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COMPUTATION OF SHAPE FACTOR OF IRREGULAR SHAPED GRAVELS

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Abstract: -Seeing the today's scenario, the water drainage problem leads to a disaster in rainy season. For solving this problem there are many solutions, one of the solutions can be Particle Characterization with respect to terminal settling velocity. By analysis of settling velocity of an irregular particle the drains may design to carry a large discharge. The rate at which a particle settles through a static fluid depends on the density and viscosity of the fluid and on the density, size, shape, roundness and surface texture of the particles. Therefore, the characterization of particle with respect to terminal settling velocity is important. As the settling velocity depends on the size and shape of particle it is important to know the shape factor of irregular particles by knowing this the settling velocity may be calculated. Shape factor can be calculated experimentally by using Corey formula.

Keywords: -Settling Velocity, Corey Shape Factor, Reynolds Number, Stokes law, Coefficient of Drag, etc.

I. INTRODUCTION

The settling velocity depends on the properties of particles such as specific gravity, density, size and shape of the particles. In this project we are calculating the size of irregular gravels particle which affecting the settling velocity. The settling velocity of a particle is the function of its size density and shape and ambient properties of the fluid. The problem encountered in case of non-spherical gravels particularly at high Reynolds number outside the Stokes range of settling velocity. Based on earliest studies it is evident that Cd is function of Re and shape of sediment particle it is also known that Cd increases with availability in shape of the particle.

To incorporate the effect of particle in predicting the fall velocity of irregular shaped particles, the shape factor terminology is used. Shape factor is a representation of irregularly shaped particles/gravels in terms of spherical particle equivalents of its diameter. Following are the techniques adopted to compute the shape factor:

i. Coefficient based on volume
ii. Coefficient based on the projected area
iii. Coefficient based on the three axes

iv.

II. LITERATURE REVIEW

Steve Darby, A. Shafaie, “Fall Velocity of Sediment Particles”, Journal of Hydraulic Research, Semantic Scholar Publication, (December 2010), pp. 39-45.

Review: Estimating the fall velocity of sediment particles is a fundamental requirement when modeling sediment transport. Many attempts to estimate the fall velocity have been carried out by a range of researchers over the last 40 years, so a large number of relations for different particle sizes across various conditions are available in the literature. However, the number of relations can cause confusion and it is not always clear which relation is the most suitable.

In this study, they have examined and re-evaluated 22 relations published by 17 researchers during the period 1933-2007, developing a new relation in the process. The new relation has been verified using two sets of laboratory data. The mean relative error of 11.7% indicates that despite the simplicity of the relation, there is a good agreement between observed and predicted data.

Song Zhiyao, Wu Tingting, Xu Fumin and Li Ruijie, “A simple formula for predicting settling velocity of sediment particles”, Journal of Water Science and Engineering, ELSEVIER Publication, Volume 1, Issue 1, (March 2008), pp. 37-43.

Review: In this paper, based on the general relationship described by Cheng between the drag coefficient and the Reynolds number of a particle, a new relationship between the Reynolds number and a dimensionless particle parameter is proposed. Using a trial-and-error procedure to minimize errors, the coefficients were determined and a formula was developed for predicting the settling velocity of natural sediment particles. This formula has higher prediction accuracy than other published formulas and it is applicable to all Reynolds numbers less than 2×10^5.

The results of this study expand the existing formulas for calculating the settling velocity of natural sediment particles. The results also verify the relationships derived by McGauhey (1956), Swanson (1967, 1975), Turton and Clark (1987), Guo (2002), Brown and Lawler (2003), and Jimenez and Madsen (2003) that express the settling velocity (or particle Reynolds number) of spherical particles or natural sediment particles in terms of the dimensionless grain size in a simpler form with three coefficients. The three coefficients in the proposed equation can be determined by a trial-and-error procedure in order to minimize errors. The equation obtained has a higher degree of prediction accuracy than other published formulas and it is suitable for engineering application.

Sabine Tran-Cong, Michael Gay, Efstathios E. Michaelides, “Drag coefficients of irregularly shaped particles”, Powder Technology, ELSEVIER Publication, Volume 139, (October 2003), pp.21-32.

Review: The steady-state free-fall conditions of isolated groups of ordered packed spheres moving through Newtonian fluids have been studied experimentally. Measurements of the drag coefficients are reported in this paper for six different geometrical shapes, including isometric, axisymmetric, orthotropic, plane and elongated conglomerates of spheres. From these measurements, a new and accurate empirical correlation for the drag coefficient, CD, of variously shaped particles has been developed. This correlation has been formulated in terms of the Reynolds number based on the particle nominal diameter, Re, the ratio of the surface-equivalent-sphere to the nominal diameters, dA/dn, and the particle circularity, c.

The predictions have been tested against both the experimental data for CD collected in this study and the ones reported in previous works for cubes, rectangular parallelepipeds, tetrahedrons, cylinders and other shapes. A good agreement has been observed for the variously shaped agglomerates of spheres as well as for the regularly shape particles, over the ranges $0.15<Re<1500$, $0.80<dA/dn<1.50$ and $0.4<c<1.0$.

III. MATERIALS AND METHODOLOGY

In methodology, we have adopted the experimental method in which materials are selected such that it can be settled in static fluid. The material is - Gravels (Kankad) – The gravels are taken from the sand of the CT lab of our College which was brought from the Kanhan river.

Equipment such as apparatus required –

1. Calibrated Screw Gauge – it is taken from the Physics lab of the College,
2. Magnifying glass, tong, stopwatch and measuring tube.
3. Liquid basic medium is water and we have taken 3 different types of solutions and they are: salt solution glycerin, acetic acid.

Procedure:

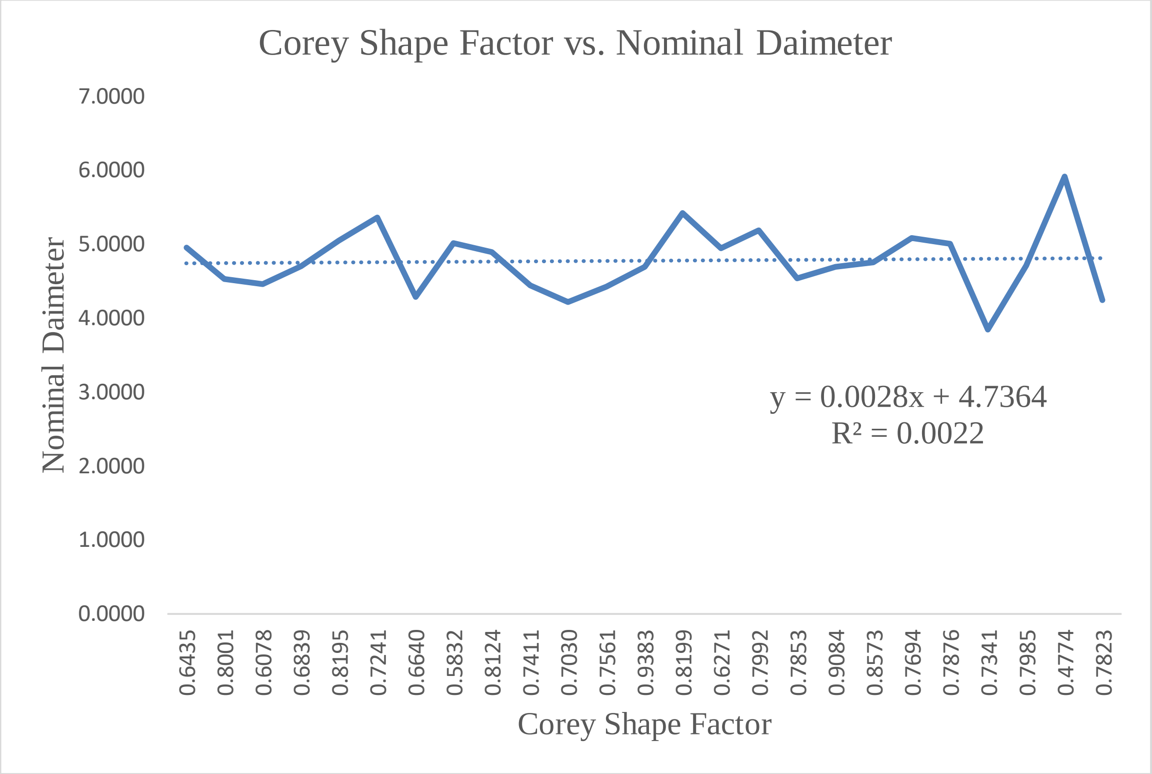
a. First we determined the specific gravity and density of both particles and liquid and we also determine the viscosity of liquid. All this parameters will be used in calculating the settling velocity of irregular particles.
b. Then we have measured the dimension of irregular particles in X, Y and Z direction by screw gauge and then we have calculated the nominal diameter, arithmetic diameter and then shape factor.
c. Correlating shape factor and settling velocity of irregular particles.

IV. CALCULATION AND RESULT

Following are the observations taken from the screw gauge in which d1 is the longer dimension of particle measured in x-axis, d2 is the medium dimension measured in y-axis and d3 is the shorter dimensions measured in z-axis.

For calculating the arithmetic diameter we have used the formula $Dam = (d1+d2+d3)/3$, for calculating nominal diameter we have used the formula $Dn = (d1*d2*d3)^{1/3}$ and for calculating Corey shape factor we have used the formula $C = [d3/(d1*d2)^{1/2}]$.

	Dimensions of Particles			**Arithmetic Diameter**	**Nominal Diameter**	**Corey Shape Factor**
Sr. No.	**d1**	**d2**	**d3**	**Dam**	**Dn**	**C**
1	7.18	4.58	3.69	5.1500	4.9508	0.6435
2	5.4	4.4	3.9	4.5667	4.5252	0.8001
3	6.93	4	3.2	4.7100	4.4598	0.6078
4	7.72	3.69	3.65	5.0200	4.7023	0.6839
5	5.76	5.05	4.42	5.0767	5.0471	0.8195
6	8.09	4.4	4.32	5.6033	5.3575	0.7241
7	6.81	3.54	3.26	4.5367	4.2834	0.6640
8	7.83	4.6	3.5	5.3100	5.0141	0.5832
9	5.5	5	4.26	4.9200	4.8931	0.8124
10	6.25	3.86	3.64	4.5833	4.4448	0.7411
11	6.41	3.5	3.33	4.4133	4.2117	0.7030
12	6.2	3.8	3.67	4.5567	4.4219	0.7561
13	5	4.6	4.5	4.7000	4.6951	0.9383
14	6.74	4.98	4.75	5.4900	5.4224	0.8199
15	7.54	4.42	3.62	5.1933	4.9412	0.6271
16	6.8	4.6	4.47	5.2900	5.1903	0.7992
17	6.04	4	3.86	4.6333	4.5348	0.7853
18	5.32	4.41	4.4	4.7100	4.6910	0.9084
19	5.81	4.31	4.29	4.8033	4.7538	0.8573
20	6.04	5.1	4.27	5.1367	5.0856	0.7694
21	5.62	5.23	4.27	5.0400	5.0067	0.7876
22	5.3	3.43	3.13	3.9533	3.8463	0.7341
23	6.32	4.07	4.05	4.8133	4.7053	0.7985
24	9.15	6.25	3.61	6.3367	5.9102	0.4774
25	5.5	3.85	3.6	4.3167	4.2401	0.7823



Description of Graph: - Here we have plotted the graph between Corey Shape Factor and Nominal Diameter in which x-axes represent Corey shape factor and y-axes represent nominal diameter. After plotting the Trend line on graph its gives the equation y = 0.0028x + 4.7364 and also gives R-squared value as $R^2 = 0.0022$.

V. CONCLUSION

This paper is all about that how the shape factor is related to nominal diameter of irregular particles because only from nominal diameter we cannot calculated the actual diameter of the irregular particles. Therefore it is necessary to calculate the shape factor of irregular particles so as to calculate the actual diameter of particle i.e. by multiplying the shape factor and nominal diameter.

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