ABSTRACT

Recently a Benchmark problem has been started, in the field of bluff body aerodynamics (Bartoli et al 2008a). The aim of the Benchmark is to provide a contribution to the analysis of the turbulent, separated flow around a fixed rectangular cylinder with chord-to-depth ratio equal to 5. In spite of the simple geometry, it is believed that the problem is of interest not only for the purpose of fundamental research, but also to provide useful information on the aerodynamics of a wide range of bluff bodies of interest in Civil Engineering (e.g. long span bridges decks, high-rise buildings, and so on) and for other Engineering applications. Given the possible interest of Research Institutions and Industries operating in different fields of Engineering, using both computational and experimental tools, the benchmark addresses both the numerical and the experimental approach.

The aims of the Benchmark are the following:

1. to deeply investigate one specific problem in the aerodynamics of bluff bodies, with contributions coming from as many researchers as possible worldwide;
2. to assess the consistency of wind tunnel measurements carried out in different facilities;
3. to assess the consistency of computational results obtained through different flow models and numerical approaches;
4. to compare experimental and computational results;

Contact person: L. Bruno, Dipartimento di Ingegneria Strutturale e Geotecnica, Politecnico di Torino, Viale Mattioli 39, 10126 Torino, Italy, Phone +39 (0)11.090.4870, Fax +39 (0)11.090.4999, e-mail: luca.bruno@polito.it
(5) to assess the possibility of developing integrated procedures relying on both experimental and computational outcomes;
(6) to develop Best Practices for experiments and computations.
In addition, the results provided by the participants are meant to create a database to be made available to the Scientific and Technical communities for future reference.

The Benchmark problem is promoted by the Organising Committee, with the support of the Italian National Association for Wind Engineering (ANIV), under the umbrella of the International Association for Wind Engineering (IAWE) and in cooperation with the European Research Community On Flow, Turbulence And Combustion (ERCOFTAC). The activities will be carried out under supervision of the International Advisory Board.

The Benchmark addresses the high Reynolds number, external, unsteady flow around and past a stationary, sharp-edged rectangular cylinder, and the associated aerodynamic actions. The breadth ($B$) to depth ($D$) ratio is set equal to 5.

Participants are invited to submit their original contributions following specified formats. These can include both results already available to the participants and results specifically obtained for the purpose of participation in the Benchmark. In addition, participants are invited to share with the Scientific and Technical communities the literature and the published results available to them.

The following common requirements are set for both wind tunnel tests and numerical simulations:
(1) the depth-based Reynolds number has to be in the range of $2 \times 10^4$ to $6 \times 10^4$;
(2) the oncoming flow has to be set parallel to the base of the rectangle;
(3) the maximum intensity of the longitudinal component of turbulence is set to 0.01;
(4) the minimum spanwise length of the cylinder for wind tunnel tests and 3D numerical simulations is set to $L/D=3$.
(5) the maximum radius of curvature of the edges of the cylinder is set to $R/D=0.05$
(6) the minimum sampling frequency is set to $f_s D/U = 8$, $f_s$ being the shedding frequency.

In addition, the following requirements are specified for wind tunnel tests:
(7) the maximum wind tunnel blockage is set to 5%;
(8) all the points of measurement have to be outside the boundary layers developed at the tunnel floor, roof and side walls. Uniformity of the flow at the locations where measurements are taken must be checked in the bare tunnel and appropriately documented.

In Figures 1 and 2 sketches of the experimental and computational setups are shown.
For participation in the Benchmark, information concerning the setup and a minimum set of output data must be provided by the participants, through upload on the Benchmark web page http://www.aniv-iawe.org/barc. These data will be available to all participants for download. This is to allow researchers to compare the results obtained by other researchers. All the problem quantities must be scaled with respect to the following reference dimensions:
- section depth $D$;
- fluid density $\rho$;
- undisturbed flow field velocity $U_\infty$;

Both set-up information and output data are classified as “required”, i.e. data that participants are requested to provide, and “encouraged”, i.e. additional data that participants are encouraged to provide (Bartoli et al 2008b, 2008c). Finally, any further data can be provided by the participant, as “additional”. As an example, Figure 3 shows required points of pressure measurement, and Figure 4 the additional points suggested.

Figure 2: sketch of the computational domain

Figure 3: required points of measurement
Reference information can be shared among participants, upgrading the non-exhaustive bibliographic database provided to the participants (Bartoli et al. 2008d).

In addition to the main set-up, sensitivity studies are strongly encouraged. The follow additional values of the parameters are suggested for both wind tunnel tests and numerical simulations:

- Angles of incidence of 1°, 3°, 6°;
- Reynolds number of 1x10^3, 1x10^4, 1x10^5, 1x10^6;
- Turbulence intensities of 0.02, 0.05, 0.10.

REFERENCES