	C	D			
13.2	100	100	100	100	100	100	
9.5	82	100	100	100	94.96	90-100	
4.75	19.5	56.5	100	100	64.41	60-80	
2.36	2	16.5	80	100	39.51	35-65	
0.3	0	0	21	100	10.4	6-25	
0.075	0	0	4	95	3.5	2-10	

Graph 1: Sieve Analysis for SDBC Mix



C. Test Result Of Cold Mixes

The Marshall properties of SDBC mix using cold emulsion and cement or GGBFS as fillers are shown in table 3 or table 4 and the optimum properties are present in table 5.

Table 3.SDBC mix with Cement Filler

Cold Mix Content%	Density gm/cc	Air Voids Vv	VFB %	Marshall stability kg	Flow mm
6.54	2.42	5.82	71.73667	310.22	4.23
7.4	2.4	5.21	76.25	375.95	4.53
8.25	2.38	4.83	79.38667	332.81	5.06
9.09	2.37	3.72	82.88667	252.69	5.5

Table 4. SDBC mix with GGBFS Filler

Cold Mix Content%	Density gm/cc	Air Voids Vv	VFB %	Marshall stability kg	Flow mm
6.54	2.4	6.27	70.47667	305.89	3.5
7.4	2.38	5.45	75.27333	374.32	3.8
8.25	2.35	5.13	78.02333	446.77	4.1
9.09	2.34	3.77	82.6	358.22	4.2

Table 5- Optimum Properties for SDBC

Optimum Marshall Properties	Mix Using Cement Filler	Mix Using GGBS Filler	Recommended Specification In MORTH	Remark
OBC	8024	8.61		All values are satisfied
Flow	4.65	3.98	2 mm (min)	
Stability	365.596	418.51	220KG (min)	
Bulk Density	2.39	2.36		
Vv %	5.11	5.25	3-5	
VFB %	77	76.95	70-80	

The variations of Marshall Stability values, density Air voids and VFB with different amount of cold emulsion is shown in figure 2 to 5.

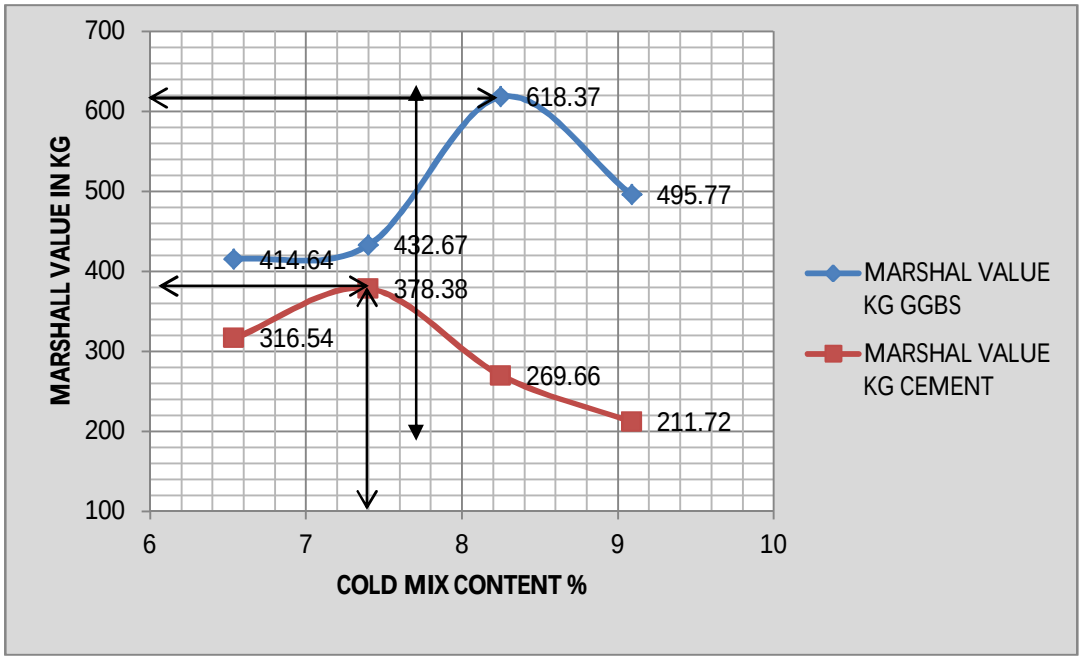


FIGURE 2: Variation of Marshall Stability Value with Cold Mix Content

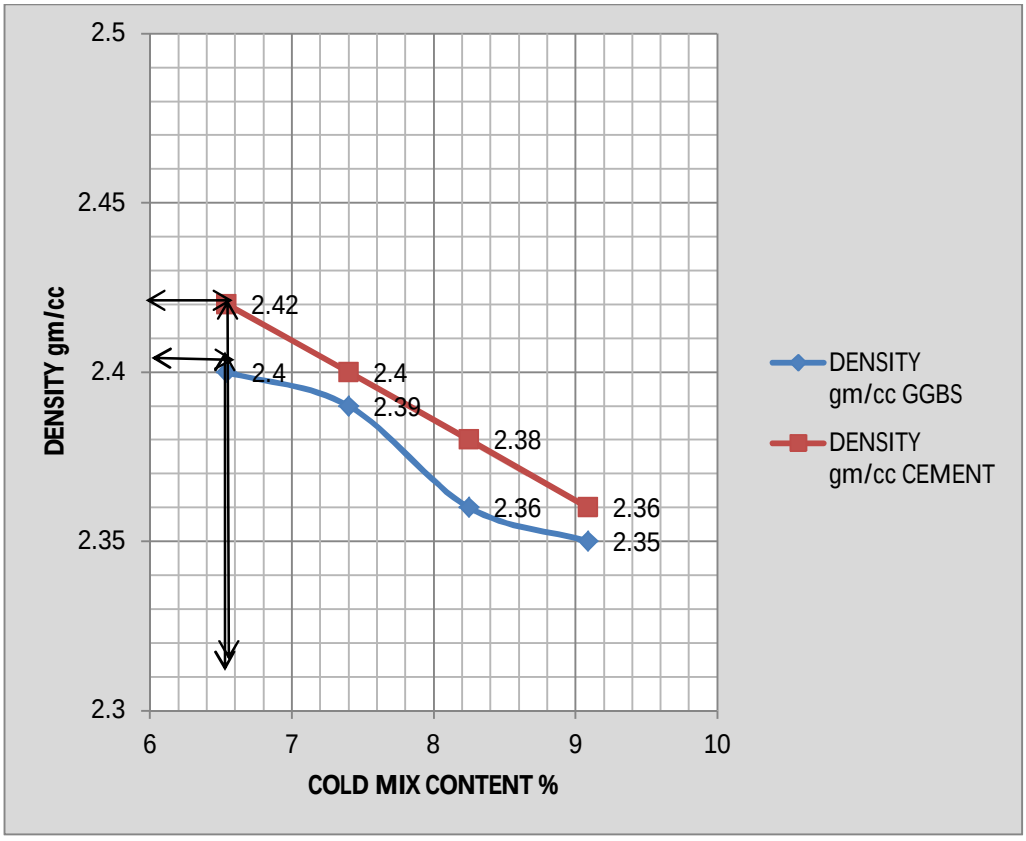


Figure 3: Variation of Density Value with Cold Mix Content

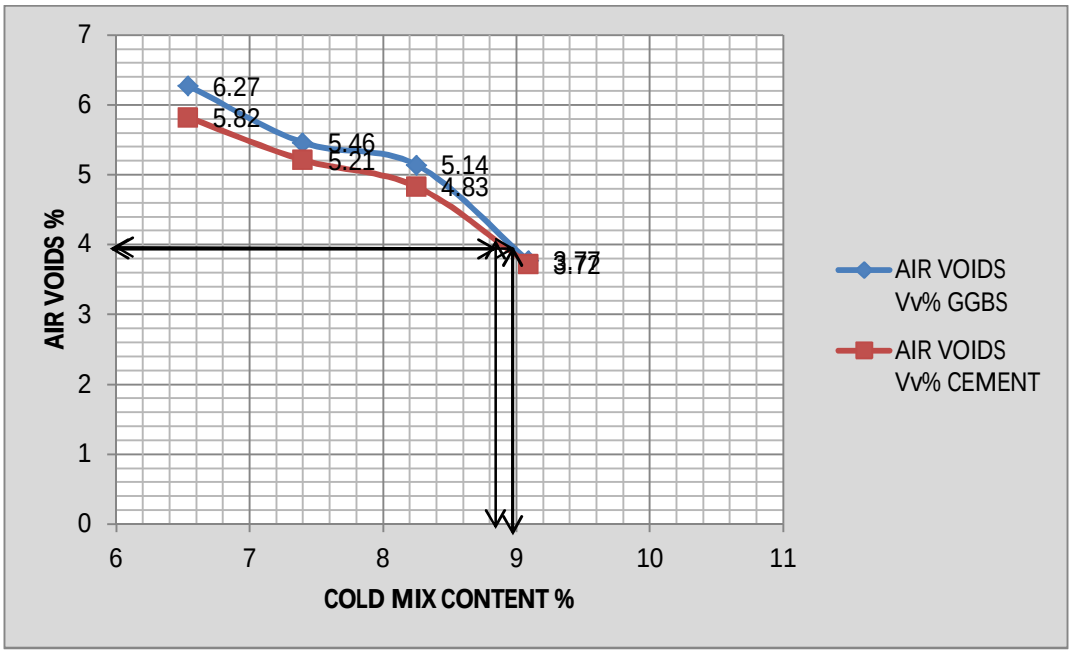


Figure 4: Variation of Air Voids with Cold Mix Content

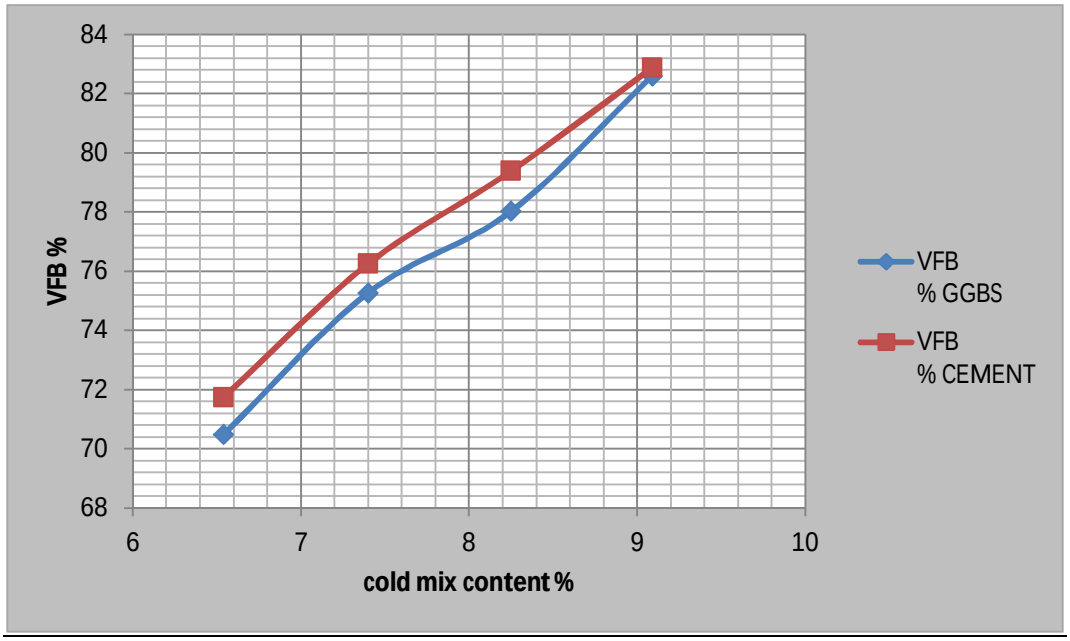


Figure 5: Variation of VFB with Cold Mix Content

IV. DISCUSSION

A. SDBC cold mix

1) Effect on Marshall Value: Maximum Marshall Satiability Load of 375.95 kg has been obtained from the Marshall test done for the SDBC with a cold mix content of 8% (With Cement Filler) and with 9% cold mix (with GGBS Filler) Maximum Marshall Stability Load of 446.77 Kg is obtained.

2) Effect on Density: The value of Maximum Density Obtained with 7% cold mix content (with cement filler) is 2.42 gm/cc and with7% cold mix content (with GGBS filler) is 2.40 gm/cc.

3) Effect on Air Voids: At cod mix content of 9.74 % (with cement filler) the value of minimum air void content is obtained is 4% and at 9.83% (with GGBS filler) the value of minimum air voids obtained is 4%.

4) Optimum binder content: The optimum binder content is the average of Maximum Marshall Stability load, maximum density and minimum air voids at 4% in the respective cold mix content.

V. CONCLUSION

From above experimental work on following conclusions are drawn based on Marshall Properties of the SDBC mix using cold emulsion with Cement and GGBS filler.

A. From the Marshall stability test perform on SDBC mix using cold emulsion as binder and cement as filler material the optimum binder content is found to be 8.24 %with Marshall stability value as 365.596 kg the corresponding flow value, density of mix, air voids, and VFB are found as 4.65 mm, 2.39 gm/cc,5.11% and 77.02 % respectively. These values are well within the ranges specified in MORTH specification.

B. From the Marshall stability test perform on SDBC mix using cold emulsion as binder and GGBS as filler material the optimum binder content is found to be 8.61 %with Marshall stability value as 418.51 kg the corresponding flow value, density of mix, air voids, and VFB are found as 3.98 mm, 2.36 gm/cc, 5.25% and 75.93 % respectively. These values are well within the ranges specified in MORTH specification

C. If we compare the Marshall Stability values using GGBS and Cement as filler it can be concluded that the Marshall satiability obtained using GGBS filler comparatively higher than those obtained cement as filler at all binder contents. The flow values using GGBS filler slightly lower than the value using Cement as filler.

Cold mix can be laid on low to medium volume road as a green paving mix. Mixture can be produced by using conventional plant or by hand. So it can be laid as surface course or bituminous base course for rural road construction. When incorporating cement, the cold mix should be compacted soon after mixing to maximize the results and to avoid workability problems.

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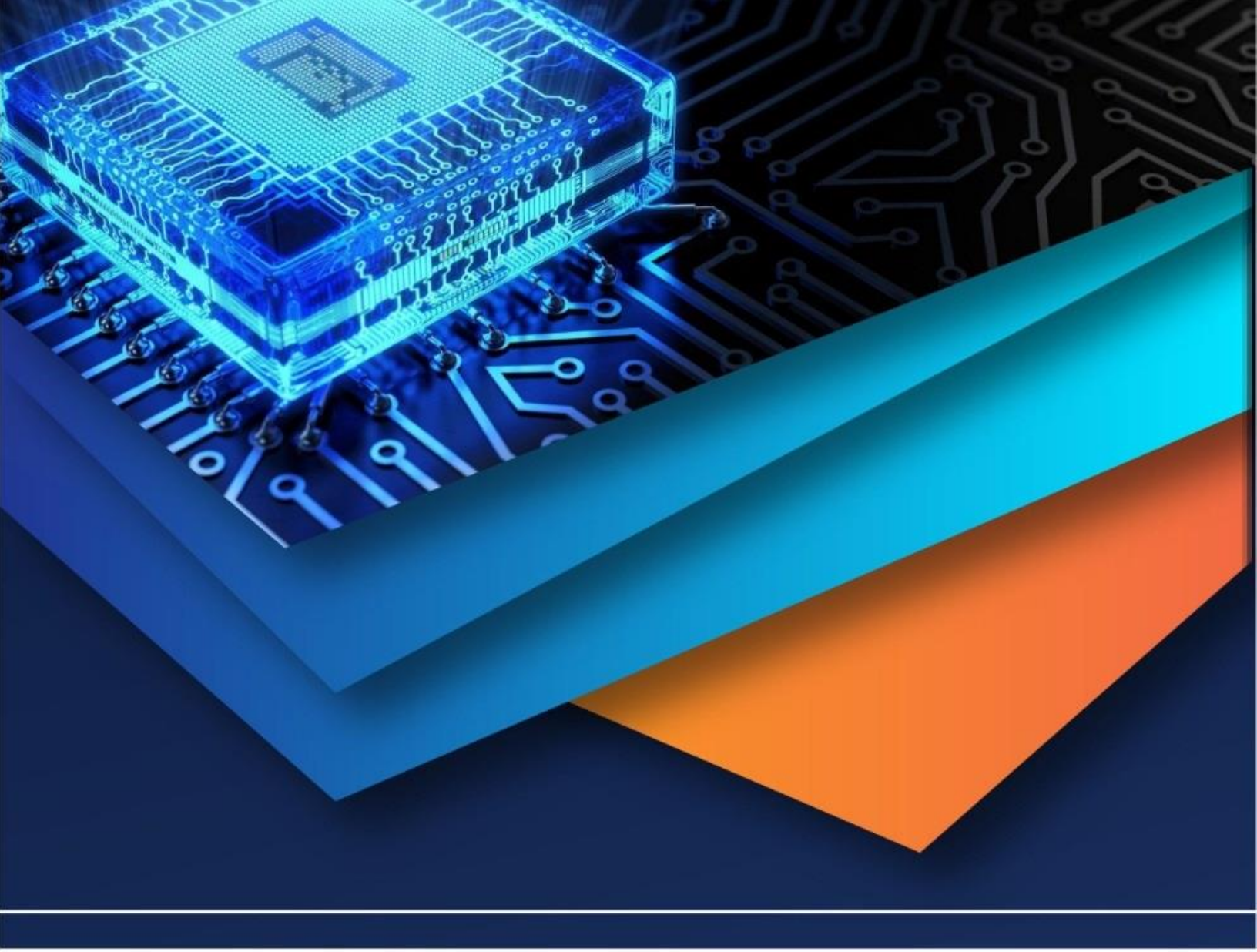

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