

Brazilian Extreme Winds

Acir M. Loredou-Souza¹

¹*Laboratório de Aerodinâmica das Construções, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, acir@ufrgs.br*

1 INTRODUCTION

The wind sensitivity of buildings and structures depends on several factors, the most important of which are the meteorological properties of the wind, type of exposure, and the aerodynamic and mechanical characteristics of the structure [1]. Severe winds are associated with a variety of meteorological phenomena, where the events of major concern are tornadoes, downbursts, hurricanes, mountain-lee-waves and down-slope winds, and extra-tropical cyclones [2]. This paper describes the meteorological events of major concern in Brazil with regard to extreme winds.

2 EXTREME WINDS IN BRAZIL

The meteorological events of major concern in Brazil regarding the development of strong winds are tornadoes, downbursts and extra-tropical cyclones. However, one hurricane formed off the coastline of southern Brazil in 2004, and there are predictions that others may form again.

2.1 Tornadoes

Occurrence of tornadoes in Brazil have been registered mainly in the southern states of Rio Grande do Sul, Santa Catarina, Paraná and São Paulo. Most are F1 tornadoes, but F3 ones are increasing in frequency and even an F4 has been registered in 1991. There is no record of an F5 in the Brazilian territory. Fig. 1 shows an F1 tornado in the city of Tubarão, state of Santa Catarina, in February 2008.



Fig. 1: Picture of a F1 Tornado at the city of Tubarão, Santa Catarina state.

2.2 Downbursts

Downbursts, also designated as thunderstorms, or TS winds, are one of the main sources of high wind speeds in the Brazilian territory [3]. Fig. 2 shows photographs of the consequences of a downburst that occurred in the south of São Paulo, in 1999.



Fig. 2: Photographs of the consequences of a downburst in the city of São Paulo, in 1999.

2.3 Extra-tropical cyclones

Extra-tropical cyclones are also known as extended mature pressure systems, or EPS storms. These low-pressure systems are of frequent occurrence and, together with TS winds, are one of the main sources of high wind speeds in the Brazilian territory. A satellite image of the south of Brazil during the formation of an extra-tropical cyclone is shown in Fig. 3.



Fig. 3: Satellite image of an extratropical cyclone forming in the south of Brazil.

2.4 Hurricanes

In March 2004, a circulation center well off the coast of southern Brazil developed tropical cyclone characteristics and continued to intensify as it moved westward. The system developed an eye and apparently reached hurricane strength on Friday, March 28, 2004. The storm has been named “Hurricane Catarina”. A picture of this meteorological phenomenon is shown in Fig. 4, where is possible to note the clockwise circulation of Southern Hemisphere cyclones, the well-defined banding features, and the eyewall of at least a Category 1 system.

Brazilian and American meteorologists still have to agree on the phenomenon that hit the southern coast of Brazil killing several people, damaging as many as 40,000 homes, and leaving hundreds of families homeless.

The storm Catarina (its main target was the state of Santa Catarina) was named 1-T-Alfa by the U.S. National Hurricane Center, and named Catarina by Brazilian scientists. The storm was considered a Hurricane Category 1 in the Saffir-Simpson scale, the first such storm on record to reach the south Atlantic region. The storm sustained velocities of 150 km/h and reached gusts up to 178 km/h. The pressure at the eye storm was estimated by the NHC to be 980 mb.

Catarina was formed about 442 km far from the south coast of Brazil, surprising meteorologists which have never seen the occurrence of such phenomenon in the region. Satellite images show a great spiral, approximate the size of Uruguay. The characteristics, shown by the satellite pictures, are that of a hurricane. It has a well defined eye, a circulation pattern which follows the expected norm, and is totally outside the influence of a cold front. On the other hand, the sea temperature does not fulfill the requirement for the formation of a hurricane.

While American weather experts analysing satellites pictures called the Brazilian phenomenon a hurricane even before it hit shore, their Brazilian counterparts regarded it as an “extra-tropical cyclone.” Brazil’s Center for Weather Forecasting and Climatic Studies, a branch of the Inpe (National Institute of Space Research), classified the storm, in its beginning, as a “conventional” cyclone, that would have winds with speeds between 70 and 80 km/h. They would be proved wrong since winds reached 150km/h [4].



Fig. 4: Picture of the Cyclone Catarina reaching the South Brazilian Coast.

3 BRAZILIAN WIND CODE

The Brazilian wind loading code NBR-6123, 1988 [5] presents a wind map (Fig. 5) with the reference wind speeds based on 3-second gust wind speed at 10m height in open terrain, with 50-year return period varying from 30 m/s (north half of country) to 50 m/s (extreme south). There is not a separation of the type of climatological event which generated each registered velocity. Therefore, a thunderstorm (TS), an extra-tropical pressure system (EPS) or even a tropical cyclone (TC) are treated the same and its resulting velocities absorbed without differentiation. There are a lot of meteorological stations and a continuing process for updating the records; however, the corresponding updating of the wind code does not receive the deserved attention required, mainly due to the lack of human and financial resources to deal with this task. Exception is the wind research team of the Universidade Federal do Rio Grande do Sul (UFRGS), in the city of Porto Alegre, which is continuously working on the improvement of the Brazilian Wind Code, but that also face great difficulties with regard to public funding. Most of the funding comes from commissioned wind tunnel tests, even though the results benefit the general public.

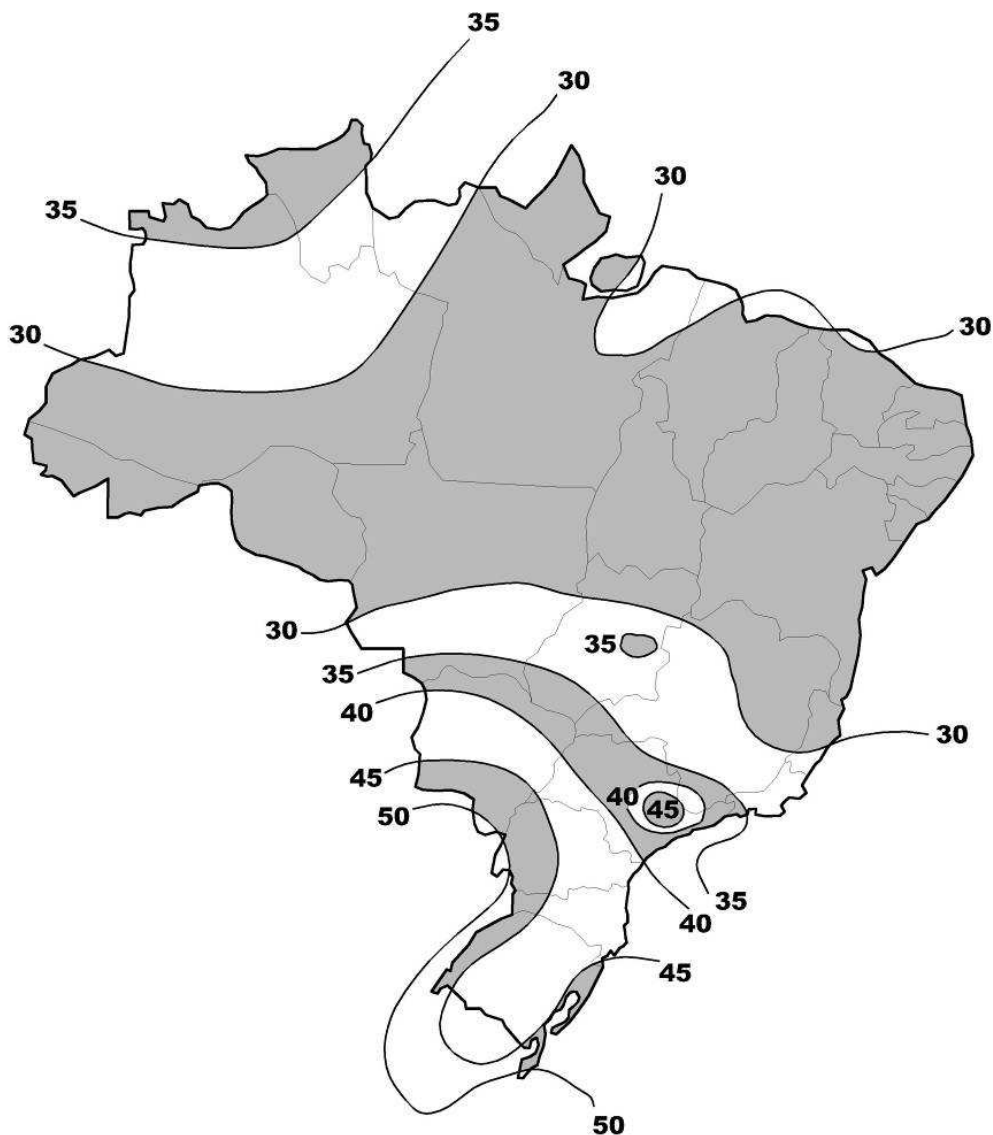


Fig. 5: Map with the reference wind speeds (50-year return period), in m/s, 3-s gust, at 10m height (NBR-6123).

4 FUTURE

Although hurricanes are still rare events in the Brazilian coastline, there are predictions of an increase in formation. Also increasing is the number of tornadoes registered in the southern part of Brazil. The wind engineering research group of the Universidade Federal do Rio Grande do Sul in Porto Alegre, is designing a new wind tunnel for the simulation of tornadoes and downbursts, and expect to generate data for each specific type of meteorological event to be used in wind codes, eventually separated by storm type.

5 REFERENCES

- [1] Davenport A.G. (1998) "What makes a structure wind sensitive?", Wind Effects on Buildings and Structures. Balkema, Rotterdam.
- [2] Cermak J.E. (1998) "Wind damage mitigation – Wind engineering challenges", Wind Effects on Buildings and Structures. Balkema, Rotterdam.
- [3] Riera J.D, Rocha, M.M. (1998) "Load definition for wind design and reliability assessments: Extreme wind climate", Wind Effects on Buildings and Structures. Balkema, Rotterdam.
- [4] Loredou-Souza A.M., Paluch, M.J. (2005). Brazil storm Catarina: hurricane or extratropical cyclone? Proceedings, Tenth Americas Conference on Wind Engineering, Baton Rouge, 31 May-4 June.
- [5] Associação Brasileira de Normas Técnicas (1988) Norma Brasileira NBR-6123 (NB-599): Forças devidas ao vento em edificações. ABNT, Rio de Janeiro.