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Analytical Study of Sedimentation Formation in Lined Canals using the SHARC Software- A case Study of the Sabilli Canal in Dezful, Iran

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Abstract**—**Sediment formation and its transport along the river course is considered as important hydraulic consideration in river engineering. Their impact on the morphology of rivers on one hand and important considerations of which in the design and construction of the hydraulic structures on the other has attracted the attention of experts in arid and semi-arid regions.

Under certain conditions where the momentum energy of the flow stream reaches a specific rate, the sediment materials start to be transported with the flow. This can usually be analyzed in two different categories of suspended and bed load materials. Sedimentation phenomenon along the waterways and the conveyance of vast volume of materials into the canal networks can potentially influence water abstraction in the intake structures. This can pose a serious threat to operational sustainability and water delivery performance in the canal networks. The situation is serious where ineffective watershed management (poor vegetation cover in the water basin) is the underlying cause of soil erosion which feeds the materials into the waterways that intern would necessitate comprehensive study. The present paper aims to present an analytical investigation of the sediment process in the waterways on one hand and estimation of the sediment load transport into the lined canals using the SHARC software on the other. For this reason, the paper focuses on the comparative analysis of the hydraulic behaviors of the Sabilli main canal that feeds the pumping station with that of the Western canal in the Greater Dezful region to identify effective factors in sedimentation and ways of mitigating their impact on water abstraction in the canal systems.

The method involved use of observational data available in the Dezful Dastmashoon hydrometric station along a 6 km waterway of the Sabilli main canal using the SHARC software to estimate the suspended load concentration and bed load materials. Results showed the transport of a significant volume of sediment loads from the waterways into the canal system which is assumed to have arisen from the absence of stilling basin on one hand and the gravity flow on the other has caused serious challenges. This is contrary to what occurs in the Sabilli canal, where the design feature which incorporates a settling basin just before the pumping station is the major cause of reduced sediment load transport into the canal system.Results showed that modification of the present design features by constructing a settling basin just upstream of the western intake structure can considerably reduce the entry of sediment materials into the canal system. Not only this can result in the sustainability of the hydraulic structures but can also improve operational performance of water conveyance and distribution system, all of which are the pre-requisite to secure reliable and equitable water delivery regime for the command area.

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Keywords**—**sedimentation, main canal, Sabilli, western canal, Dez diversion weir.

I. Introduction

SEDIMENTATION and its complex process along the waterways of arid and semi-arid regions where various topographic and climatic factors are reportedly the contributory factors are emerging as the major hydraulic considerations in project feasibility study (Hedayat [2]). The study of sediment loads are crucial because they have major consequences on the hydraulic behavior of the waterways in terms of their morphology and transported loads that may have scouring effect in certain parts and establishment of sediment islands on the other(Shirin et al [3], Ashkarian et al [5]). This, as various studies have indicated, can have grave consequences for the operational sustainability and performance efficiency of the water abstraction, conveyance and distribution system of the vital hydraulic structures that are fed by the flow originated form these natural sources (Sajedi et al [4]).

The aim of the paper is to analytically investigate the sedimentation process and sediment load transport into the main Sabilli canal and its comparison with the hydraulic conditions in the western canal of the diversion weir in the Dez Irrigation and Drainage scheme in Iran.

II. Materials and Methods

Background of the Study Site

Dez River is considered to be one of the vital flowing rivers and the main source of irrigation water supply commanding a gross area of 125000ha in Khuzestan, Iran. It is bounded from the north to the slopes of the Zagross Mountain, from the south to the Haftapeh and Shahoor, from east to the Shureh River and the west to the Karkheh River in southwestern Iran. The net irrigated area is 90,000ha. The irrigation and drainage scheme commanded by this vast hydraulic structure includes a hydro-electrical dam, a regulating dam and a diversion weir with three main canals, one which incorporates a pumping station and other two are supplied by two gravity-fed canals in both banks of the river Dez. The Sabilli canal is fed by the pumping station with a capacity of $13m^3$/sec, whereas the eastern and western canals supply $85m^3$/sec and $154m^3$/sec respectively.

Investigating the Sedimentation by SHARC Software

This computer software is used in this study to separately simulate the suspended and bed load sediment materials in the water course like the canal network using the Design Tools menu incorporated in the program.

III. Results and Discussion

The entry of the sediment loads in the water intake structures that feed the irrigation and drainage network has reduced the conveyance and distribution efficiency on one hand and incurred a considerably heavy operational and maintenance costs on the other. Results further showed the sediment trapping efficiency at 97.9% whereas the observed data shows that to be non-significant (figure1).

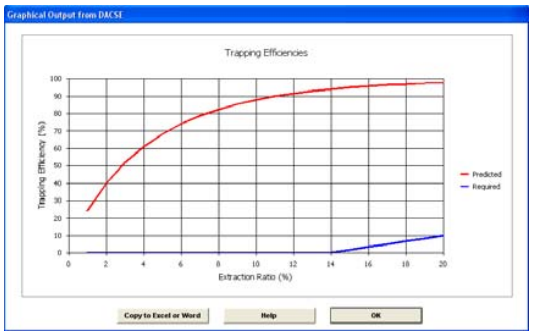

Fig. 1 Trapping efficiencies in Sabilli canal

Results (figure 2) indicated an increasing trend in sediment trapping in the study area whereas there is not a significant trapping shown by the observational data. It can be deducted from the analysis of data that the sediment load transported through the feeding canal is settled in the stilling basin prior to getting into the Sabilli main canal. This is not substantiated by the observational data.

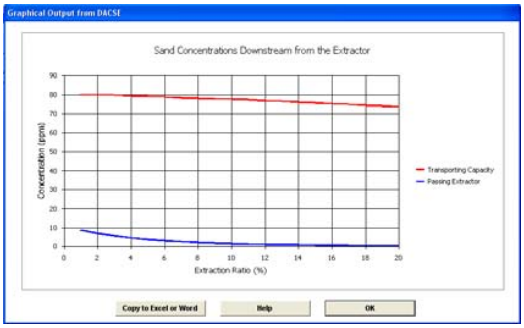

Fig. 2 Sand concentration downstream from the Extractor in Sabilli canal

As can be observed from figure 2, the estimated transporting capacity of the canal and the sediment loads passing through it showed a decreasing trend. However, they have significant differences in nature. In other words, whereas the model results estimated the sediment load density of the transported load downstream as 80 ppm , the real-time measure of this was in fact 10 ppm. This clearly indicates the important role that the settling basin plays in settling of the sediment materials prior to the pumping installation. Results further indicated that sediment trapping of the river bed is to the extend that necessitates annual cleansing of the settling basin floor at a considerably high costs. It is for this reason that while researchers (Shirin et al [3], Mansoujian et al [6]) acknowledging the entry of a considerable volume of sediment load being transported into the main irrigation and drainage network, they go further to highlight their implication for the O&M of the system. Moreover, such analysis has pointed out the important influence by which this phenomenon could have on the performance of the system particularly the e ways in which the sediment loads could change the hydraulic behavior of the river namely the flow pattern that might be destructive on one hand and influence the water abstraction on the other.

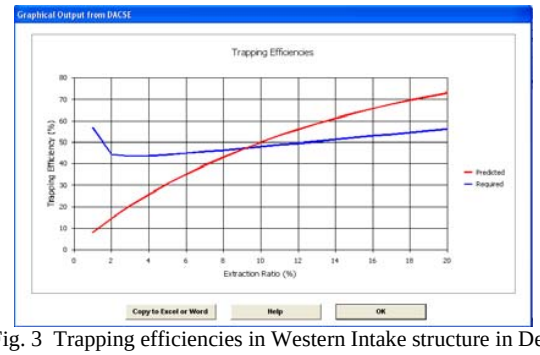

Fig. 3 Trapping efficiencies in Western Intake structure in Dez Diversion Weir

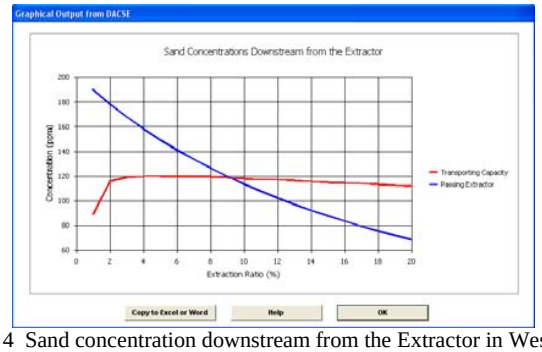

Fig. 4 Sand concentration downstream from the Extractor in Western Intake structure in Dez Diversion Weir

Comparison of figures 2 and 3 with 4 and 5 indicated that the absence of appropriate sediment basin prior to the water intake structure on one hand and the gravity nature of the western intake on the other has been instrumental in the transport of the suspended loads into the irrigation and drainage network (Sajedi et al [4]), a trend which has also been reported on the eastern water intake (Shirin et al [3], Mansoujian et al [6]).

It can be deducted from the analysis of the results that the sediment transport into the western canal system of the Dez Diversion weir is much greater than the corresponding rate observed in the Sabilli canal due to the design configuration where it has incorporated a sediment basin prior to the pumping station. For this reason, the settling basin has been instrumental in reducing the sediment load into the canal system despite the fact that it is located upstream of the Dez

Diversion weir.

Based on the relative accuracy of the model as an analytical tool in simulating the hydraulic behavior of the area under investigation, it would be possible to apply it as a measure in estimating the sediment load transport on one hand and mitigate the potential destructive consequences of sedimentation on the operation and maintenance of the irrigation network on the other. This would make it possible to improve the performance of the water conveyance and distribution system and improve the environmental sustainability of the scheme on the other (Hedayat [2], Shirin et al [3], and Ashkarian et al [5])

An accurate analysis of the status-quo situation would place the operational managers in a position to not only eradicate the major operational obstacles in the water conveyance and distribution networks but would succeed in doing so with minimum operational costs. The reason being that a great portion of these costs could be saved by destruction-prevention measures (Shirin et al [3], Mansoujian et al [6]) which Hedayat [2] has stressed to be the major pre-requisites for sustainability of the hydraulic structures in semi-arid and arid regions where flexible and equitable water delivery systems play an important role.

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