INFLUENCE OF FREE-STREAM TURBULENCE ON THE FREQUENCY SIMILITUDE BASED ON FROUDE'S NUMBER

CLAUDIA REIBENWEIN [1], REINHARD PRENNER [2] and HELMUT DROBIR [3]

[1] M.Sc., University Assistant, Institute for Hydraulic and Water Resources Engineering, Vienna University of Technology, Karlsplatz 13, 1040 Vienna, Austria (Tel: +43-58801-22241, e-mail: claudia.reibenwein@kw.tuwien.ac.at)
[2] M.Sc., Ph.D., Project Manager, Institute for Hydraulic and Water Resources Engineering, Vienna University of Technology, Karlsplatz 13, 1040 Vienna, Austria (Tel: +43-58801-22244, e-mail: reinhard.prenner@kw.tuwien.ac.at)
[3] M.Sc., Ph.D., Em. Professor, Institute for Hydraulic and Water Resources Engineering, Vienna University of Technology, Karlsplatz 13, 1040 Vienna, Austria (Tel: +43-58801-22230, e-mail: helmut.drobir@kw.tuwien.ac.at)

Due to problems in identifying the resonance frequency of prototype structures, e.g. trashracks or gates, which can be forced to vibrate by flow-induced mechanisms, it was of vitally interest to verify Froude's law of similitude applied to the conversion of frequencies on basis of model experiments. Vortex shedding frequencies in the wake of stationary mounted smooth circular bars were investigated experimentally in a water channel.

Special emphasis was put on adopted measures to reduce the turbulence level of the approaching flow, taking results of investigations into account, formerly conducted in wind tunnels (Baines, W.D., et al., 1951; Collar, A.R., 1939; Dryden, H.L., et al., 1947).

It can be demonstrated, that the incoming turbulence of the approaching flow has a considerable influence on the evaluation of results. The adding of flow-soothing screens enables a significant reduction of the turbulence intensity of the approaching flow conditions. Beside the general "damping" function of the screens, the influence of the turbulence level on the frequency similitude by variation of the screen-number should be investigated.

By means of a model-family vortex frequency calculations were carried out to obtain information about the verification of Froude's similitude related to the frequency scale. The model-family consists of circular bars with a scale-range 1:1 up to 1:5. In comparison to former model tests (Binder, M., 2002) on square plates to a scale of 1:1 up to 1:2.5, it was possible to extend the scale-range in the present study.

The hydraulic model tests were conducted in the subcritical Reynolds number range ($2 \cdot 10^3 < Re < 2 \cdot 10^4$, where Re is in terms of the diameter for circular profiles). The subcritical Reynlolds number range is characterized by nearly constant Strouhal numbers, which are situated at around 0.2.

In the case of the flow around circular cylinders, the boundary layer remains laminar, whereas the shear layers in the wake of the body show turbulent behaviour.

The determination of the shedding frequency was carried out in the convective wake of the investigated profiles at the half height of 40cm submergence and was measured by means of an ADV probe. The position of the probe was varied until an approximately sinusoidal signal occurred.

REFERENCES

Baines, W.D., et al.: "An Investigation of Flow Through Screens", *Transactions of the ASME,* May 1951.

Collar, A.R.: "The Effect of a Gauze on the Velocity Distribution in a Uniform Duct", *British A.R.C. Reports and Memoranda*, No.1867, February 1939.

Dryden, H.L., et al.: „The Use of Damping Screens for the Reduction of Wind-Tunnel Turbulence", *Journal of the Aeoronautical Sciences*, April 1947.

Binder, M.: „Schwingungsuntersuchungen im wasserbaulichen Versuchswesen", *Dissertation*, TU-Wien, 2002.