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Sent: Monday, October 19, 2009 12:40 PM

To: structuralsafety@nist.gov

Subject: Comments on Draft NIST Report on Cowboys Practice Facility

Hello,

I have the following comments on the Draft NIST Report on the Dallas Cowboys Practice Facility:

1. The report emphasizes a reliance on the fabric to provide lateral bracing for column stability of the top chord. I agree with this conclusion as there are no documented tests or literature that suggest that the type of fabric used has either adequate stiffness or reliable strength to provide bracing. Detailed analytical evaluations of frame and membrane structures confirm this. However, the emphasis on the bracing aspect misses a larger design issue, which is the lack of design of the top chord for any horizontal bending moments. Such moments would arise from the unbalanced horizontal component of the fabric membrane in-plane force (note this is much higher than the applied vertical component) due to pattern loading on adjacent fabric panels, or could result from a tear in a fabric panel on one side of an internal truss frame. It is good engineering practice to design for unbalanced horizontal loading on a top chord resulting from the tear case under some form of "extreme event" load combination. This is unfortunately not widely followed in practice, but is consistent with the spirit of Section 1.4 "General Structural Integrity" of ASCE 7-05. Likely if the truss chords had been sized for horizontal bending they would have been of adequate proportion to function as a compression member between cable brace points.

2. The report comments that the building should have been designed as partially enclosed rather than fully enclosed based on the extent of openings. While the statement made on page 41 regarding door openings is debatable, consideration should also be given to the potential for internal pressure changes resulting from tears in the fabric membrane skin. Often such membranes are treated as non-structural covers and not explicitly designed, but reliance on the integrity of the enclosure has a large influence on the total wind design pressures on the building frame. In my opinion the consequences of

breaches in the enclosure likely have a larger influence on the sequence of collapse than is addressed in the draft report.

3. As discussed above the potential for tears in the fabric can lead to significant design issues. Fabric tearing is not a well understood phenomenon, and is currently not an explicit design consideration when evaluating fabric design (reference draft ASCE tensioned fabric structures standard). As a result, many common structural fabrics in use today have relatively low tear strengths as compared to their tensile strength. This area needs more research to better develop appropriate design methods.

4. Figure 5-3 indicates a pattern of reactions from fabric membrane preloading applied to the frame. These appear to have been derived from hand calculations based on the fabric curvature. It is unclear whether a proper large displacement nonlinear fabric analysis was done by either NIST or the original designer for either prestress or applied loads. Even for what seem like relatively simple structures like this, fabric behavior can be quite complex and should be explicitly evaluated. The NIST analysis appears to include only the self-equilibrating horizontal loading under prestress, and does not account for the potentially significantly higher horizontal loads that would be imparted on the steel frame with the membrane under full wind or live load. It is also unclear whether the fabric membrane stress limits under load were evaluated by the original designer.

5. The report does not appear to address whether the cable bracing system was adequate for local chord compression member bracing or global frame bracing. Stability of roof truss systems is a complex subject that is not well understood. A proper evaluation would generally include an eigenvalue buckling analysis of the full system, and more detailed studies of modes identified as critical in the buckling analysis. This particular system is somewhat more complex due to the potential for non-linear behavior (slack/not slack) in the cable braces. It is unclear whether the cable braces were prestressed in any way.

The October 6, 2009 press release mentions that "NIST will brief and provide technical support on the recommendation to the American Society of Civil Engineers (ASCE) committee currently developing a building standard specifically for tensioned fabric structures." I would recommend that NIST also engage the ASCE SEI Progressive Collapse Standards and Guidance Committee of which I am a member as well as several of the NIST staff, including H.S. Lew and Fahim Sadek. Also, Dr. Todd Helwig at the University of Texas at Austin is currently conducting the only significant research on truss bracing of which we are aware, and his recent findings may help lead to a better understanding of the truss stability issues seen in the Cowboys Practice Facility collapse.

Please do not hesitate to contact me if you have any questions on the above comments.

Best Regards,

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