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'HK MODEL' FOR DETERMINATE THE SAFETY LEVEL OF RIVER EMBANKMENTS

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Abstract

Floods of rivers /tributaries caused a lot of damages in the farm, fields and settlements. To counter these floods, embankments have been constructed on one side or both side of the river bank, by which the water of the river does not come outside the river bank due to that, upto some extent a lot of damages of the people's lives and the wealth becomes minimized. The safety of these embankments is highly required. The security of embankments depends on many factors, for this reason, determining the level of safety of them is extremely difficult and circumstantial. The available literature and research on this subject are very less. The deficiency is felt during the security management of embankments. In the research presented, a new method has been introduced to find out the level of security of river embankments. This would be particularly suitable for more meandering and alluvial soil. In this method, the values of factors affecting the security of embankments are filled directly; therefore, it can very easily know the level of their security.

Keyword: *Flood protection embankment, levee safety, embankment breaching, over toping, River Jacketing, Riverine flood*

I. INTRODUCTION

There are very few rivers in the world, in which almost equal amount of water is available throughout the year.In most of rivers, the amount of water becomes very high in rainy season. There are many rivers/ tributaries which originate from the Hills/Mountains in India, in which availability of water is very low during summer and reaches the abyss, but during the rainy season, the water level in the rivers increased up to6 m. or more. This increased water of flood, spreads very far away outside the banks situated nearby Low Water Level (LWL). Crops, houses, life-properties, animals, road, rail, etc. come in the grip of flood, and they often suffer heavy losses. (However, the flood water flowing in the river, how much it will spread, when flood will comes down and how much it will make damage? Depend on the topography and conditions). In order to avoid, these conditions, the construction of embankments on single side or both sides of the river bank are in tradition. The height of these embankments is kept more than 1.5 to 2.0 m of estimated maximum flood water level. Due to construction of these embankments, lives of people, animals, losses of crops and other resources outside the river will become safe. Huge loss occurs at the breakdown of these embankments. Thus, theseembankmentsare highly effective and beneficial in preventing the impact of flood water from river and make a very important contribution to flood protection.

Keeping in view, the benefitsof embankments, thousands of kilometres of embankments have been built up on various rivers /tributaries in India. Except the exception, all embankments are made of soil, and so easily vulnerable to damages. This creates a serious threat to flood protection.If proper care and protection of these embankments are not done then these embankment often breaks down which leads to heavy losses. To avoid this, it is very useful and important to anticipate the security of embankments.The protection of embankments depends on 20 to 40 factors,that's why it is not easy to know the gravity of threat.There is also lack of practical and adequate study on this subject, in the presently available methodologies, either all the factors have not been considered or some of them are missing or some becomes indirect or do not clarify about the specific places.In the presented research, efforts have been made to known the results by involving most of these factors open and directly in calculation,

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which affects the safety of the embankments,which were missing till date. In this research paper, the Rapti river basin and its tributaries of Uttar Pradesh in India are considered as the basis.

II. BODY OF MANUSCRIPT AND ANALYSIS :

There are many factors which affect the security and utility of the embankment.The major factors are such as-reaching offlood waterabove the top of the embankment,the top level of the embankment reach below high flood level (HFL), crack or rupture in the embankment or its cutting or damaging, or cross section of the embankmentbecomes weak, exposure of the Hydraulic Gradient (HG) Line, encroachments or intentionally cutting of the embankments, flow of river nearest to the embankment causes the toe cutting, angular strike of the river flow to the embankments, no revetment works towards the riverside/upstream side of the embankment, in condition of river jacketing, lack of required inner area of river to carried out flood, collapsing of embankment, settlement/sinking of embankment, use of unsuitable quality soil in the embankment, Heavy seepage,cavity in embankment, river morphological changes, sudden drawdown, and others.

Most of the above factors acts directly. And in indirectfactors,opening of HG line, piping, cavity in embankment, heavyseepage and sudden draw downaremajor.All these factors affect the embankments according to their ‘degree of intensity’. According to table number 01, their ‘degree’ in form of numeric numbers have been estimated/ determined.The increasing number of factors in this table generally reflects their activeness /importance and the increasing danger on the embankment.To find outthe level of safety of any place in the embankment, this table will be filled by reaching that place. Out of the various factors described in the table, the factors which do not apply to that place, the related row to its will be considered as Nil value and points for such factors will not be added.In other words the factor which appears to be active on the embankment or is applicable there, will only be consider points. Because the intensity of factors depends on the place and situations,therefore their value can be reduce or increased as per actual condition of embankment.

Table No. 1

Category of ‘level of safety’	**Status of embankments**		**Score / marks weightage**	**Cell number**	**Source of marks/ column ‘C’**
A	**B**		**C**	D	**E**
1	Level of existing top of any ‘embankment part/segment’ reaches below the danger level	Up to 1 meter below	80	1	Field inspection
		Up to 2 meter below or more	200	2	
		The top is touched to the ground or below it i.e. ***In other words there is gap or cut or breach in embankment.***	800	3	
	Rain cut or Depressions or Cracks due to	If the width of the crack is up to 1 meter.	50	4	

	earthquakes or any transverse cracks **which has gone below the danger level**	Width of crack is more than 1 meter.			60	5	
	Overtopping of embankment by heavy flood	If there is possibility of going up of flood water up to 0.50m from designed top level/(HFL+FB) of embankment.			70	6	Flood forecast model and Field input
		If there is possibility of going up of flood water more than 0.50m from designed top level/(HFL+FB) of embankment.			200	7	
2	The main stream of the river is flowing within 10 m to the embankment	Erosion and scouring Phenomena	U/S of Embankment is protected with Revetment works	Main stream of river is nearby parallel to the embankment	70	8	Position of main stream and revetment works and by field inspection, And strike angle by satellite images studies
				Main stream of river has strike angle more than 25^0 with embankment.	80	9	
				Stud/spur exists.	(-)65	10	
			u/s protection work is not exist	Stream of river is nearby parallel to the embankment	300	11	
				Main stream of river has strike angle more than 25^0 with embankment.	300 or more	12	
3	The main stream of river is flowing at distance between 10m to 300m from the embankment and there is no revetment work on u/s of the embankment	Main stream of River is nearby parallel to embankment			Up to 40	13	
		The stream of the river is striking at an angle with the embankment		0 to 25^0	50	14	
				between25^0 to 90^0	150	15	
		Stud/spur exists.			(-)65	16	
	In condition of river jacketing, if the distance between both embankments is less than 3P (P=√4.75xdischarge)				7 to 40	17	By satellite images Andfield inspection
	Phenomena of manual cutting	The embankment which is in well condition, but situate in those area in which manual cutting occurs frequently.			Up to 150	18	experience of department
	Decayed width of top of embankment			Remain nearby 1m or less after decay	6	19	
	Cave or Khoh or cluster of rat holes X-sectionally in embankment.			Up to 3 m long	10	20	
				long more than 3 m	30	21	

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	Weaker Cross section		If Cross section remain less than nearby50%	30	22	field inspection
			If Cross section remain less than 30%	120	23	
	Opening of the Hydraulic Gradient Line (this is the main reason if seepage in d/s of embankment) Note: It is not necessary that H.G. line opens equally at every place in embankment. The value showing here are maximum opening.		If cover becomes less up to 50 centimetres	40	24	
			If cover (-) becomes less than 1m anywhere	100	25	
			If cover (-) becomes less than 2m anywhere	120	26	
	Shifting of main stream of River towards the embankment	main stream is exists within 300 meters range of the embankment	If Shifting Rate becomes from 25m to 50m/year	30	27	River morphological studies
			If Shifting Rate reaches between 50m/year or more.	40	28	
		main stream is existsmore than 300 meters range of the embankment	If Shifting Rate becomes from 50m to 100m/year	15	29	
			If Shifting Rate becomes from 25m to 50m/year	10	30	
	Sudden draw down	Type of soil of embankment	Black cotton soil	40	31	Field inspection
			clay	30	32	
			Sandy soil	5	33	
		water decreasing rate	2.5m in a day or more	200	34	RTDAS and Flood forecast model
			1 m to 2.5m/Day	100	35	
			0.75 to 1 m/Day	60	36	
	Deep saturation of embankment Due to continuous rain and high flood	soil type	sand	10	37	Field inspection
			clay	25	38	
		Weakness of x- section	week Up to 40 %	10	39	
			Week More than 55 %	35	40	

The factors that come under the serial no.01 of the table given above are of that category,if no timely remedial measures were takes place then, there is more than90% chances of break/breach of embankment by flood, or water will definitely flow through the embankment.The factors that come under serial no.02 are of that category, if no timely remedial measures takes place then, there will be very high possibility of the breakdown of embankment.The factors described in serial no. 01 and 02, can be destroy the embankment with in few hours if immediately safety action no taken. The factors that come under serial number 03 are of that category, there is no possibility of major accident immediately but ignore them can lead to a fatal state. In other word due to these factors,possibility of breakdown of the embankments will increase.Normally any location of embankment may be affected by one or several of these listed factors. According to the condition, these factors can also be categorized in each other's. Apart from these, it may be some other factors to affect the safety of embankment.By this model it is possible to determine safety level of any particular place or any segment of embankment.

III. DISCUSSION AND RESULT

Along with the influence of various factors, their intensity also significant.So it is must to analyse all factors according to their weightage. In order to do this different factors have been given as per their weightage numbers in table no. 01.all the activating factors mentioned in Table number 01 are added by providing points according to their trilogy during the field inspection of embankments,and results ofother inputs sources such as flood forecast model, real time data acquisition system, satellite imagery and morphological studies.After this, the level of threat is categorised according to the number classification as given in table number 02. Nomination of risk category as described in Table Number 02 can be change as per local glossary.

Table No. 02

Total Score (HK Scoring)	Result
800 or More	It is sure that Water will escape theembankment(by breach or by over-toping)
150 to 800	Embankment is High Vulnerable
50 to 150	Embankment is Vulnerable
25 to 50	It is important to pay a little attention to the embankment except unexpected extraordinary accident.
Till 25	Embankment is under Normal condition except unexpected extraordinary accident.

IV. BRIEF REVIEW AND WHAT I FOUND

To find out the level of threat by providing all the big and smallest factors affecting the security of the embankment, based on their weightage score and conditionswill helpful in deciding the risks to the embankments with best accuracy.This method is more direct and easier to assess.This method also take care the apparent numerical load/weightagefrom indirect factors,as a result, this method can become very effective.The number of factors influencing embankments is more and many others or less, in this method the quality assessment of risks to the embankment may not be affected.

V. DISCLOSER AND CONCLUSION

The security of embankments depend on 20 to 40 factors, therefore, it is very difficult to determine their level of security.There is also lack of adequate study on this subject.In the available methods, either all the factors are not been consider or some of them missed out,or some of them indirect or no clear assessment of location specific.In the presented research paper, numbers have been assigned to the maximum factors which have been directly incorporated and attempted in result of risk assessment ofsafety of the embankments,which have not been attempted so far.The main purpose of the research is to find out the given results by estimating the urgent need of all the factors described in table 1. Having the name of the researcher of this paper Er. Hemant Kumar, this method is called as HK Model and the numbers assigned to different factors considered are called HK scoring.

Factors affecting the embankments infrequent such as seismic deformities or rapture or cavity created by people or animal burrows, or often found factors like the top of the embankment below the designed level, not enough cover on the hydraulic gradient line, river morphological changes,rain cuts or deliberate manual cutting or decaying of the embankments and sudden drawdown, have been considered and probable estimation are made in this method.By this reason, this method can be very helpful in determining the real assessment of threat to embankment.It can also make better conclusions in the much meandering rivers.Because in this, the striking angle between river stream and embankment has been considered.

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General study and Research Paper about, safety level of River levees.

Biographical note:

Hemant Kumar is working as an Assistant Engineer in Irrigation & Water Resources Department UP in India. He passed diploma in Civil Engineering from K.L.P. Roorkee. He has many interests in designing, researchand general science. He filed eight inventions for patent and a design too. He wrote and published an another research paper about RCC beam. He has more than 15 years' experience in construction of building. He Promotes and encourage the 'Building Construction Techniques' to village and remote area personally. By this purpose he wrote a book also and writing two more.