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Hossein, Ahmad; Javaheri, N.; Daghigh, Y.; Tolooiyan, A.

Simulating of Unsteady Flow in Tidal Zones By Using HEC-RAS Model

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Simulating of Unsteady Flow in Tidal Zones

By Using HEC-RAS Model

Ahmad Hosseini, N. Javaheri, Y. Daghigh, A. Tolooiyan

Abstract: In this paper, the manner of simulating and flood plain limiting of areas which have affected of sea tide, has shown by using HEC-RAS model in unsteady flow condition. At firs, meanwhile physiography and hydrology studding and producing floodwater unit hydrograph in different recur period, statistics and data of maximum oscillation of sea tide produced, and by using topography maps of zone, started out to producing cross sections of main route and its flood water sheet. At the end, by right and exact defining of boundary conditions of upstream and downstream of zone, the model of enforcement and results, analyzed.

Comparing results of simulating which has done by model, whit natural conditions and height digits of occurred tide in under consideration zone, are the expositors of high accuracy on flood simulating for using on similar zones.

Introduction:

This study has done on a tidal zone which itHs area is 60 km^2 and situated at the north border of *Boushehr-Borazjun* road at the beginning input of *Boushehr* city. This zone has almost 7×8 kilometers dimensions, which parted to two almost equal west and east parts by the access road of *SADRA* industrial island, so that east part boundary limited to shore road and west and south boundaries limited to *Boushehr-Borazjun* road. Also this zone limited to *Khor lashgari* and Persian Gulf from north boundary. Situation of under study zone including downward and upward lands from *Boushehr-Borazjun* road, has shown in figure 1.

Materials and Methods:

- Study on hydraulic conditions of zone

At tidal zone, Locative and time oscillations of water surface, is reaction of gradient balance between topographic effect and changes in bed resistance. The target of this study is, producing Locative and time data of water level of under study zone, at synchronism conditions of incidence of floodwater and sea tide, at zone.

Figure (1).sketch of total under study zone

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Using HEC-RAS mathematic model is a method to determining water level and hydraulic specifications of flow. Therefore, the parameters of water surface profile, within times of maximum tide level at zone, and for unsteady flow conditions, have calculated. This calculations, determine the hydraulic specifications of flow, such as speed, flow depth, critical depth, flow energy and other hydraulic parameters of zone.

- Introduction of HEC-RAS model

HEC-RAS model which is a part of *USARMY ENGINEERING CORPS* models, is able to calculating the profiles of water surface in 1D steady and unsteady flow conditions by each cross section in over critical, under critical and compound flow conditions. Also this model, can calculate the structures effects, such as bridge, culvert, spillway and ext.

Most important hydraulic property is water level changing along the time. Naturally, this changing at each location of zone, leads to change in flow hydraulic specifications such as depth and speed. Therefore, for hydraulic specifications calculating, it's necessary to using unsteady conditions equation. In this case, these equations are calculable by HEC-RAS model in step by step method.

This model has produced for calculating Longitudinal profiles of water surface in gradual variable and unsteady conditions for natural or artificial streams to characterizing hydraulic specifications of flow such as speed, flow depth, flow energy amounts and ext.

Also, by this simulator it's possible to calculating the profiles of water surface at the conditions which, water flow can escape over the walls and hydraulic structures.

- Input data of HEC-RAS model

1- Topographic specifications of bed
2- Time series and boundary conditions of zone (in this study, there are amounts of floodwater flows and tidal oscillations of sea)
3- Manning factor of zone

In this study by using digital elevation map (DEM), along 7 kilometers of under study route, 14 cross sections with almost 500 meters spacing and in perpendicular on zone declivity ward, traced and geometric specifications of them produced. Figure 2 shows the situation of produced cross sections.

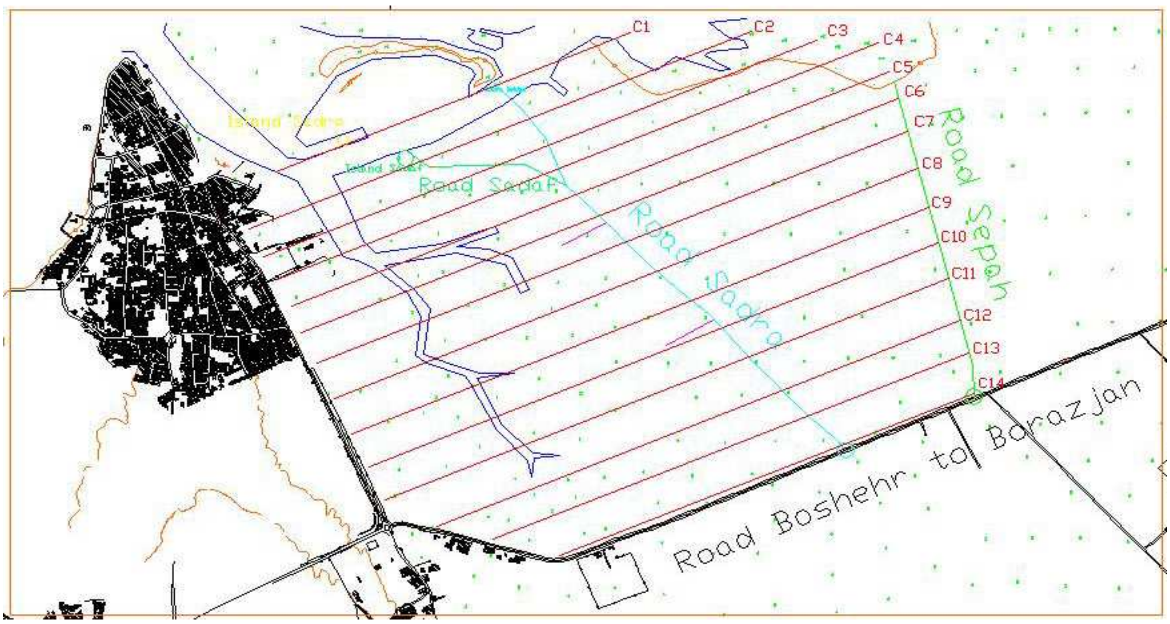

Figure (2).situation of produced cross sections (C1-C14), for using in model

- Study on oscillations of sea tide

In this study and similar cases, it is necessary to producing statistics and information of maximum oscillations of sea. Study on statistics of sea tide also field evaluations, shows that two times per month the oscillations of sea tide attains to maximum amount. So that, at peak amount of floodtide, the maximum length of flow front is almost 5 kilometers, and in this condition the flow front arrived to 2 kilometers spacing from *Boushehr-Borazjun* road.

Study on monthly statistics of tide in *Boushehr* station, which has midday tide, shows that the amount of maximum tide is 1.7 meter, the amount of maximum floodtide is 2.4 meters and the average of minimal value of ebb is 0.68 meter.

Because the oscillations of sea tide are almost fixed and in longtime this statistics have no considerable changes whit annual statistics of zone, it is possible to calculating based on annual statistics.

After study on data, acutest daily conditions due to oscillations, which are because of sea tide along one year, deliberated and mentioned amounts used in model under cover of boundary conditions of downstream.

- Estimation of manning factor

By using field evaluations and conformity of natural conditions of soil and zone cover whit present standards, roughness coefficient of zone estimates almost 0.02 to 0.03. And amounts of roughness of each section, imported in model suitably. Figure 3 shows generic conditions of soil texture and grass cover of zone for estimating of manning factor.

Figure (3).sample of soil texture and grass cover of zone

-Boundary conditions of upstream and downstream, which have imported in model

For exact calculating of water surface profile, it is necessary to allocate to model floodwater hydrograph under the notion of boundary conditions of upstream, and maximum oscillations of tide level under the notion of boundary conditions of downstream. There, by using results of hydrology analyzes of zone, hydrographs of floodwater of zone in 25 years return period produced and allocated to model under the notion of boundary conditions of upstream.

Table 1 shows maximum produced amounts of level of seawater surface in time series of *Boushehr* station, which used in HEC-RAS model under the title of boundary conditions of downstream.

- Simulation of hydraulic flow

For simulating hydraulic flow of zone, by using amounts of water surface level due to sea tide along the time of maximum level of floodtide at zone and hydrograph amounts of floodwaters, started out to studding on hydraulic flow conditions by using HEC-RAS model. For this reason, at first it is necessary to take talweg of understudy zone under the notion of riverbed, and after importing specifications of cross sections and their spacing in model, amounts of manning factor imports in model. Then after importing boundary conditions of upstream (amounts of floodwater hydrograph) and boundary conditions of downstream (maximum amounts of oscillations and water surface level along the time of maximum level of flood tide at zone), mentioned model runs in defined hydraulic conditions and time-period.

Results due to model running have shown in figure 4 to figure 17.

Table (1).maximum amounts due to tide oscillations of understudy zone, along one day

Time (hr)	Elevation (m)	Time (hr)	Elevation (m)
0	1.28	12	2.05
1	1.19	13	1.66
2	1.07	14	1.23
3	0.95	15	0.81
4	0.93	16	0.44
5	1.08	17	0.22
6	1.38	18	0.19
7	1.73	19	0.3
8	2.05	20	0.51
9	2.28	21	0.76
11	2.39	22	1.01
12	2.31	23	1.18

- Study on parameters of hydraulic flow

Based on results due to model running, the parameters such as maximum amounts of flow elevation (W.S.Elev), amounts of flow energy digits (E.G.Elev), conditions of slope profile of flow energy (E.G. slope), amounts of total cross section of flow in each range (Flow Area) and amounts of width of total water section in each section (Top Width) along the route, produced.

Also in model running, it is necessary to considering time convergence of befalling peak of floodtide and peak of floodwater.

Results of studding showed that in return period, the level of flow height will not arrive to asphalt edge of *Boushehr-Borazjun* road and there is no problem of road submersion.

- Totalization and Propositions

1- Comparison the results due to simulating of flow by model with natural conditions and tide digit in zone, shows high accuracy of HEC-RAS model on plain limiting and flow simulating in such as this zone.
2- Logical cognition of natural conditions of zone and right defining of boundary conditions of upstream and downstream, have important effect on results due to model running. Therefore recommend that extreme of accuracy be utilized in defining these conditions.
3- Supplying topographic maps and exact producing of cross sections information of zone, is very important in final analyzing of model. Therefore recommend that, surveying of zone, compass under the scale of 1:2000.
4- Because in not stormy conditions, the oscillations of water surface level in embouchure of tidal rivers are almost fixed, by using HEC-RAS model it's possible to simulating submersible zone due to sea floodtide with high accuracy.
5- Results due to model running show that, because manufactured road in understudy zone is in earth slope ward, oscillations of water flow level at roadside of *Boushehr*, don't have essential changes after and before manufacturing the road. On the other hand as for increasing exude of manufacturing road, foresee that there is no essential level difference at two sides of the road for a longtime.

- Reference

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Appendix

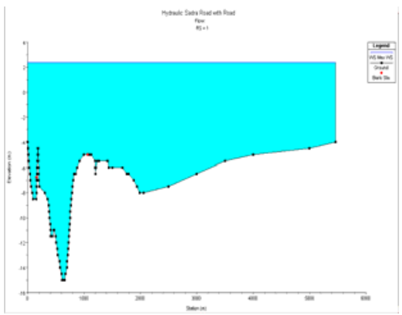

Figure (4).Profile of water surface at conditions of maximum floodtide and floodwater, in section 1

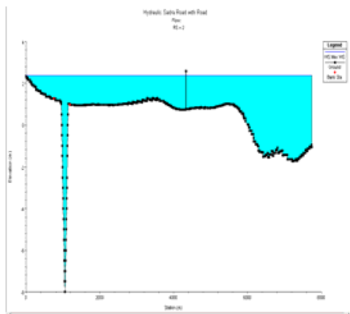

Figure (5).Profile of water surface at conditions of maximum floodtide and floodwater, in section 2

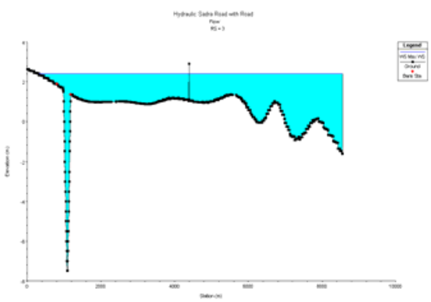

Figure (6).Profile of water surface at conditions of maximum floodtide and floodwater, in section 3

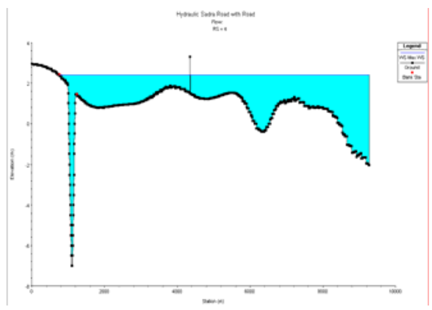

Figure (7).Profile of water surface at conditions of maximum floodtide and floodwater, in section 4

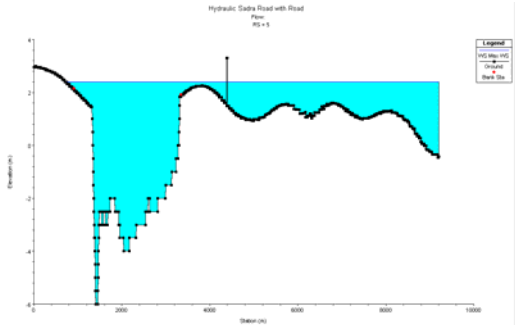

Figure (8).Profile of water surface at conditions of maximum floodtide and floodwater, in section 5

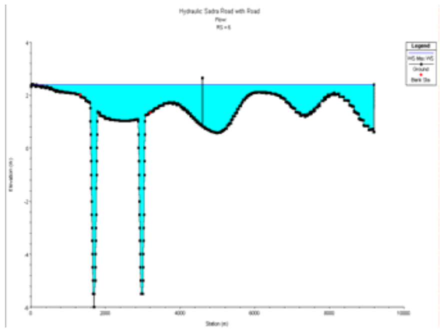

Figure (9).Profile of water surface at conditions of maximum floodtide and floodwater, in section 6

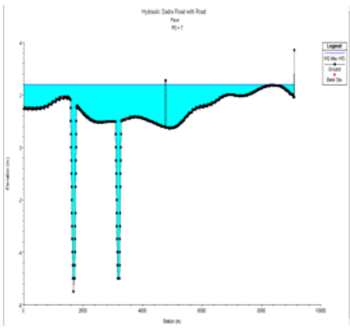

Figure (10).Profile of water surface at conditions of maximum floodtide and floodwater, in section 7

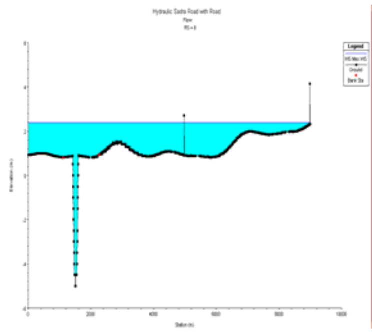

Figure (11).Profile of water surface at conditions of maximum floodtide and floodwater, in section 8

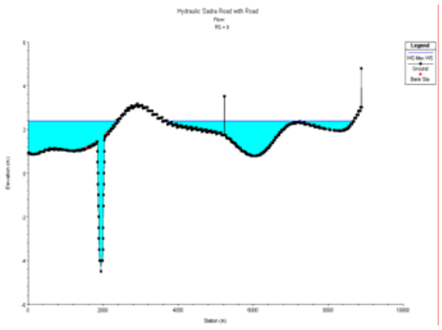

Figure (12).Profile of water surface at conditions of maximum floodtide and floodwater, in section 9

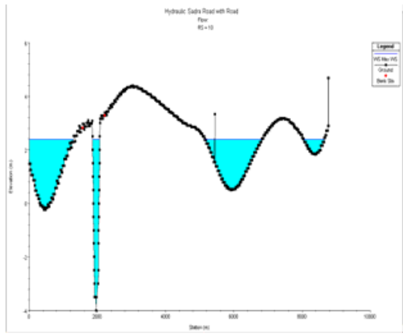

Figure (13).Profile of water surface at conditions of maximum floodtide and floodwater, in section 10

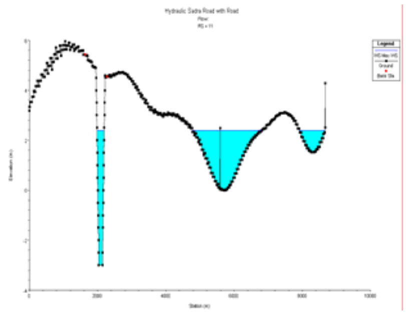

Figure (14).Profile of water surface at conditions of maximum floodtide and floodwater, in section 11

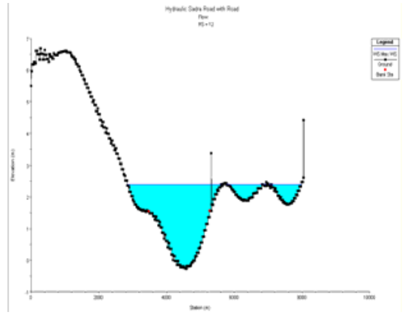

Figure (15).Profile of water surface at conditions of maximum floodtide and floodwater, in section 12

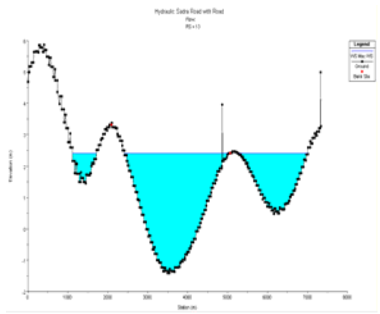

Figure (16).Profile of water surface at conditions of maximum floodtide and floodwater, in section 13

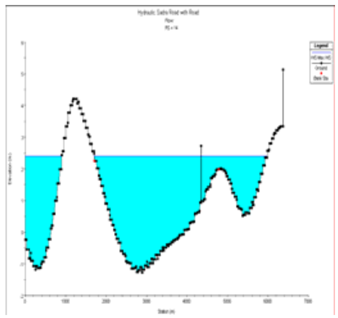

Figure (17).Profile of water surface at conditions of maximum floodtide and floodwater, in section 14

Autoren:

Ahmad Hosseini, Senior Research Engineer, Deputy Dept. of River Engineering, Soil Conservation and Watershed Management Research Center, P. O. Box 13445-1136, Tehran, Iran
N. Javaheri, Assistant Professor of Gilan University of Iran
Y. Daghigh, Assistant Professor of Soil Conservation and Watershed Management Research Center
A. Tolooiyan, Research Engineer of Soil Conservation and Watershed Management Research Center