PREDICTABILTY OF YANG (1984) FOR SAND-GRAVEL BED MATERIAL

Sahita I Waikhom[1], Dr.S.M.Yadav[2], Hilay Prajapati[3]

[1]Associate Professor, Civil Engineering Department ,Dr.S &S.S. Ghandhy Government Engineering College, Surat,Opp.RTO ,Nr,Majura Gate

[1]siwgecs@gmail.com

Abstract— Immense quantity of sediment of various sizes shapes and density get carried away by different modes of movement like bed load, suspended load and wash load depending upon the flow and channel characteristics. Yang (1972) defines unit stream power as the velocity-slope product. Sediment transport analysis through the stream power concept was introduced by Bagnold in 1966, Yang C. T has worked on this concept elaborately. The rate of work being done by a unit weight of water in transporting sediment must be directly related to the rate of work available to a unit weight of water. Thus, total sediment concentration or total bed material load must be directly related to unit stream power. Yang (1973) developed dimensionless unit stream power equation for sand transport which was found to be good predictor by many researchers. Yang (1979) gave another dimensionless equation without considering incipient motion which he considered in 1973 for sediment concentration higher than 100 ppm. Yang (1984) extended his earlier stream power equations for gravel transport as well as sand transport. Due to the uncertainties involved in determining the flow conditions precisely at incipient motion, the present paper will examine the applicability of Yang's (1984) unit stream power equation for total load in the sand size and gravel size range using incipient motion criteria.

Keywords— Fall velocity, incipient motion, sediment transport, shear velocity, total sediment load, unit stream power, Yang C. T.

Introduction

In alluvial river System River banks will erode sediment will be deposited and flood plains and side channel will undergo modification with time. Effects of Sedimentation River reduce carrying capacity which may lead to flood water damage to surrounding area. Most of the rivers have water flowing in monsoon season only for the remaining time of year the flow is either very low or absent. The significant factor that affected the natural sediment transport behavior in an open channel is construction of hydraulic structure like check dams, weir, hydroelectric plants etc. The knowledge and correct prediction of total sediment load carried by the channel is necessary to tackle hydraulic problems like aggradation, degradation, river training etc. contributors to the development of total load sediment transport theories refers names of Laursen(1958), Ackers and White(1973), Garde and Albertson(1961), Garde and Dattatri(1963), Graf and Acaroglu(1968), Toffleti(1968), Graf(1971), Yang C T (1973, 1979, 1984), Shu-Qing Yang (2005) and Jennifer Duan (2013) etc.. The relationship between rate of sediment transport and rate of potential energy expenditure has been studied in detail. The concept of the rate of work done should be related to the rate of energy expenditure was used by Bagnold (1966). It was demonstrated by Yang (1972) that the rate of sediment transport depends on the unit stream power more than any other hydraulic parameter. Unit stream power, defined as the time rate of potential energy expenditure per unit weight of water is shown to be the dominant factor in the determination of total sediment concentration. Yang's (1973) unit stream power equation for the computation of total sediment concentration includes the incipient motion criteria while Yang's (1979) unit stream power equation for the computation of total sediment concentration is obtained without using any criteria for incipient motion.

Data collection

The selected flume data set have been used for testing Yang (1984) approach as described below in Table No. 1.

Table 1. Summary of Data set used in the study

Data Sets	Discharge, L/s	Flow depth, m	Flow width, m	Energy Slope, m/m	Mean grain size, mm (D_{50})
US WWES - A (1936)	6.68 to 62.55	0.03 to 0.2	0.7	1 to 2	0.95
Chyn S. D (1935)	12.29 to 35.96	0.05 to 1	0.61	1.1 to 3	0.59 to 0.84

Methodology

The required hydraulic parameters collected in the flume and field data sets for computing the total load transport rate of the Yang's unit stream power approach are processed through computer programs developed in the MS Excel spread sheet. Statistical parameters like root mean square error (rmse), inequality coefficient (U), discrepancy ratio (r) is calculated for the predictability of total sediment load transport formula

Chih Ted Yang (1984):

Yang (1984) define unit stream power as the time rate of expenditure of flow potential energy per unit weight of the flow, which can be expressed by the product of average flow velocity and energy slope. Earlier function of Yang's used for the sand transport while Yang (1984) is used for gravel transport. Below equation represents the gravel load transport rate.

$$\log C_t = I_1 + J_1 \log\left(\frac{VS}{\omega} - \frac{V_C S}{\omega}\right) \quad (1)$$

Yang (1984) using the same multiple regression method which was used by Yang (1973), a dimensionless unit stream power equation for gravel transport can be obtained and the new correlations of I and J factors were found as

$$I_1 = 6.681 - 0.633 \log\left(\frac{\omega d_s}{v}\right) - 4.816 \log\left(\frac{u_*}{\omega}\right) \quad (2)$$

$$J1 = 2.784 - 0.305 \log\left(\frac{\omega d_s}{v}\right) - 0.282 \log\left(\frac{u_*}{\omega}\right) \quad (3)$$

Eq. 1, 2 and 3 were proposed by Yang (1984) for the prediction of total sediment concentration Ct in parts per million by weight for the particles in the gravel size range with ds = d50 = median sieve diameter of bed material.

International Journal of Engineering Research and General Science Volume 3, Issue 4, July-August, 2015
ISSN 2091-2730

Result Analysis

Yang (1984) sediment transport function is tested against large data sets for flume data of US WWES (1936) and of Chyn S.D (1935). The discrepancy ratio of calculated value to measured value for each sets of data is consider for comparison of performance. The percentage of data coverage between accepted lower and upper limit of the discrepancy ratio and their statistical properties is taken as the criteria of the goodness of fit. The predicted values are plotted against the observed values for same data set, so that the scatter about the perfect agreement line also be consider.

Application of Yang'S 1984 Approach:

Graphical comparison is made between observed and predicted values as shown in Fig.1 for the data set of 1936 US WWES-A with an error range of -20% to -60% with most of data lying between an error ranging from -20% to -60%. In fig.2 for the data set of Chyn S.D (1935) with an error range of -30 % to – 85% .

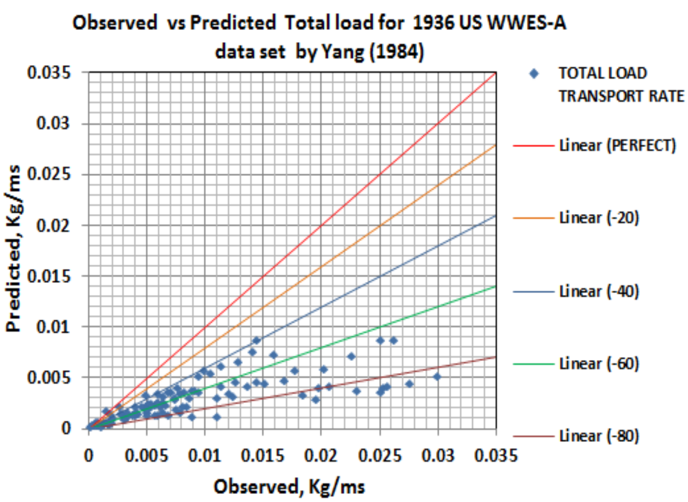

Fig : 1 Observed vs Predicted values for 1936 US WWES data set

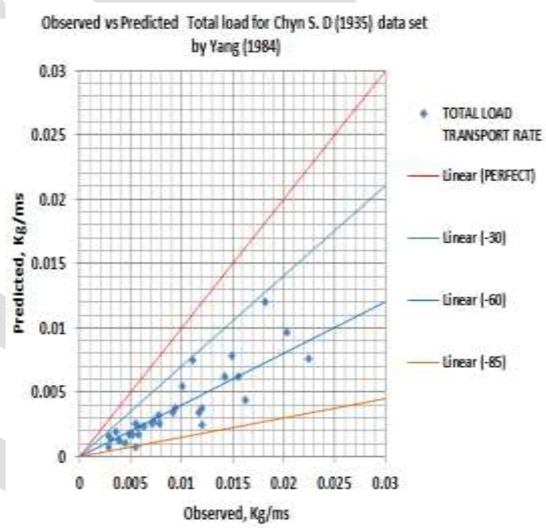

Fig : 2 Observed vs Predicted values for Chyn S.D (1935) data set

Statistical Parameters to check the predictability of Yang's Approach

Various statistical parameters such as Root mean square error (RMSE), Discrepancy ratio (r) and Inequality coefficient (U) are calculated to analyse the predicted results of the Yang's Approach.

Table 2. Summary of Statistical Parameters used to analyze Yang's total load function using Flume and River Data sets.

Statistical Parameters						
Sr. No	DATA SET	D50	RMSE	DR	INEQUALITY COEFFCIENT	AVG %
1	1936 US WWES -A	0.95	0.0083	0.3859	0.5666	-61.4
2	Chyn S. D (1935)	0.59 to 0.89	0.0063	0.3935	0.41544	-60.6

Conclusion

- Yang (1984) approach provide good results for 1936 US WWES -A as well as Chyn S. D (1935) data set with minimum discrepancy.
- For both the selected data set, Yang (1984) approach under predicts giving an avg. error of -61.4% and -60.6 %.
- Value of Inequality coefficient (U) for both the data sets are 0.56 and 0.41 which is far below 1 so, Yang's (1984) approach predicts well for 1936 US WWES -A as well as Chyn S. D (1935) data sets.
- Consistency of predicted value is observed in Yang (1984) approaches.

REFERENCES:

1. Yang, C.T., 1972. Unit stream power and sediment transport. J. Hydraul. Div., A.S.C.E., Proc. Pap. 9295, 98(HY10): 1805--1826.
2. Yang, C.T., 1973. Incipient motion and sediment transport. J. Hydraul. Div. A.S.C.E., Proc.Pap. 10067, 99(HY10): 1679--1704.
3. Yang, C.T., 1976. Minimum unit stream power and fluvial hydraulics. J. Hydraul. Div.A.S.C.E., Proc. Pap. 12238, 102(HY7): 919--934.
4. Yang, C.T., 1977. The movement of sediment in rivers. In: Geophysical Survey Vol. 3:Holland, pp. 39--68.
5. Yang, C. T., "Incipient Motion and Sediment Transport," Journal of the Hydraulics Division, ASCE, Vol. 99, No. HY10, Proc. Paper 10067, Oct., 1973, pp. 1679-1704.
6. Ackers, p. (1972). "Sediment transport in channels an alternative approach", Report INT 102, march, Hydraulics Research Station, Walling ford, England.
7. Bagnold, R.A., 1966. An approach to the sediment transport problem from general physics.U.S. Geol. Surv., Prof. Pap. 422-I, 37 pp..
8. Karim, M.F. and J.F.Kennedy. Computer-Based Predictors for Sediment Discharge and Friction factor of alluvial Streams. Proc. Of 2nd Int. Symposium on River Sedimentation Nanjing, China, Oct. 1983.
9. Shen, H.W. and C.S. Hung. An Engineering Approach to total bed material load by Regression Analysis. Proc. Of the sedimentation symposium on river sedimentation nnanjing, china, oct 1983..
10. Vanoni, V.A., ed., 1975, Sedimentation Engineering: American Society of Civil Engineers, Manuals and Reports on Engineering Practice, no. 54, 745 p.
11. Guy, H.P., Simons, D.B. and Richardson, E.V., 1966. Summary of alluvial channel datafrom flume experiment, 1956-1961. U.S. Geol. Surv., Prof. Pap. 462-I, 96 pp.
12. Vanoni, V.A. and Brooks, N.H., 1957. Laboratory studies of the roughness and suspendedload of alluvial streams. Calif. Inst. Technol., Pasadena, Calif., Sediment Lab., MRD Sediment Ser. No.ll, pp.35-36.
13. Williams, G.P., 1967. Flume experiments on the transport of a coarse sand. U.S. Geol. Surv.,Prof. Pap. 562-B, 31 pp.