Lessons Learned from Wind Turbine Failures Caused by Natural Hazards

*Jui-Sheng Chou¹

1. National Taiwan University of Science and Technology

In recent decades, the Taiwanese government has been vigorously promoting the development of the green energy industry, investing greatly in the photovoltaic and wind-energy sectors with the goal of developing renewable energy, the economy, and a sustainable environment. However, owing to its location, Taiwan is vulnerable to typhoons that bring fierce winds and torrential rain in the summer. These natural phenomena have damaged wind turbine blades and the collapse of many wind turbine towers in Taiwan, causing serious economic losses. This work examines the causes of these incidents and the mechanisms of turbine tower collapse and blade fracture to support risk prevention and the hazard-resistant design of wind turbines. Relevant domestic and foreign data are obtained to simulate wind turbine collapse. Next, mechanical analyses are performed using the finite element method to identify mechanisms of failure and structural weakness planes, with the ultimate goal of identifying possible causes of collapse. The structural mechanics of wind turbine blades are then analyzed using simulation models to identify the mechanisms of damage. Then, the root causes of strong wind-induced damage to, and collapses of, wind turbines are identified. Based on the results, methods for reducing the risk of such accidents are developed and solutions for improving the strong wind-resistance of wind turbine towers and their advantages are discussed. Recommendations concerning the use of weaker blades as a safety mechanism for a wind turbine tower, the torque capacity of the pitch system, and the required strength of joint bolts to be installed in steel structural connections, are made to help wind turbines and towers withstand severe storms. Hopefully, the analytical results of this study will help to prevent related engineering incidents in the future and provide a reference for stakeholders who must devise strategies to improve risk management and natural disaster prevention in wind power plants.

Keywords: Renewable Energy, Wind Turbine, Natural Hazard, Structural Failure, Forensic Investigation, Risk Management