Composite Resistance of a straight Rectangular compound channel with varying Bed roughness and flow

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Abstract – *A compound channel consists of the main channel and flood plain. Bed resistance for main channel and flood plain are quite different. Here, proper prediction for flood in a compound channel the proper estimation of resistance is very important. Generally a composite resistance is estimated which depends on the resistance of the main channel and flood plain. Here, under this study the composite resistance predictions by different investigation have been compared with actual resistance value in case of a straight rectangular compound channel. Different investigated has found different formula for composite resistance. The percentage error for different resistance of composite formula has been calculated and analyzed for different bed material, slope and discharge. Related formulae for the composite resistance has been review from the journal and its has been applied with the actual value in manners to know the appropriate value for each cases with different bed material..*

Key Words: Composite resistance, compound channel, manning's, discharge, floodplain

1. INTRODUCTION

A major area of uncertainty in river channel analysis is that of accurately predicting the capability of river channels with floodplains which are termed compound channels. Cross-sections of these compound channels are generally characterized by a deep main channel, bounded on one or both sides by a floodplain, which is rougher and has slower velocities than as compared to that of main channel. Due to interaction between the main channel and floodplains, there are bank of vertical vortices along the interface, which lead to extra resistance in terms of consumption a lot of energy.

1.1 LITERATURE REVIEW

The flow resistance of compound channels has also been studied by many researchers, such as Myers (1990), Shiono and Knight (1991), Nalluri and Adepoju (1985), Yang et al. (2005). Myers (1990) analyzed the influence of the width ratios of main channel to floodplain on the redistribution of flow resistance.

Shiono and Knight (1991) discussed the variations of the Darcy–Weisbach friction factor, the dimensionless eddy viscosity and the secondary flow factor in smooth compound channels. Research concerning resistance to flow in compound open channel has been studied by many scholars, such as Lotter (1933), Pavolvoskii (1932), Einstein and Banks (1950), Krishnamurthy and Christensen (1972), Myers and Elsawy (1975) developed models for composite friction factor. Habersak et al. studied flow resistance caused by wooden sticks representing vegetation in floodplain with flood flows condition.

Posey (1967), Worm-eaten (1982) have Experimentations and observed that the Manning's equation and the Darcy-Weisbach equation are not suitable for compound channels. Knight and Hamed (1984) extended the work of Knight and Demetriou (1983) to rough floodplains. Pang (1998) conducted experiments on compound channel in straight reaches under isolated and interacting conditions. It was found that the distribution of discharge between the main channel and floodplain was in accordance with the flow energy loss, which can be expressed in the form of flow resistance coefficient.

1.2 RELATED FORMULAE

Related formula review from the journals which is related to composite resistance are given below :

Sl. no	References	Equation's for Composite resistance
1	Manning's formula`	$\frac{1}{v} R^{\frac{2}{3}} S^{\frac{1}{2}}$
2	Horton(1933) and Einstein (1934)	$n_c = \left[\frac{1}{p} \sum \left(n_i^{\frac{3}{2}} p_i\right)\right]^{2/3}$
3	Cox(1973)	$n_c = \frac{\sum n_i A_i}{A}$
4	Felkel (1960)	$n_c = \frac{P}{\sum (P_i / n_i)}$
5	Yen 1 (2002)	$n_c = \frac{\sum (n_i p_i)}{P}$

6	Pavlovskii (1931)	$n_c = \left[\frac{1}{p}\sum\left(n_i^2 p_i\right)\right]^{1/2}$
7	Yen 2 (2002)	$n_c = \dfrac{\sum\left(\dfrac{n_i p_i}{R_i^{1/6}}\right)}{PR^{1/6}}$
8	Yen 3 (2002)	$n_c = \dfrac{\sum\left(n_i P_i R_i^{1/3}\right)}{PR^{1/3}}$
9	Colebatch (1941)	$nc = \left[\dfrac{\sum(ni^{3/2}Ai}{A}\right]^{2/3}$

2. EXPERIMENTAL DETAILS

A straight rectangular compound channel has been taken ,here longitudinal length of the channel is 6 m, depth is 0.45 m and width is 0.3 m. Many cases has been taken with the different bed resistance , slope and different discharge in m^3/sec.

Table -1: Differences of bed condition and slope of the channel

Case no.	Slope	Discharge in m^3/sec	Different Resistance
Case – 1	0.286	Q1=0.00133	CC with Boulders
Case – 2	0.286	Q2=0.00137	CC with Boulders
Case – 3	0.286	Q3=0.00092	CC with Boulders
Case – 4	0.381	Q4=0.00134	CC with Boulders
Case – 5	0.381	Q5=0.00137	CC with Boulders
Case – 6	0.381	Q6=0.00118	CC with Boulders
Case – 7	0.286	Q7=0.00115	PVC with Boulders
Case – 8	0.286	Q8=0.00127	PVC with Boulders
Case – 9	0.286	Q9=0.00083	PVC with Boulders
Case – 10	0.381	Q10=0.00143	PVC with Boulders
Case – 11	0.381	Q11=0.00093	PVC with Boulders
Case – 12	0.381	Q12=0.00091	PVC with Boulders

Where, CC= Coconut coir, PVC= Polyvinyl chloride

Fig -1: Cross section of the compound channel with the bed resistance coconut coir along with the Boulders

It represent the cross section of rectangular compound channel with the main channel bed resistance are coconut coir along with the boulders and both side are flood plains with grass carpet and plants.

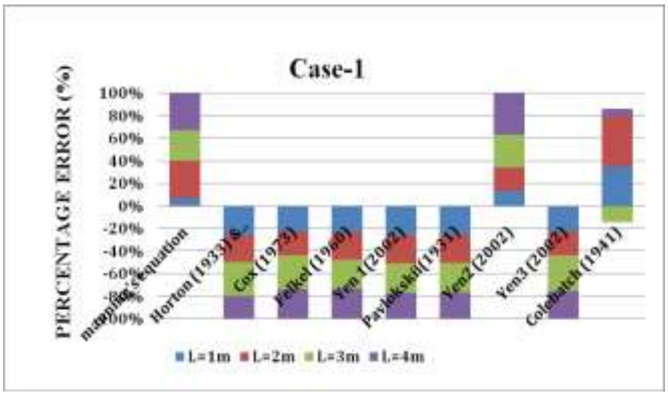

Chart -1 Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00133m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the chart-1 . Here, the positive percentage (%) values represent that the actual value is more than the composite value.

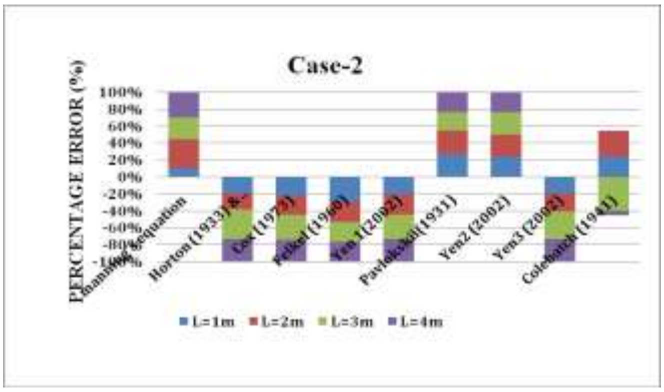

Chart -2: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00137m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the Chart-2 . Here, the positive percentage (%) values represent that the actual value is more than the composite value

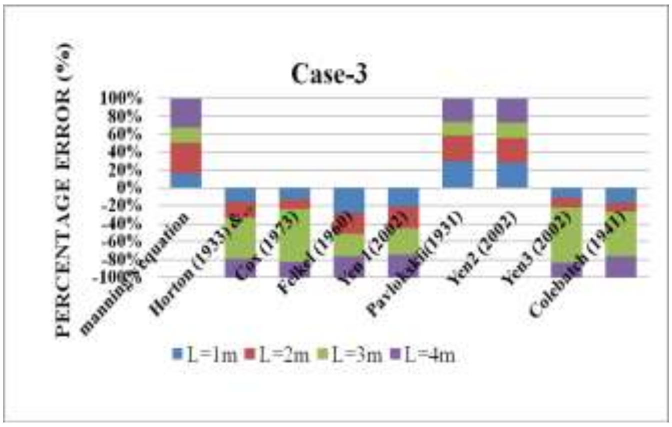

Chart -3: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00092m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the Chart-3. Here, the positive percentage (%) values represent that the actual value is more than the composite value

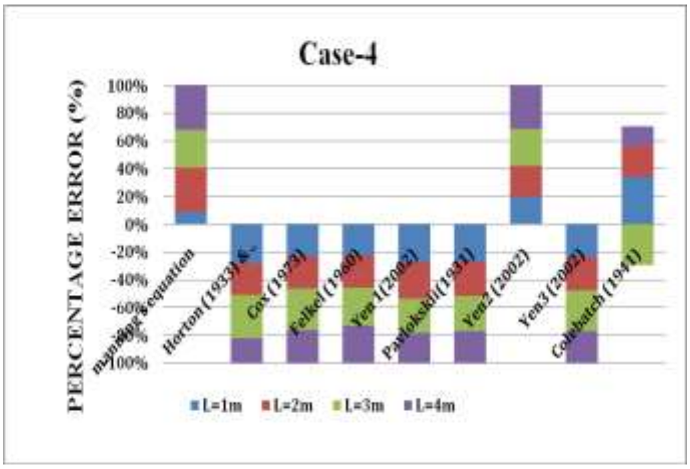

Chart -4: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00134m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the Chart-4 . Here, the positive percentage (%) values represent that the actual value is more than the composite value

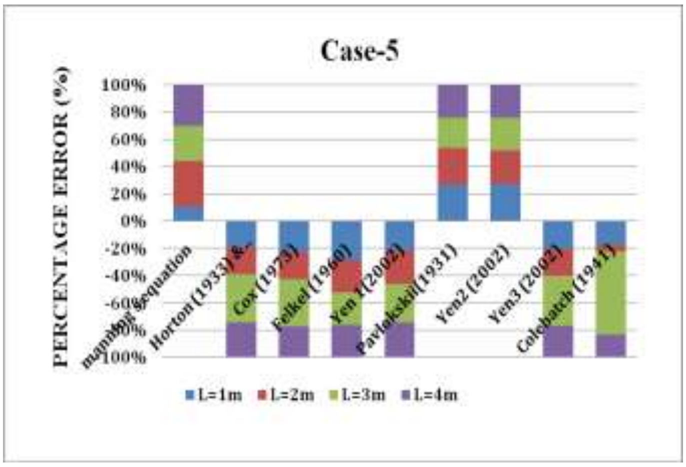

Chart -5: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00137m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the Chart-5 . Here, the positive percentage (%) values represent that the actual value is more than the composite value

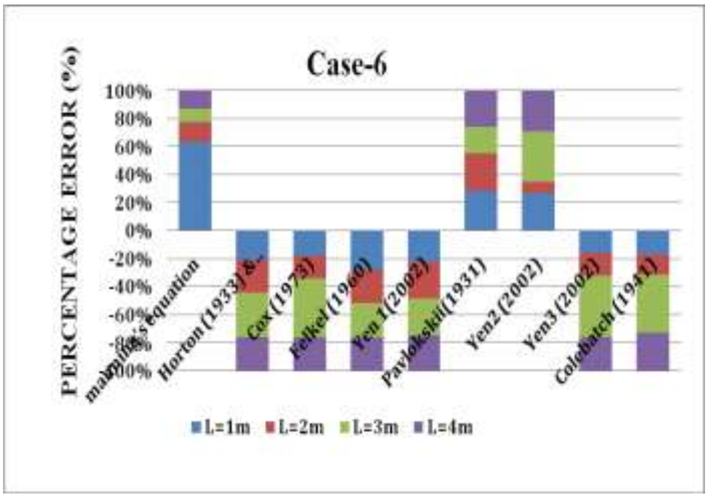

Chart-6: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00118m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the Chart-6. Here, the positive percentage (%) values represent that the actual value is more than the composite value

Fig -2: Cross section of the compound channel with the bed resistance PVC along with the Boulders.

It represent the cross section of rectangular compound channel with the main channel bed resistance PVC along with the boulders and both side are flood plains with grass carpet and plants

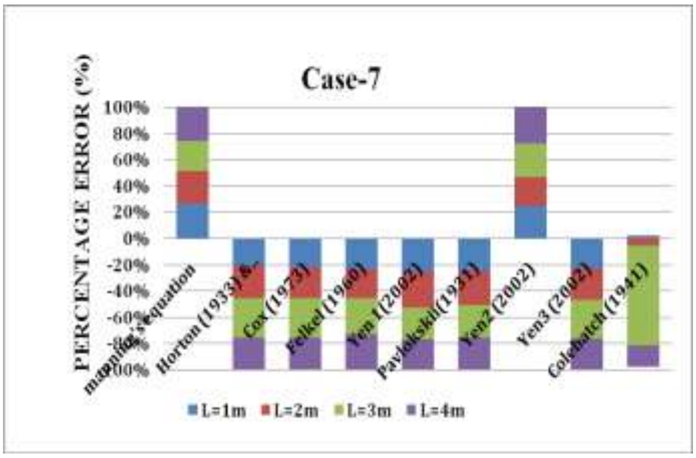

Chart -7: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00115m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the Chart-7. Here, the positive percentage (%) values represent that the actual value is more than the composite value

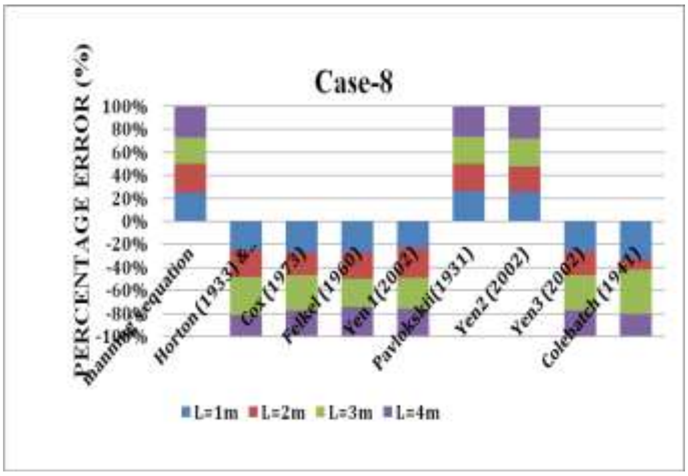

Chart -8: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00127m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the Chart-8 . Here, the positive percentage (%) values represent that the actual value is more than the composite value

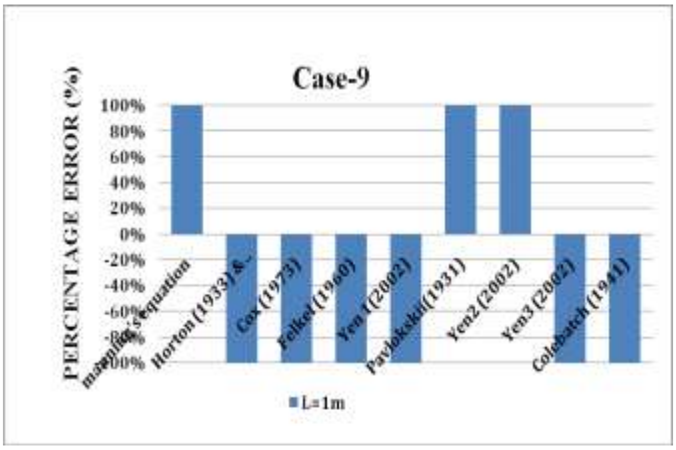

Chart -9: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00083m^3/sec

The percentage error (%) of the composite resistance of the cross section of 1 m flume length has been represented in the Chart-9. Here, the positive percentage (%) values represent that the actual value is more than the composite value

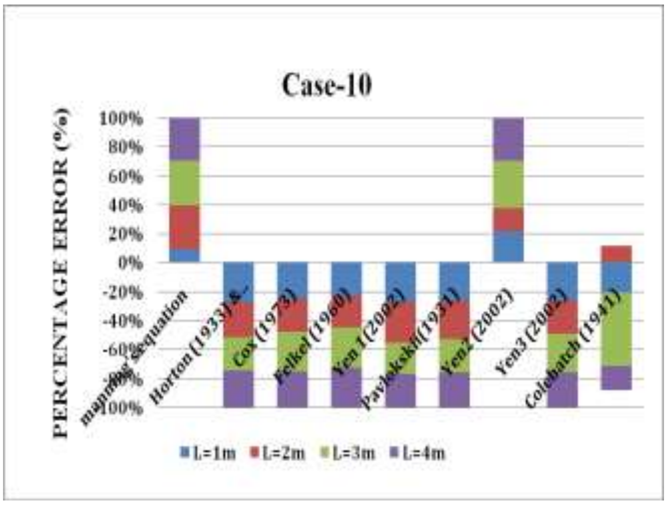

Chart -10: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00143m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the Chart-10. Here, the positive percentage (%) values represent that the actual value is more than the composite value

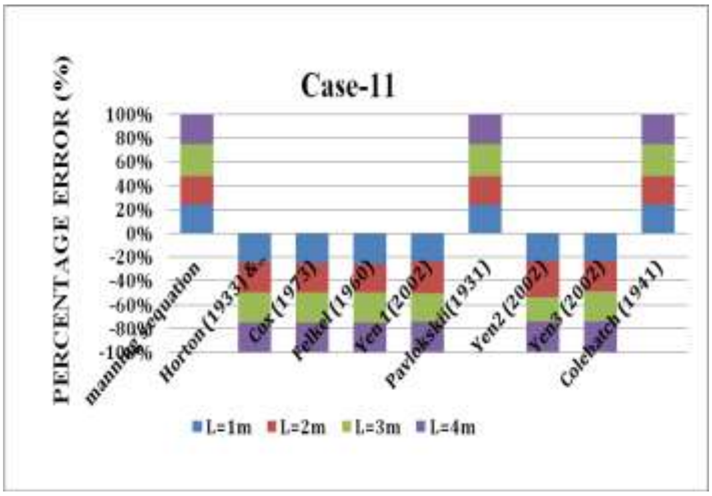

Chart -11: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00093m^3/sec

The percentage error (%) of the composite resistance of the cross section of each flume length has been represented in the Chart-11 . Here, the positive percentage (%) values represent that the actual value is more than the composite value

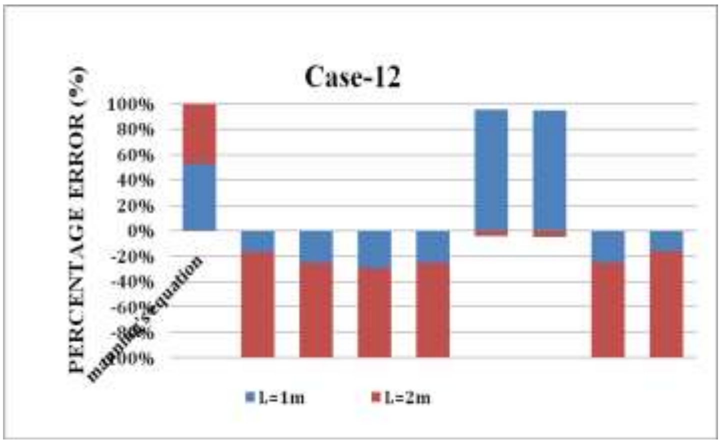

Chart -12: Variation of composite resistance by different composite equation with respect to the actual value of resistance, Q1=0.00091m^3/sec

The percentage error (%) of the composite resistance of the cross section of 1 m and 2 m flume length has been represented in the Chart-12 . Here, the positive percentage (%) values represent that the actual value is more than the composite value

3. OBSERVATION AND DISCUSSION

Experimental work has been analysed in all the composite resistance in different bed material with different slope and discharge. In this studies it represent that all the composite resistance do not give the appropriate value . In the case -9 (9%) and case-12 (1m is 10% and 2 m is 9%) the composite resistance can be taken only till 1 m and 2 m of the flume , both the cases comes under the bed resistance PVC with boulders. Analysis of the composite resistance is represented in the percentage error (%) in each cases .

4. CONCLUSIONS

Here in a rectangular compound channel consist with the main channel and flood channel has been considered with 12 cases . After the analysis of the composite resistance in case of both the resistance i.e i) coconut coir along with the boulders and ii) PVC along with the boulders were considered . The composite resistance of Pavlovskii (1931) and Yen 2 (2002) give the appropriate value with the actual value.

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