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Similitude:

Similitude is defined as the similarity between the model and its prototype in every respect, which means that the model and prototype have similar properties or model and prototype are completely similar.

Types of similarities:

1. Geometric similarity
2. Kinematic similarity
3. Dynamic similarity

Geometric Similarity:

The geometric similarity is said to exist between the model and the prototype is the ratio of all corresponding linear dimension in the model and prototype are equal.

Let L_m = Length of model
D_m = Diameter of model
V_m = Volume of model
b_m = Breadth of model
A_m = Area of model.

Similarly L_p, D_p, V_p, b_p, A_p for prototype.

Then, geometric similarity,

$$\frac{L_p}{L_m} = \frac{b_p}{b_m} = \frac{D_p}{D_m} = L_r$$

[L_r - scale ratio]

For area and volume's ratio,

$$\frac{A_p}{A_m} = \frac{L_p \times b_p}{L_m \times b_m} = L_r \times L_r = L_r^2$$

$$\frac{V_p}{V_m} = \frac{L_p^3}{L_m^3} = \frac{b_p^3}{b_m^3} = \frac{D_p^3}{D_m^3}$$

$$\frac{V_p}{V_m} = \left(\frac{L_p}{L_m}\right)^3 = \left(\frac{b_p}{b_m}\right)^3 = \left(\frac{D_p}{D_m}\right)^3$$

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Kinematic Similarity:

Kinematic similarity means the similarity of motion at the corresponding points between model and prototype.

The directions of the velocities in the model and prototype should also be the same.

Let V_{p_1} = Velocity of fluid at point 1 in prototype
V_{p_2} = " " " " " 2 in "
a_{p_1} = acceleration " " " " 1 in "
a_{p_2} = " " " " " 2 in "

Similarly, V_{m_1}, V_{m_2}; a_{m_1}, a_{m_2} for model.

then,

$$\frac{V_{p_1}}{V_{m_1}} = \frac{V_{p_2}}{V_{m_2}} = V_r$$

V_r - velocity ratio

$$\frac{a_{p_1}}{a_{m_1}} = \frac{a_{p_2}}{a_{m_2}} = a_r$$

a_r - acceleration ratio

Dynamic Similarity:

Means the similarity of forces at the corresponding point between the model and prototype. Directions of the corresponding forces at the corresponding points should be same.

Let $(F_i)_p$ = Interia force at a point in prototype
$(F_v)_p$ = Viscous force " " " "
$(F_g)_p$ = Gravity force " " " "
$(F_p)_p$ = Pressure force " " " "
$(F_s)_p$ = Surface tension force " " "
$(F_e)_p$ = Elastic force " " "
and $(F_i)_m$, $(F_v)_m$ .... for model.

Then dynamic similarity,

$$\frac{(F_i)_p}{(F_i)_m} = \frac{(F_v)_p}{(F_v)_m} \cdots\cdots = F_r$$

F_r - Force ratio