Summary of June 24, 2012 Lake Placid Tornado

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Background

The June 24, 2012 Lake Placid tornado was one of eighteen tornadoes spawned on that same day by Tropical Storm Debby, a slow moving storm system that tracked across Florida, dumping over 20 inches of rain on some locations and spawning at least 22 confirmed tornadoes over the three day period of its impact, 18 of those coming on the 24th of June. While the majority of these tornadoes were relatively weak and short-lived, common characteristics of Florida tornadoes, several were strong enough to cause significant damage to homes within their paths. Figure 1 shows the paths of seven tornadoes, including the Lake Placid tornado (labeled [3]), that impacted the Southwest region of Florida. Local reports estimated that the tornadoes in Highlands County, which included the Lake Placid tornado, damaged 28 properties and caused at least $1.37 million in property damage [1]. According to multiple reports, the Lake Placid tornado touched down at approximately 3:23PM ET and remained on the ground for nearly 5 miles before dissipating around 330 PM ET. Figure 2 shows the approximate tornado path based upon the damage observations.

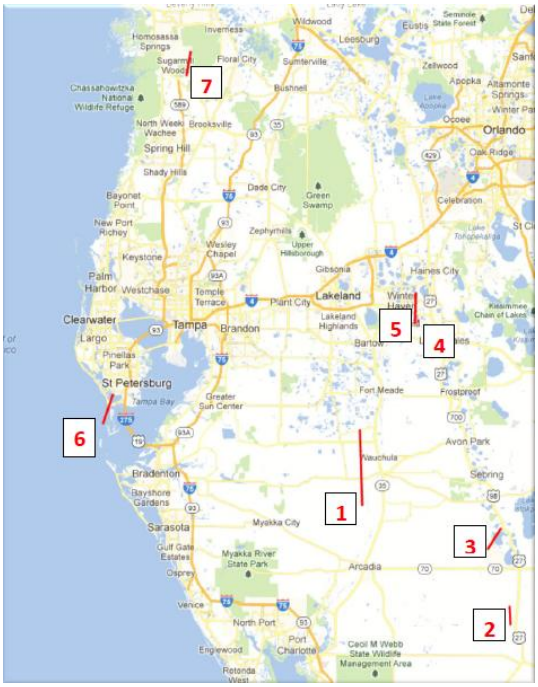

Figure 1: Florida Tornado Tracks, June 24, 2012

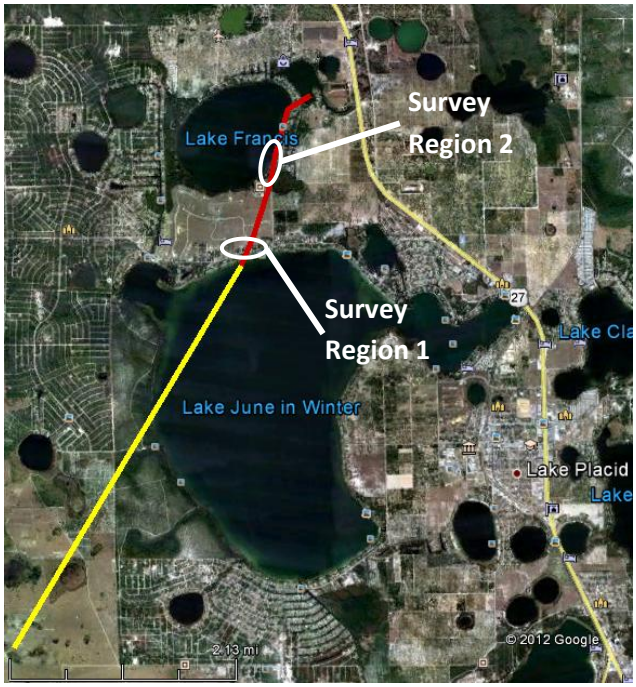

Figure 2: Close-up View of Estimated Tornado Track with Surveyed Portion in Red

The majority of the tornado track was over uninhabited regions and water but it did significantly impact approximately 10 homes between Lake June Rd and Cloverleaf Rd.

Survey Methodology

A team of graduate students from the University of Florida arrived at the scene at 10:30am on June 27th, three days after the tornado strike. The survey team first made a quick visual assessment of the region to identify the homes with the most damage. Surveys of each home were conducted as follows:

1) Contacted homeowner, if available, to obtain permission to survey and photograph the damage.
2) Interviewed owner or occupant to learn/confirmed age of original structure, pertinent information on construction materials, dates of additions, and to record their first-hand account of the tornado strike, and sequence of failure.
3) Photographs and hand-drawn sketches were used to capture the overall effect of the tornado on the house on all sides.
4) Video was taken of the entire home and surrounding areas to provide the "big picture" as well as include multiple angles and views in a more compact format than can be provided with still-shot cameras.
5) Details were noted or photographed, including key structural connection types, spacing of connections, evidence of wind direction, and sizes of structural members. These allow for more accurate back-calculations to estimate the wind speed and tornado intensity.

A variety of equipment was used by the survey team to capture the effects of the tornado on the various structures. These included the following:

- Sony DSC-HX9V GPS-enabled cameras
- Sony HDR-SR12 Super SteadyShot HD video camera
- Damage survey sheets
- Notebooks
- Measuring Tape

The photo locations and directions are shown for Lake June Rd and Cloverleaf Rd in Figure 3.

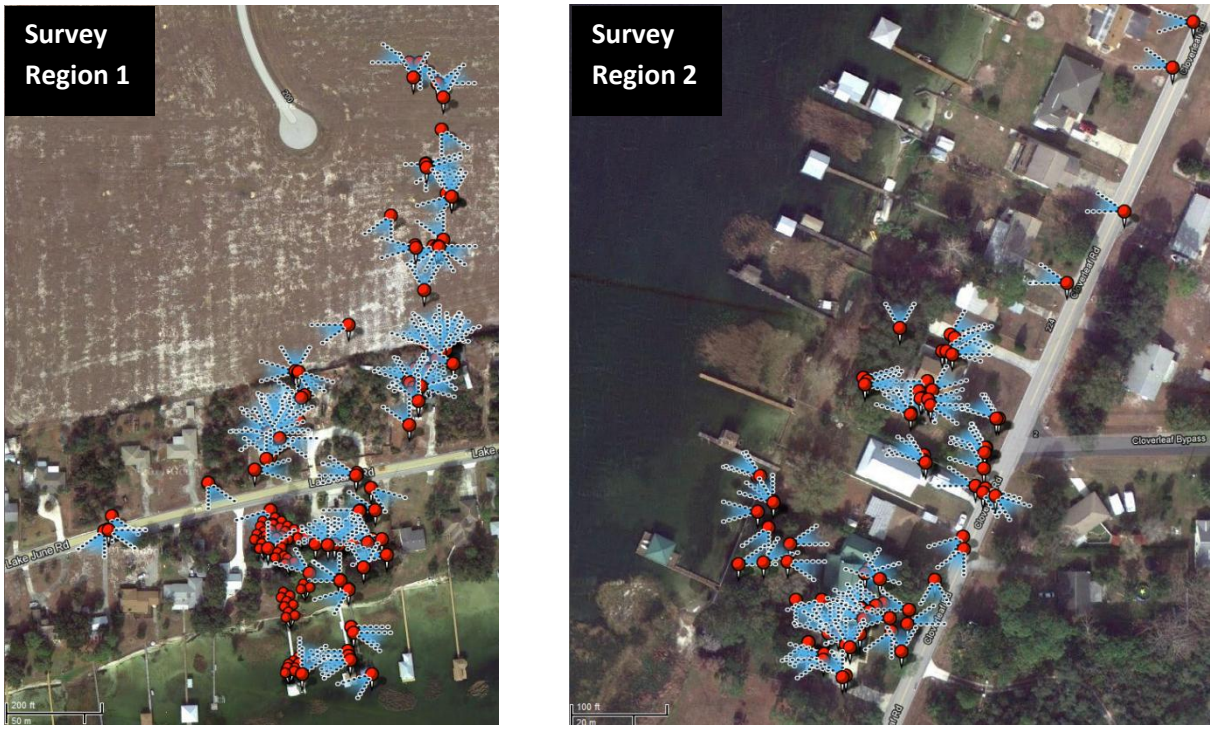

Figure 3: Locations and directions of photos taken during damage survey

Analysis

Each of the surveyed homes were assigned a DOD rating using the recommendations of the EF Scale [2]. These DOD ratings were then used to estimate the wind speed necessary to cause the observed damage, taking into consideration the construction quality of the home and other factors such as tree damage. The EF rating is then assigned based upon the wind speed estimate. Figure 4 shows the location of each home surveyed and the assigned EF rating.

Survey Region 1 - Lake June Road Survey Region 2 – Cloverleaf Road

Figure 3: EF Ratings for Surveyed Homes (no rating indicates no damage was observed)

EF Ratings were assigned using the recommendations of the EF Scale and the included Degrees of Damage. The following Degrees of Damage were observed, leading to the EF ratings assigned.

DOD 1: Threshold of Visible Damage

Minor damage such as loss of a few shingles but no evidence of any further damage.

DOD 2: Loss of roof covering material (<20%), gutters and/or awning; loss of vinyl or metal siding

A few homes were observed which had relatively significant roof covering loss together with other minor damages, such as metal edge flashing, gutters, etc.

DOD 3: Broken glass in doors and windows

Several homes observed with broken glass. The picture to the right is in the garage door of a home off Cloverleaf Rd. Larger windows with broken glass were also observed, for the most part in walls facing the direction of the tornado's translation.

DOD 4: Uplift of roof deck and loss of significant roof covering material (>20%); collapse of chimney; garage doors collapse inward or outward; failure of porch or carport

Loss of roof deck was observed in several homes, including one which had been fastened with 4d nails in a 6:6 nailing pattern. Metal roof decking had also failed which had been fastened with #4x1-1/2" screws every 8" laterally and every 24" longitudinally.

DOD 7: Top floor exterior walls collapsed
DOD 8: Most interior walls of top story collapsed

This condition observed in one home which suffered significant structural damage to the top floor and the roof of the single-story portion. Conversation with the homeowners confirmed that it was not trees which caused the damage. Connections of the walls to the floor were made with nails only however, so a lower-bound wind speed estimate is recommended for this DOD.

DOD 9: Most walls collapsed in bottom floor, except small interior rooms

Conversation with the homeowner and neighbors indicated this DOD may have occurred to one home but no pictures were available as further evidence. The surveying team took this picture upon arrival, but as can be seen the debris-cleanup was already in progress so the original state of the home could not be ascertained. Debris from this home though, including a complete, approximately 20' long truss, was found over 300 feet from the home location.

Case Studies

Address: 832 Lake June Rd	DOD Rating: 7
Structure Use: Single Family Residential	Wind Speed Estimate: 132mph
Year Built: 1960	EF Rating: EF2
This two-story single-family home was originally constructed in 1960, but garage and second floor were additions built in the 1970s. Original structure was CMU block with wood rafters forming essentially a monoslope roof constructed from 2x8 wood beams. Second story roof was also monoslope using rafters. Second story walls were constructed using 2x4 wood studs and plywood sheathing.	
	Original view from Google StreetView, clearly showing the flat roof original portion and the added gabled second story.

	Overview of house showing damage to second story, including removal of roof and collapse of exterior and most interior walls in second story. Only the interior walls of a small bathroom upstairs remained intact. Large sections of roof were carried approximately 50ft over into a neighboring yard.
	Rear view of house showing debris impact on rear exterior wall and roof failure over first and second stories. Nearly all windows on back side were broken. The small portion of exterior wall remaining formed one wall of a small interior bathroom, where the multiple perpendicular walls in close proximity likely provided adequate lateral bracing allowing it to stay standing.

Address: 832 Lake June Rd	DOD Rating: NA
Building Use: Boat House	Estimated Wind Speed: TBD
Year Built: Unknown	EF Rating: TBD

This boat house was on the lake behind the 2-story home damaged at the address above. Conversation with the homeowner and personal observations indicated that the boat house was a partially covered wood-frame structure with partial metal roofing. A sketch of the general roof plan is given below and was validated by the homeowner. Columns consisted of round 6” wood posts set in the lake bottom. Roof framing consisted of (2) wood 2x8’s bolted to the posts on the exterior and nailed to the posts on the interior. Exterior bolts were ½”Øx14” long with rounded heads. Interior nails connecting 2x8 beams to posts were 0.25”x4”. Hurricane straps were present on the right side of the structure for each rafter. On the left side a few straps were present near the front of the structure but none on the rafters, however this area was not accessible enough to determine what type of connection was used. Failures were clearly visible on the right side connections. The outer 2x8 split above the anchor bolts at the back connections, breaking the load path from the hurricane straps to the posts. In the front connections, two hurricane straps failed in tension at the center of the strap. The other straps likely failed through nail withdrawal but no nails remained in the straps and there was no indication that the nails pulled through the straps. Therefore either the nails fell out after the strap was separated from the rafter or were never installed in the first place. If the latter case was true the lack of a connection in those places likely accelerated the failure of the correctly installed straps.

Overview Picture of Boat House

Failed roof-to-wall strap connections and split spandrel on right side

Failed hurricane strap at right-side spandrel

Sheared hurricane strap on left interior spandrel

Address: 819 Lake June Rd	DOD: 7
Year Built: 1972	Wind Speed Estimate: 130mph (low confidence)
Building Type: Single Family Residential	EF Rating: EF-2

Summary: This home was purchased by the homeowner in the early 1980's for $57,000. It was a wood-frame house built onto a CMU block stem-wall with grouted cells 8' O.C. Workers were already cleaning up debris from the home by the time the assessment team arrived but from discussion with the homeowner and the workers there was very little remaining from the house after the tornado had passed through. Debris from the house, including a complete 20' truss, were scattered several hundred feet further in the path of the tornado. From analysis of the remaining debris the house appeared to be poorly built. The only foundation anchorage consisted of metal straps embedded in the concrete footing of the stem wall and screwed to one side of the sill plate with two small screws. There were no anchors in the grouted cells. Some metal straps were visible but they only appeared to be used at the corners and were anchored through the ground to the stem wall foundation. Trusses were toe-nailed with (3)8d nails. No indication as to how corners were connected.

Adjacent to the house was a large workshop constructed out of 6x6 wood columns at 8' O.C. anchored to a concrete slab with wood purlins overlaid with metal sheathing. The wood purlins were fastened to the columns with (4) 3" long nails. Three of the four walls were totally collapsed, largely due to the shattering of the wood columns at the base along the front wall perpendicular to the path of the tornado. Fracture of wood purlins was also observed in multiple locations.

Original View from Google StreetView

Only Stem Wall Remains of the Original House

Only Back Wall Remains from Adjacent Workshop

Fracture of Post Anchored Concrete Slab

Address: 831 Lake June Rd	EF Rating: EF1
Year Built: 1982	DOD: 4
Building Type: Single-Family Residential	Wind Speed Estimate: 85mph

This 2211 square foot home consisted of a gable roof structure and 2-car garage at the front of the street. Walls were constructed of CMU block with unknown reinforcement. The roof consisted of wood trusses, plywood sheathing and asphalt shingles. The home experienced minor roof damage including the loss of approximately 200 square foot of roof sheathing and shingles. The garage door was blown inward and separated from its track. The support frame, consisting of wood 2x6's, for the garage was detached from the CMU wall on one side, but close inspection revealed that while ½" diameter bolts were used to fasten the frame to the CMU block, no nuts or washers were used to close the connection, allowing for failure at minimal wind speeds. Approximately 6-8ft of soffit was missing or damaged and a window shutter was disconnected from the wall. No broken glass or other damages were observed.

Overview of House from Street

Roof Sheathing Failure

Garage Door Failure

Garage Door Frame with Bolt Missing Nut

Address: 218 Cloverleaf Rd	EF Rating: EF1
Year Built: 1981	DOD: 4
Building Type: Single-Family Residential	Wind Speed Estimate: 97 mph

This 2269 square foot gable home was built to South Florida Building Code standards. The homeowner was originally from Miami and when he moved from there to have this home built, he directed the builders to use the much more stringent Southeastern Building Code rather than the Central Florida Building code that was in existence. Because of this the construction quality of the house was above average. The walls were constructed of reinforced concrete. A wood top plate was bolted to the concrete wall with ½" bolts and 1" washers every 4' O.C. Wood trusses were fastened to the top plate with metal hurricane straps, although it was noted that some hurricane straps only used three nails. A vent along the entire ridge of the house was provided by means of an approximately 3" gap in the sheathing at the ridge joint. Structural damage to the house was relatively minor at first glance. Approximately 30% of the roof sheathing had been lost and the garage door had buckled inward. However the failure of the sheathing led to the ingress of large quantities of water into the interior, which consisted of mainly wood paneling. As a result the economic impact of the structural failure was substantial.

Original View from Google StreetView

Post-tornado View from Damage Survey

Hurricane Strap with only three nails

Ridge Vent provided by gap in sheathing joint

References:

[1] P. Agarwal, "Florida Tornado Damage: $1.37 Million," in *Highlands Today*, ed. Sebring, FL, 2012.

[2] J. McDonald and K. C. Mehta, "A Recommendation for an Enhanced Fujita Scale," 2006.