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Flood Modeling for Computation of Submergence Area Using Arc GIS, HEC Georas & Hecras

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Abstract: This paper presents a one-dimensional hydrodynamic modeling of a river network and floodplains. The main issues are related to preparing input data for the hydraulic model in a consistent and georeferenced database and to representing different flow regimes. Geographic information systems based automatic procedures were developed in order to produce cross-sectional profiles that encompass the large flood plains and to link hydraulic data and spatial location. The marked seasonal flow regime and relative smooth hydrographs of River were quite well reproduced by the hydraulic model. For the tributaries, it must be mentioned the model's ability to simulate both cases when the hydrograph does not present a marked peak flow, due to water loss for the floodplain, and when the hydrograph presents a more common shape, with recession and peak flows well defined.
Keywords: Flood, Inundation Map, Geographic Information System, Hydraulic Modeling.

I. INTRODUCTION

In recent years there is an increasing demand for large scale hydrologic studies, primarily aiming to understand the hydrologic functioning of river drainage network for ecologic purposes and also to investigate the impacts of climatic variability and land use changes in flow regime. One-dimensional 1D hydraulic model are often used to mathematically represent flow routing along a river reach. In this case, simplified schemes, such as linear reservoirs, Muskingum-Cunge or kinematic wave methods may be applid. For restraining the injuries due to floods, various flood controller approaches or strategies are implemented. The flood control procedures - which should more accurately be designated as ―Flood Management‖ can be planned either through structural engineering organizations or non –structural organizations. The justifiable and effective management of flood risk mitigation measures demands a universal approach that can assimilate the flood risk calculation information in the decision making procedure in any planned developmental activity.

II. ROLE OF RESEARCHERS IN GEOSPATIAL TECHNIQUES.

A. Chidinma Blessing Okoye et al (2015). Describes mapping of flood prone zones in Surulere region of Lagos in Nigeria. The researchers were interested in recognizing the issues that lead to flooding and with the help of GIS software it will chart the flood prone zones in Surulers. The factors that affect the flooding in Surulers were high precipitation concentration; terrestrial use patterns, human act, urban expansion etc. were recognized.
B. CollinsFosu et al (2012) DEM was involved for any actual flood modeling which was obtained from contour data. The geometric information was taken out from DEM, topographic chart and ground dimensions. All this data were exported to HEC-RAS and GIS software and shows a picture of stage discharge due to flood actions. By the help of remotely sensed image a terrestrial cover plan of the catchment was generated and with the help of land cover map it will outline infrastructural and other damage estimation.
C. Chinmoyee Gogoi et al. (2013) The areas were defined from post monsoon satellite image and identified as the inundated area of flood. The researcher identified the three zones that are liable to flood they were chronically inundated zone, occasionally inundated zone and rarely inundated zone. From the result it shows that most of the chronically and occasionally inundated zones lying on the left bank of the river Subansiri. The areas were always susceptible not only to the flood because of the low-lying nature of the Subansiri and its tributaries but also due to breaching of embankments of the Brahmaputra River.
D. *Roleof Researchers In Geospatial Techniques*
E. F.E.Hicks et al (2005) River Flood predictions were held in two steps which can be reduced to one step with the help of using HEC-RAS software. HEC-RAS software has been elongated to simplify unsteady flow analyses, while the numerical arrangement is not healthy enough to handle vibrant actions (such as ice jam release floods) or supercritical flows, it has an

ability to route simple open water floods and at the equal time the produce water level is estimated. This case study shows that flood mapping and flood level predicting can easily be implemented using HEC-RAS software which is public domain and it does not require costly acquisition for surveying channel geometry data between resident's centers.

F. Agnihotri P.G et al (2011) The concept of channel adjustment of river Tapi by means of geospatial practices are introduced in this paper. These technologies will be useful in designing flood mitigation strategies for the city and also a innovative measure which helps to regulator big disaster in future. This paper proposes different alternatives of river modification by the use of HEC-RAS software. The hydraulic strategy of river segment is carried out from the flood inundation map which is prepared in the ARCGIS software and then it's exported by HEC-Georgas software and as a result there will be decline in the area of submergence for modified river segment which is evaluated by geospatial techniques. The total submergence area for the flood of 9.1 lacs cuses reduced to 87.51 %, 81.03% and 78.30% for adjusting caring discharge of river.

G. Eric C.Tate et al (2002) describes on creating a Terrain Model for Floodplain Mapping. The paper expresses the use of a geographic information system (GIS) method accessible for the growth of a topography model based on tributary channel depiction of the HEC- RAS model. The researcher has an idea for developing an automated terrain modeling approach in which a technique combine a topography model from HEC-RAS cross section data and DEM.

III. STUDY AREA & DATA COLLECTION

Machhu River rises in the hills of Jasdan near village Khokhara in Chotila taluk of Surendranagar districts at an elevation of 220m above m.s.l. This is one of the North flowing rivers of Saurashtra in Gujarat state. The Machhu basin is situated between 22° 10' to 23°10' North latitude and 70° 40' to 71° 15' East longitude. The river Machhu originates from the hill ranges of Jasdan Sardar and Mandva in Rajkot district and Chotila in Surendranagar district and flows in North Westerly direction along the district boundary of Surendranagar and Rajkot up to village Beti and then flows mostly towards North in Rajkot district and finally disappears near Malia in the little Rann of Kachchh. Machhu along with its tributaries flows 52% in the hilly area and 48% in plain region.

IV. INTRODUCTION TO SOFTWARE

A. Geographic Information System (GIS): is a system of hardware, software and procedures to facilitate the management, manipulation, analysis, modeling, representation and display of geo referenced data to solve complex problems regarding planning and management of resources. Functions of GIS include data entry, data display, data management, information retrieval and analysis.

B. HEC-GeoRAS : creates a file of geometric data for import into HEC-RAS and enables viewing of exported results from RAS. The import file is created from data extracted from data sets (ArcGIS Layers) and from a Digital Terrain Model (DTM). HEC-GeoRAS requires a DTM represented by a triangulated irregular network (TIN) or a GRID. The layers and the DTM are referred to collectively as the RAS Layers. Geometric data are developed based on the intersection of the RAS Layers.

C. HEC-RAS: system comprises four one-dimensional river examination components for: (1) stable flow water surface profile computations; (2) unstable flow simulation; (3) detachable boundary sediment carrying computation; and (4) water quality investigation. A important element is that all four modules use a common geometric data representation and mutual geometric and hydraulic working out procedures. In addition to the four river examination components, the structure comprises several hydraulic strategy features that can be raised once the basic water surface profiles are work out.

V. METHODOLOGY

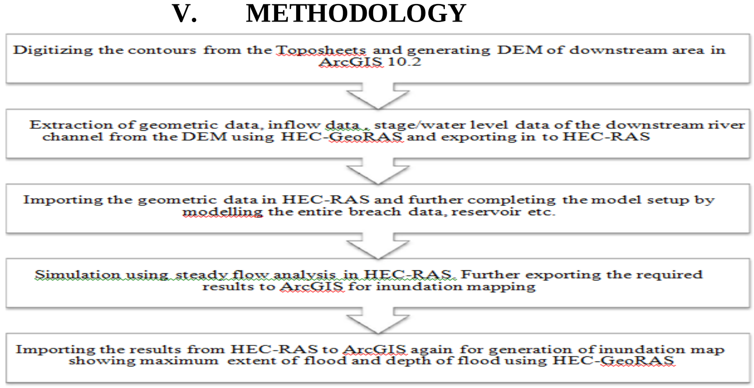


Fig. 1 Flow chart for methodology

VI. MODEL DEVELOPMENT

A. The projections were defined using “Data management tools” → Define a projection. The WGS 1984.prj from geographic co-ordinate system was selected for the projection.

B. Using the “Topo to Raster” tool, the Digital elevation model was generated. The developed DEM was primarily in Raster form. This was further converted to TIN format by using the conversion tools.

C. The created raster is merged using “Data management tools”→Raster→RasterDataset→Mosaic.

D. The generated DEM by using the above process is having a projection of WGS 1984. This projection does not contain a linear measurement unit, i.e. meters. In order to use DEM for modeling watershed and its characteristics in HEC-RAS, the DEM must be in UTM projection.

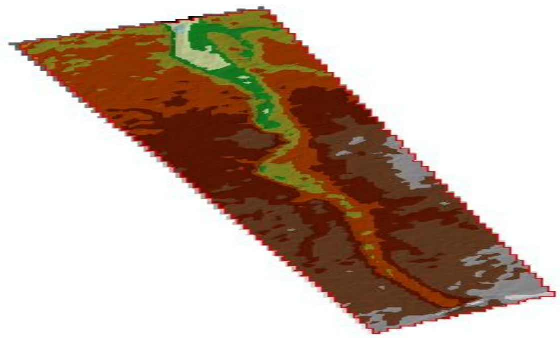
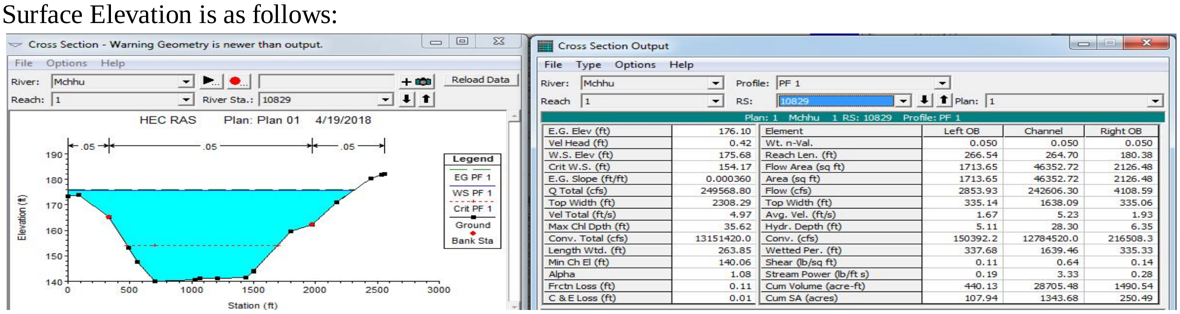


Fig. 2 Digital elevation model showing the river

VII. RESULT

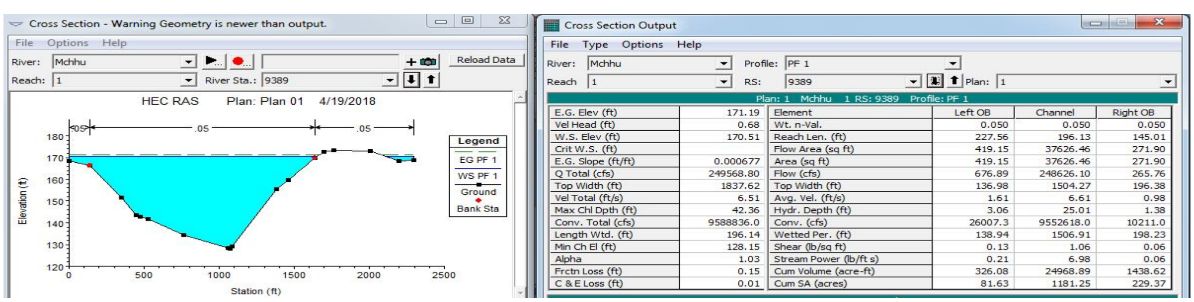
A. In order to identifying whether resulted discharge creates flood or not. Flow is analyzed at two cross- sections at Machchu 1 Dam. For plotting cross sections transverse dimensions on either side of the center of river has been considered extended to a distance such that it covers range of floodplain on either side of the river Optimum data set division is done by trial and error method and it is found that 70% training , 10% Testing and 20 %Validation data division gives better result

B. The Water Surface Elevation is as follows:



E.G. Elev (ft)	176.10	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.42	Wt. n-Val.	0.050	0.050	0.050
W.S. Elev (ft)	175.68	Reach Len. (ft)	266.54	264.70	180.38
Crit W.S. (ft)	154.17	Flow Area (sq ft)	1713.65	46352.72	2126.48
E.G. Slope (ft/ft)	0.000360	Area (sq ft)	1713.65	46352.72	2126.48
Q Total (cfs)	249568.80	Flow (cfs)	2853.93	242606.30	4108.59
Top Width (ft)	2308.29	Top Width (ft)	335.14	1638.09	335.06
Vel Total (ft/s)	4.97	Avg. Vel. (ft/s)	1.67	5.23	1.93
Max Chl Dpth (ft)	35.62	Hydr. Depth (ft)	5.11	28.30	6.35
Conv. Total (cfs)	13151420.0	Conv. (cfs)	150392.2	12784520.0	216508.3
Length Wtd. (ft)	263.85	Wetted Per. (ft)	337.68	1639.46	335.33
Min Ch El (ft)	140.06	Shear (lb/sq ft)	0.11	0.64	0.14
Alpha	1.08	Stream Power (lb/ft s)	0.19	3.33	0.28
Frctn Loss (ft)	0.11	Cum Volume (acre-ft)	440.13	28705.48	1490.54
C & E Loss (ft)	0.01	Cum SA (acres)	107.94	1343.68	250.49

Fig. 3 Water Surface Elevation of station 1



E.G. Elev (ft)	171.19	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.68	Wt. n-Val.	0.050	0.050	0.050
W.S. Elev (ft)	170.51	Reach Len. (ft)	227.56	196.13	145.01
Crit W.S. (ft)		Flow Area (sq ft)	419.15	37626.46	271.90
E.G. Slope (ft/ft)	0.000677	Area (sq ft)	419.15	37626.46	271.90
Q Total (cfs)	249568.80	Flow (cfs)	676.89	248626.10	265.76
Top Width (ft)	1837.62	Top Width (ft)	136.98	1504.27	196.38
Vel Total (ft/s)	6.51	Avg. Vel. (ft/s)	1.61	6.61	0.98
Max Chl Dpth (ft)	42.36	Hydr. Depth (ft)	3.06	25.01	1.38
Conv. Total (cfs)	9588836.0	Conv. (cfs)	26007.3	9552618.0	10211.0
Length Wtd. (ft)	196.14	Wetted Per. (ft)	138.94	1506.91	198.23
Min Ch El (ft)	128.15	Shear (lb/sq ft)	0.13	1.06	0.06
Alpha	1.03	Stream Power (lb/ft s)	0.21	6.98	0.06
Frctn Loss (ft)	0.15	Cum Volume (acre-ft)	326.08	24968.89	1438.62
C & E Loss (ft)	0.01	Cum SA (acres)	81.63	1181.25	229.37

Fig. 4 Water Surface Elevation of station 2

C. THE PROFILE PLOT: In addition, to plot cross-sections longitudinal profiles of the river have also been plotted and water levels corresponding to different recurrence have been shown as per figure

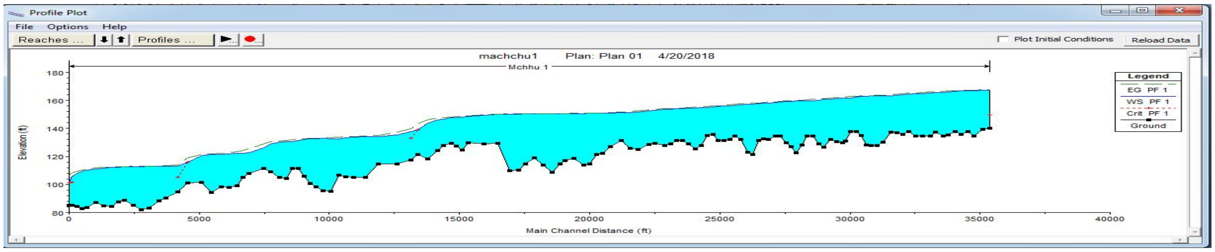


Fig. 5 Profile Plot

VIII. SENSITIVITY ANALYSIS:

Represents perspective plot for different recurrence interval. Above mentioned type is the plots wise cross-sections, L- profile and perspective plot gives presentation of the water spread for flood estimated corresponding to various recurrence intervals.

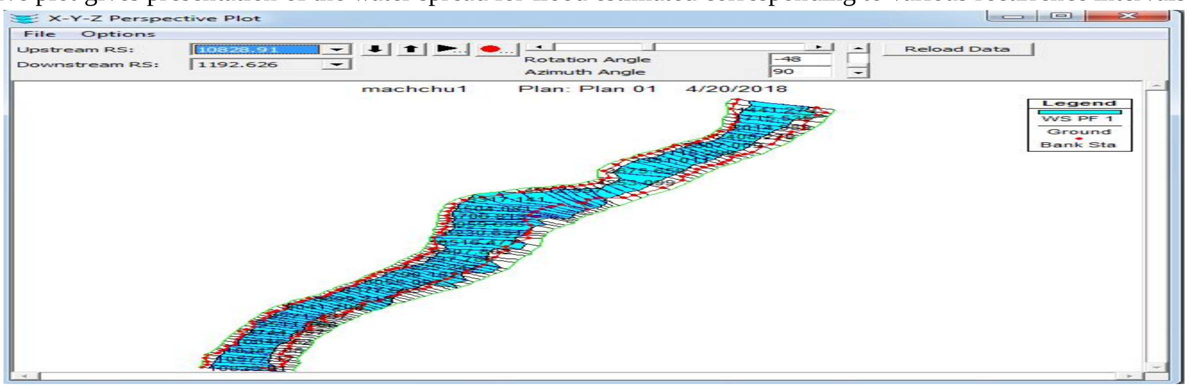


Fig. 6 X –Y-Z Perspective plot.

Figure is showing a discharge rating curve which shows that water surface rises sharply.

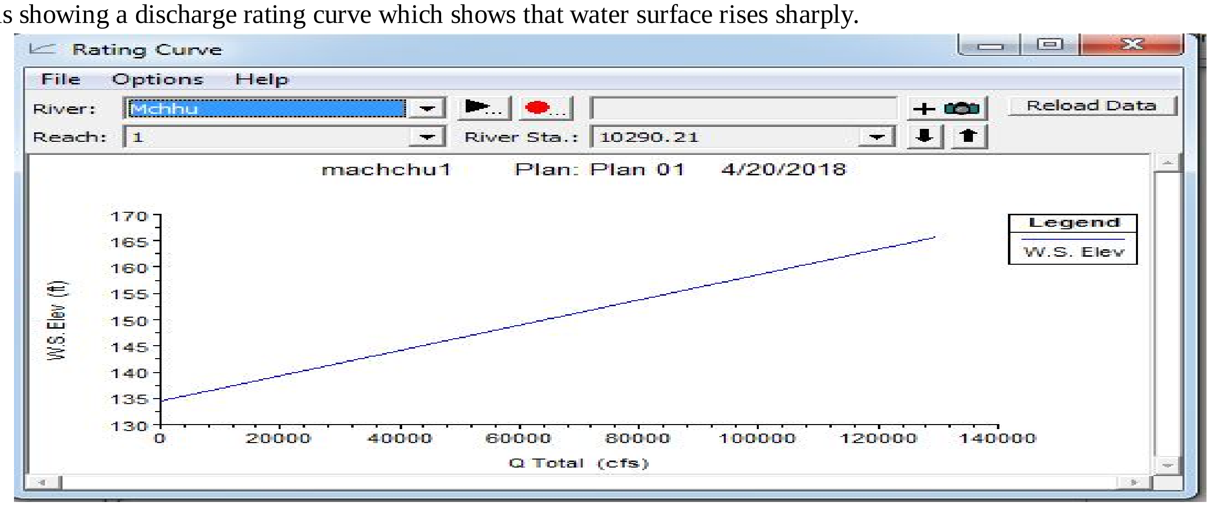


Fig.7 Rating curve.

IX. CONCLUSION

A. Advantage of using GIS is that it has the capability to map areas along the boundary of the flooded area where improbability in flood or land elevations transforms into uncertainty about the amount of submergence

B. GIS could generate and manipulate digital elevation models representing the land surface and the flood surface. Elevation models of the flood surface are interpolated linearly between cross sections and, therefore, it should be inspected.

C. Flood maps generated with GIS tool allow users to overlap supplementary digital information such as roads, buildings, and other facilities - allowing rapid calculation of the potential influences of a given magnitude of flood level. Map storage and allocation is significantly shortened because maps can be stored and allocate electronically, and prepared at any scale.

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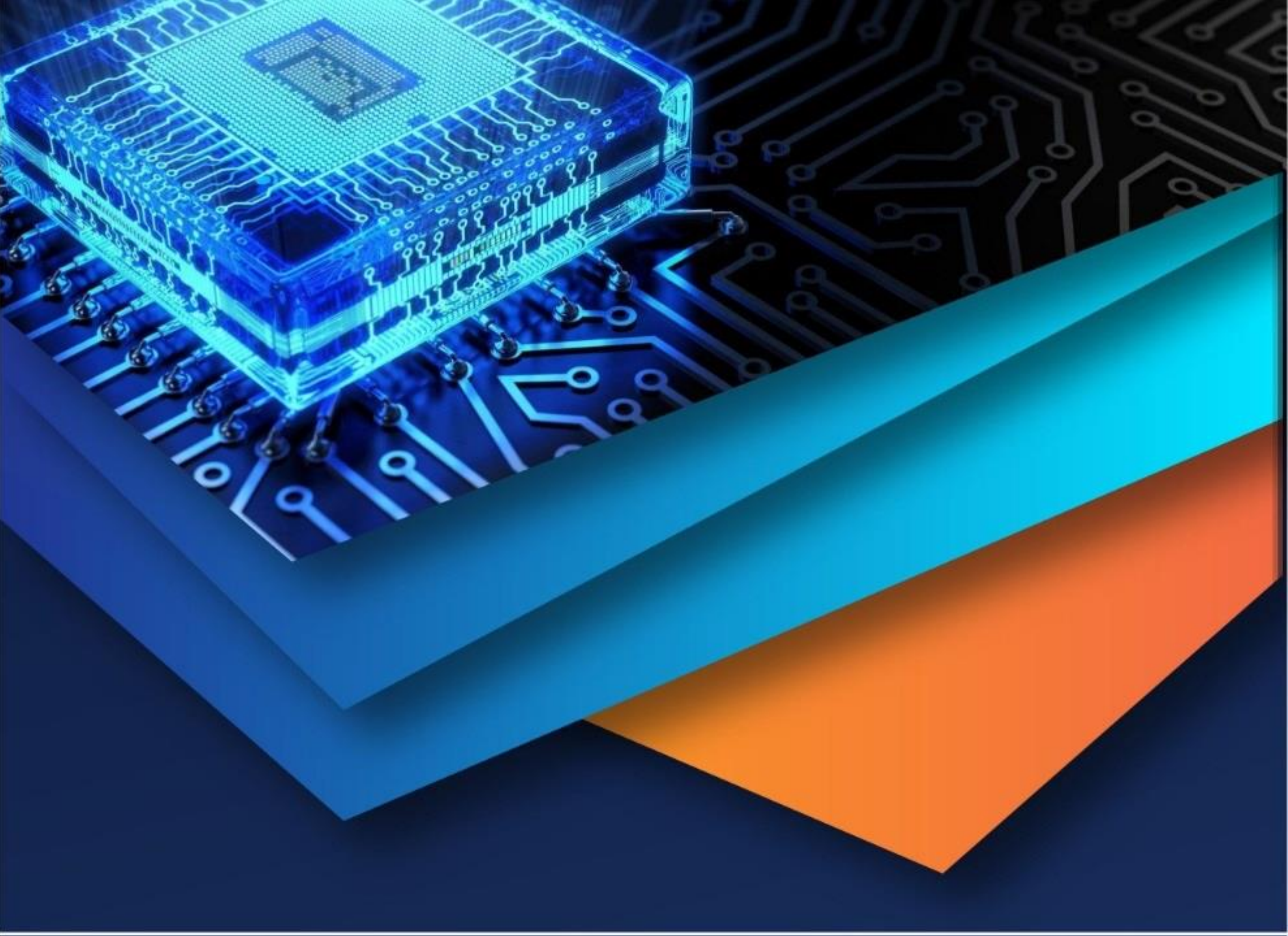

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