DEPARTMENT OF AEROSPACE ENGINEERING

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Year & Branch	:	**II AEROSPACE**	Semester	:	**III**
Course	:	**23AST202 – Fluid Mechanics for Aerospace**			

UNIT III - DIMENSIONAL ANALYSIS AND MODEL STUDIES

TYPES OF MODELS

Hydraulic models can be broadly classified into two categories namely,

(i) Undistorted Models

(ii) Distorted Models

(i) Undistorted Models

An undistorted model is the one which is geometrically similar to its prototype, that is, the scale ratios for corresponding linear dimensions of the model and its prototype are same. As the basic condition of perfect similitude, i.e., geometric similarity, is satisfied, prediction in case of such models is relatively easy and many of the results obtained from the model tests can be transferred directly to the prototype.

(ii) Distorted Models

Distorted models are those in which one or more terms of the model are not identical with their counterparts in the prototype. As the basic condition of perfect similitude, i.e., geometric similarity, is not satisfied, the results obtained with the help of such models are liable to distortion and have more qualitative value only. A distorted model may have either geometrical distortion, or distortion of hydraulic quantities or a combination of these.

What is geometric distortion?

The geometric distortion can either be *dimensional distortion* or *configurationally distortional*. For example, when the scale ratio adopted for thelongitudinal dimension of the model and the prototype is different from the scale ratio adopted for the vertical dimension of the model and the prototype, the model is said to be *dimensionally distortional*. In general, when different scale ratios are adopted for the longitudinal, transverse and vertical dimensions, then it is said to be a distortion of dimensions.

Where dimensionally distorted models are frequently employed?

Distortion of dimensions is frequently adopted in river models where a differentscale ratio is adopted for depth. In river models, the scales for vertical dimensions are larger than scales for horizontal dimensions. Such models are called '*vertically exaggerated models*'.

When the general configuration of the model does not bear a resemblance with its prototype, it results in a *configurationally distortional* model. For example, a river model will have a distortion of configuration if it is constructed with a bed-slope different from the one given by vertical exaggeration.

What is material distortion?

When the physical properties of the corresponding materials in the model and the prototype do not satisfy the similitude conditions, the material distortion arises.

Material distortion may have to be adopted in river models constructed for the studies of sediment transport.

Further, it may not be possible to obtain similitude in respect of certain uncontrollable hydraulic quantities such as time, discharge, etc., which may leadto distortion of hydraulic quantities.

Typical examples where distorted models are required:

(i) Rivers

(ii) Dams across very wide rivers

(iii) Harbours

(iv) Estuaries, etc.,

In all the above cases, the horizontal dimensions are large in proportion to the vertical ones.

What are the reasons for adopting distorted models?

(i) to maintain accuracy in vertical measurements

(ii) to maintain turbulent flow

(iii) to obtain suitable bed material and its adequate movement

(iv) to obtain suitable roughness condition

(v) to accommodate the available facilities such as space, money, watersupply and time.

Merits of Distorted Models

(i) the vertical exaggeration results in steeper water surface slopes and magnification of wave heights in models. Hence, the water surface slopes and the wave heights can be measured easily and accurately.

(ii) Due to exaggerated slopes, the Reynolds number of a model is considerably increased and the surface resistance is lowered. This assists in the simulation of flow conditions in the model and its prototype.

(iii) Sufficient tractive force can be developed to produce adequate bed movement with a reasonable small model.

Model size can be sufficiently reduced by distortion. This effects simplification in its operation and considerable reduction in cost.