

## Field survey of the impact of Typhoon 26 on the Sendai Coast (October 17, 2013)

Theme : Storm waves, storm surge, breakwaters, harbor

Location : Sendai Port, Arahama coast

IRIDeS faculty members Volker Roeber and Jeremy Bricker (Hazard and Risk Evaluation Research Division) visited the Sendai coast to observe the impact of storm surge and nearshore waves during Typhoon 26 (Wipha). At 11:00 near Sendai Shinko (port), the typhoon was offshore of the Northern Tohoku coast so that the wind came from the NW. The coastline near Shinko is oriented NNE, which resulted in a very offshore-directed wind. We estimated the wind speed at about 40 knots with locally higher gusts.

The offshore wind prevented the generation of local wind waves, meaning the approaching nearshore waves were generated offshore over the course of the typhoon. The wave formation was regular with wave face heights in the 4-6 m range. The surf zone was only about 200m wide, which might indicate that most nearshore sand bars had been eroded in the early hours of the storm. The breakwaters near the southern part of the harbor entrance as well as parts of the detached breakwaters offshore were frequently overtopped. However, no storm wave impact was directly visible inside the harbor basin, indicating that the breakwaters had been designed well for harbor protection. Nonetheless, it appeared ship operations were temporarily suspended. Further south at Arahama Beach, the wind had significantly subsided around 14:00, whereas the nearshore wave height looked fairly consistent. The waves overtopped the detached breakwaters made of tetrapods.

Wave runup reached the local dune in some areas around Shinko even though the tide level was not at its peak. At Arahama Beach, the runup went up to the gravel road on the beach that is located on dry sand during normal weather conditions. With a minimum barometric pressure of about 980 hPa in Sendai, it can be assumed that the barometric setup was around 0.3 m. Though the tide gauge record of Sendai harbor of Oct 16, 2013 indicates two significant peaks of the water level that were about 0.7 m above the predicted tidal elevation. The first peak occurred in the morning around 9:00 and might be attributed to the wind setup that had built up over night from the onshore-directed wind. The second peak is visible around 14:00. Even though the tidal elevation was slightly higher by that time, the wind setup had subsided drastically, since the wind had turned offshore later in the morning. However, it might be possible that the local wave setup compensated for large portions of the missing wind setup and hence generated another peak of the storm surge. The effects and impacts of nearshore waves is one of our major research topics.



(Left) Wave overtopping of the breakwater near Sendai Shinko. (Right) Wave overtopping of tetrapod-based breakwater near Arahama Beach. Local wave runup up to the gravel road on the beach is visible in the lower part of the picture.