

EFFECTS OF HURRICANE ALLEN ON BUILDINGS AND COASTAL CONSTRUCTION

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INTRODUCTION

The eye of Hurricane Allen crossed the Texas coast about 200km south of Corpus Christi during the early morning hours on August 10, 1980. The Institute for Disaster Research at Texas Tech University had dispatched a team of engineers and a meteorologist in advance of the storm to observe the storm in progress, and to record and evaluate the damage following storm passage. Significant observations were made which relate wind and storm surge to damage induced by these effects.

Two major buildings in Corpus Christi experienced extensive amounts of window glass damage: the 18-story Guaranty Bank Building, and a 12-story wing of Spohn Hospital. Window glass failures in these buildings are of interest because recorded wind speeds during the time period in which failures occurred were only 45 knots, gusting to 71 knots. In both cases, windborne roof gravel was a factor in causing window glass breakage.

Meteorology

The approximate center of Hurricane Allen is plotted with time in Figure 1, along with the average sustained wind speeds and peak gusts in knots. Hurricane Allen developed from a tropical depression in the mid-Atlantic on August 3, 1980 and moved west-northwestward, traversing the Gulf of Mexico. As the storm approached the Texas coast, the forward velocity decreased and the storm became nearly stationary before turning more northwestward near 5 p.m. (CDT) on August 9. The eye of the storm reached landfall near Fort Mansfield at 3 a.m. on August 10, with an estimated peak gust of 130 knots. The hurricane rapidly decreased in intensity and was downgraded to a tropical storm at 5 p.m. that evening.

The majority of the wind damage was confined to coastal regions mostly north of the storm track. Most of this area north of the eye is undeveloped land includes the sprawling King Ranch. Corpus Christi, Kingsville, Bishop, Alice, and several smaller communities experienced hurricane force winds.

Guaranty Bank Building, Corpus Christi

Substantial glass failure occurred at the Guaranty Bank Building in Corpus Christi (Figure 2). Witnesses who remained in the building stated that the majority of the glass failures occurred near 5 a.m. on August 10. Upon investigation, it was discovered that almost all the glass failures occurred on the windward (east and south) elevations and that the failures were caused by both missile impact and wind pressure (Figure 3). Extensive glass damage also occurred on this building during Hurricane Celia on August 3, 1970. Peak gusts recorded at the CRP weather service were 140 knots in Hurricane Celia and 80 knots in Hurricane Allen.

The 1/4 inch annealed (window) and heat strengthened (spandrel) lites were inserted into an "H" shaped molding which also received an aluminum "lip" from the window frame. Apparently, glass plate deflections were large enough to permit the lites to roll out of the molding or to fracture within the molding at the edge of the glass plate. Other fractures were caused by small missile impacts.

In regions where the glass lites were completely gone, roof gravel was found inside the building. This

evidence and missile impact marks on glass remaining in place suggest that missile impact also caused failures. Structures surrounding the Guaranty Bank Building include buildings about 20 stories high about a block to the east and south. It appears that roof gravel from the adjacent buildings were a contributing factor to window failures in the Guaranty Bank Building. Also, two buildings that are upwind are separated by approximately a 100 ft. corridor. During the hurricane, a police officer reported what could have been a standing vortex at the end of the corridor in front of the Guaranty Bank Building. It is possible that the acceleration of the wind through the corridor produced vortex shedding effects which contributed to the window failures.

Spohn Hospital, Corpus Christi

Spohn Hospital is located on the bayfront in Corpus Christi, with an open wind fetch to the east. Window glass failures occurred in this building from missile impacts. The failures were confined to a new, 12-story north wing (Figure 4). These windows consisted of tempered insulating glass units which were secured in an aluminum frame. In all but one case, only the outer of the two 1/4 inch lites had failed. Each failure originated from a single impact point and spread radially outward causing the patterns seen in the photograph. Evidence of roof gravel was found atop the 3-story roof below the window wall. Failures occurred on every floor. The roof gravel originated from an adjacent east-west oriented wing of the hospital. It is theorized that as the wind accelerated over the east-west wing from the east-southeast, roof gravel was lifted over a two-foot parapet and injected into the air-stream. The gravel then fell into the east facing windows at the north wing. There were no other sources of roof gravel in the vicinity of the north wing.

Storm Surge

Beach erosion was significant along the barrier islands which protect the Texas shoreline. From South Padre to North Padre and Mustang Islands, severe beach scouring was evident. Storm tides caused considerable damage to a seawall on North Padre Island (Figure 5).

Conclusion

Hurricane Allen afforded an opportunity to study behavior of buildings at wind velocities near design values. Different modes of window glass failure were also studied. Window glass failures at the Guaranty Bank Building could be attributed to a combination of glazing anchorage, missile impacts and wind pressures aggravated by local wind environmental effects. The roof gravel impacts and wind pressure failures were evenly distributed throughout the windward face. The glass failures at Spohn Hospital were due entirely to missile impacts from roof gravel. Even with a two-foot parapet, wind effects can lift the gravel into the air stream. Nearly four to six feet of sand were removed by scouring effects of the waves along the barrier islands.

ALLEN PAPER FIGURES

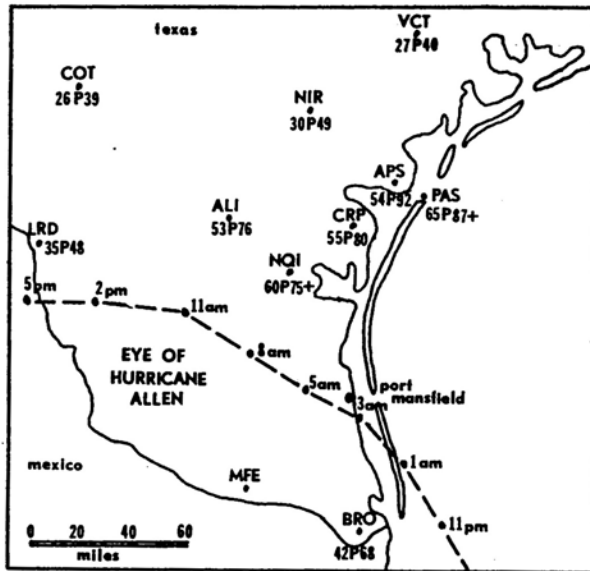


Figure 1. Positions of the eye of Hurricane Allen with the highest sustained wind speed and gusts in knots.



Figure 2. Many windows were lost at the Guaranty Bank Building during Hurricane Allen.



Figure 3. Window glass debris at base of Guaranty Bank Building.



Figure 4. Tempered insulating glass failures from roof gravel impact at Spohn Hospital.



Figure 5. Seawall on North Padre Island was severely damaged by wave action during Hurricane Allen.