CONTINUITY ANALYSIS IN HYDRAULIC GEOMETRY RELATIONSHIPS FOR AL ABBASIA REACH IN EUPHRATES RIVER

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ABSTRACT

Most of the hydraulic geometry relationships derived under premises that there are direct or indirect relation, at least statistically, between meander geometry characteristics include width, depth, cross sectional area and some hydraulic variables as discharge and velocity. The hydraulic variables satisfy for rectangular channels the continuity equation. The authors developed four power functions for predicting the hydraulic geometry properties of Abbasia reach, in the middle of the Euphrates river, Najaf governorate. These power models with certain coefficients (a, c, k and p) and exponents (b, d, m and n). The recent work is to perform the continuity of the results on the predicted models in previous paper. The results indicate that there was an remarkable degree of consistency for both coefficients and exponents.

Keywords: Euphrates; Al Abbasia; Najaf; Continuity of Results; River Geometry; River Meandering.

1. INTRODUCTION

Hydraulic geometry includes parameters such as width, depth, cross sectional area, and meander length, and other hydraulic variables such as mean slope, friction, and mean velocity which depends on many factors like discharge, and type of bed material ,[4]. Most of the hydraulic geometry relationships derived under premises that there are direct or indirect relation, at least statistically, between meander geometry characteristics and some hydraulic variables as discharge and velocity. [4 & 5]

The hydraulic geometry relations are of great practical value in prediction of channel deformation; layout of river training works; design of stable canals and intakes, river flow control works, irrigation schemes, and river improvement works; and so on. Richards (1976) has reasoned that hydraulic geometry relations through their exponents can be employed to discriminate between different types of river sections. These relations can be used in planning for resource and impact assessment.[5]

Leopold and Maddock (1953) expressed the hydraulic geometry relationships for a channel in the form of power functions of discharge as:[2]

$$B = aQ^b \dots (1)$$

$$d = cQ^{f} \quad \dots (2)$$

$$V = kQ^{m} \quad \dots (3)$$

Where B is the channel width; d is the flow depth; V is the flow velocity; Q is the flow discharge; and a, b, c, f, k, and m are parameters. To equations (1, 2 and 3), also added are:[2]

$$n = NQ^{p} \quad \dots (4)$$

$$S = sQ^{y} \quad \dots (5)$$

Where n is Manning's roughness factor; S is slope; and N, p, s, and y are parameters. Exponents b, f, m, p and y represent, respectively, the rate of change of the hydraulic variables B, d, V, n and S as Q changes; and coefficients a, c, k, N and s are scale factors that define the values of B, d, V, n and S when Q = 1.

The hydraulic variables, width, depth and velocity, satisfy for rectangular channels the continuity equation:

$$Q = BdV \quad \dots (6)$$

Therefore, the coefficients and exponents in equation (1) satisfy:[2]

$$ack = 1 \quad \dots (7)$$

$$b + f + m = 1 \quad \dots (8)$$

The at-a-site hydraulic geometry entails mean values over a certain period, such as a week, a month, a season, or a year. The concept of downstream hydraulic geometry involves spatial variation in channel form and process at a constant frequency of flow. Richards (1982) has noted that the downstream hydraulic geometry involving the channel process and form embodies two types of analyses both of which are expressed as power functions of the form (Rhoads, 1991) given by equations (1, 2, 3, 4 and 5). The first type of analysis is typified by the works of Leopold and Maddock (1953) and Wolman (1955) whoformalized a set of relations, such as equations (1, 2, 3, 4 and 5), to relate the downstream changes in flow properties (width, mean depth, mean velocity, slope and friction) to mean discharge. This type of analysis describes the regulation of flow adjustments by channel form in response to increases in discharge downstream, and has been applied at particular cross-sections as well as in the downstream direction.[2]

The recent paper focuses on examining the available formulas predicted by authors (four power functions) using the stability of hydraulic geometry relations scheme. These models were developed to predict the hydraulic geometry properties of Abbasia reach, in the middle of the Euphrates river, Najaf governorate.

2. PROBLEM STATEMENT

The authors were developed power function models for the hydraulic geometry in the selected reach (4 models) then were compared with other power functions models in previous studies.[5] Using the continuity of the results, the authors verify these four models.

3. THE SELECTED REACH

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Al-Abbasia reach along the middle part of the Euphrates river was selected to investigate the different geometry hydraulic characteristics. This region is approximately (6000 m) located between Latitudes (32.04°- 32.03°) and Longitudes (44.26°- 44.29°). This selected reach was divided into 21 sections to perform the field work which included measurement of the hydraulic characteristics of the river sections and longitudinal slopes of the stream and soil sampling. Plate (1) shows the selected sections.

Plate (1): The Selected Reach and Sections.

4. DATA LIMITATIONS

Table (1) lists the limitations of the different characteristics of the selected reach in Euphrates river in Al-Abbasia to perform the analysis in order to produce different models. These characteristics were including discharge (Q), velocity (V), area of cross-sections (A), width of water surface (W), mean depth (Dm), max. depth (Dmax), Main channel slopes (S), mean size of bed material (d50), specific gravity (Gs), and viscosity (v).

Many parameters as (Ground acceleration , the density of water and others) were considered fixed within this analysis either because they are Low changes or that the change does not affect the results, therefore them fixed to facilitate the calculations and comparison. finally, steady flow assumed for analysis operations in this research.

Table (1): Limitations of The Characteristics In Al-Abbasia Reach.

No.	Characteristics	Symbols	Limitations	Units
1	Mean Depth	D_m	1.7 –4.5	m
2	Discharge	Q	34 - 78	m^3/sec
3	Width of the river	W	48 - 184	m
4	Area of cross-sections	A	135 - 535	m^2
5	Average Flow Velocities	V	0.1 - 0.4	m/sec
6	Maximum Depth	D_{max}	2.5-9	m

5. THE RECENT PREDICTED MODELS

Model (9) correlates the values of water surface width (W) with discharge (Q) which were observed through field work. Model (10) correlates the values of mean depth (Dm) with discharge (Q). Model (11) correlates the values of cross section area (A) with discharge (Q). Model (12) correlates the values of mean velocity (V) with discharge (Q)

$$W = 0.5.Q^{1.3} \quad \dots (9)$$
$$Dm = 99.Q^{-0.91} \quad \dots (10)$$
$$A = 50.Q^{0.4} \quad \dots (11)$$
$$V = 0.02.Q^{0.61} \quad \dots (12)$$

5.1. Continuity Analysis

The hydraulic geometry relationships, models (9) to (12), can be expressed in general forms, as in model (5) to (8):

$$W=a\,Q^{b} \quad \dots (13)$$
$$D_m=c\,Q^{d} \quad \dots (14)$$
$$V= k\,Q^{m} \quad \dots (15)$$
$$A=p\,Q^{n} \quad \dots (16)$$

Where : W is the width, D_m is the mean depth, V is mean velocity, and A is area of cross section of river, a, b, c, d, k, m, n, and p are constants.

$$\text{But, } Q = \text{Area} \times \text{Velocity} = A\,.\,V = W\,.\,D_m\,.\,V \quad \dots (17)$$
$$\text{So, } Q = a\,Q^{b}\,.\,c\,Q^{d}\,.\,k\,Q^{m} \quad \dots (18)$$
$$\text{Or, } Q = a\,.\,c\,.\,k\,Q^{b+m+d} \quad \dots (19)$$
$$\text{And } Q = p\,Q^{n}\,.\,k\,Q^{m} = p\,.\,k\,Q^{m+n} \quad \dots (20)$$

equalize the sides of equation (19) and (20), then:

$$a \times c \times k = 1 \quad \dots (21)$$
$$b + d + m = 1 \quad \dots (22)$$
$$p \times k = 1 \quad \dots (23)$$
$$n + m = 1 \quad \dots (24)$$

Figure 1 shows the trends of the results, sectional area and the (W*Dm). one can notice that there are approximately similar trends.

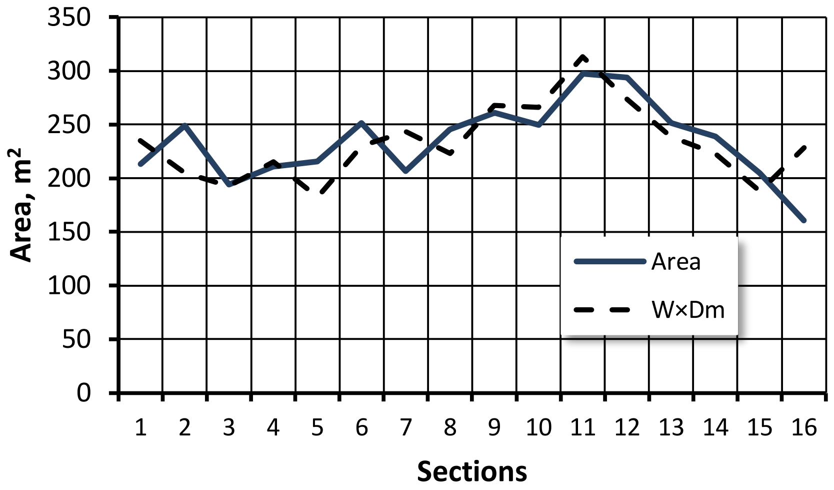

Figure (1): The Trends of the Results.

6. RESULTS AND DISCUSSION

Tables (2) and (3) illustrate the results of equation (21) to (24) corresponding to the prediction models (9) to (12). One can notice that the mentioned results are so close to 1, and this different may be caused by the selection of cross sectional area. This results revealed that the present new models are acceptable and applicable.

Table (2): Values of Coefficients.

Variable	Coefficients	Values	a × c ×k	p × k
W	a	0.5	**0.99**	**1**
D_m	c	99		
V	k	0.02		
A	p	50		
Q	-	1		

Table (3): Value of Exponents of Variable.

Variable	Exponents	Values	b + d + m	n + m
W	b	1.3	**1**	**1.1**
D_m	d	-0.91		
V	m	0.61		
A	n	0.4		
Q	-	1		

7. CONCLUSIONS

The results indicate that there was an remarkable degree of consistency for both coefficients and exponents of the predicted models for hydraulic geometry relationships.

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