hurricane katrina

Katrina: Wood-Frame Damage Assessment

Preliminary Observations

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A team, consisting of three university scientists and two industry professionals, surveyed the structural wind damage to the wood-frame buildings caused by Katrina. For three days, the team toured the towns of Gulfport, Biloxi, Diamondhead and surrounding communities in Southern Mississippi. They observed structural wind damage can be summarized as follows:

The majority of the failure can be attributed to inadequate connection at critical locations that created a discontinuity in the load path which ultimately resulted in the structural failure. Inadequate connections were found at truss to top plate, sheathing nailing, post to top plate (or beam) and foundation. *Figure 1* shows a porch overhang which collapsed due to lack of connection between the columns supporting the porch and the foundation. Since the porch was tied back to the roof diaphragm, collapse of the porch resulted in breaching the roof envelope. This caused wind-driven rain to enter the house, and resulted in water damage inside the home. This story was repeated time and again where a small connection detail resulted in breaching the building envelope (roof or wall) resulting in wind-driven rain entering the building, causing the loss of ceiling gypsum wall boards and the contents of the house. *Figure 2* shows a similar type of failure for a carport.

Figure 1: Porch overhang collapsed due to poor anchorage between columns (white) and foundation

Figure 2: Carport collapsed and structure breached

Figure 3a shows the loss of a complete roof, mainly due to roof truss to top plate connection failure. Apparently trusses were connected to top plate with hurricane clips but only one or two nails were used to connect to the top plate instead of four (as shown in *Figures 3b* and *3c*, respectively). Fortunately, this gable roof was built later on a flat roof. The flat roof survived, preventing water damage.

Loss of roof sheathing at corners and edges was observed in several buildings (*Figure 4*). This was probably due to the high suction pressure at discontinuities (edges and corners), which is consistent with the ASCE-7 wind load calculations. In these areas, the nail spacing was more than the minimum-code required. Either the minimum code-required nailing for conventional construction (for areas where wind speed is less than 110mph) or properly designed nail spacing for higher wind speed zones would have prevented this type of failure.

One of the common types of failures was loss of non-structural, foam-substrate, insulation sheathing panels at the gable-end walls (*Figure 5*). This was probably caused by air entering through blown up vents and creating a balloon effect in the attic. This blew out a few foam sheathing panels of the gable end wall (structural wood panels remained intact at these locations). This allowed water to get into the attic, resulting in wet insulation and ceiling drywall. Once attic insulation and ceiling drywalls were saturated, the whole ceiling collapsed due to its weight resulting in significant water damage to the contents of house. This is probably the single most common economic loss (which is non structural) from a hurricane, along with damage due to storm surge. In one subdivision, extensive damage was caused by failure of vinyl siding and foam sheathing panels, resulting in extensive damage to the interior (and contents) of the house. In most of these homes, structural wood panel siding remained intact. It is recommended that the whole house (all walls plus roof) should be sheathed with structural wood panels with code-required nailing requirements, to prevent future losses.

Figure 4: Roof sheathing damage at the corner of a roof, fastener spacing was in excess of the code minimum

Figure 3a: Multi-family condominium roof collapse

Figure 3b: Truss to top plate connected using hurricane strap but only one nail instead of four nails

Figure 3c: Truss to top plate connected using hurricane strap but only two nails instead of four nails

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Figure 5: Non-structural, foam-substrate, insulating sheathing panels failed at the gable end