2012 Benghazi Attack: Development of a Forced Entry and Ballistic Resistant Louver

MAE 3195/3196 Project and Report
Spring 2013

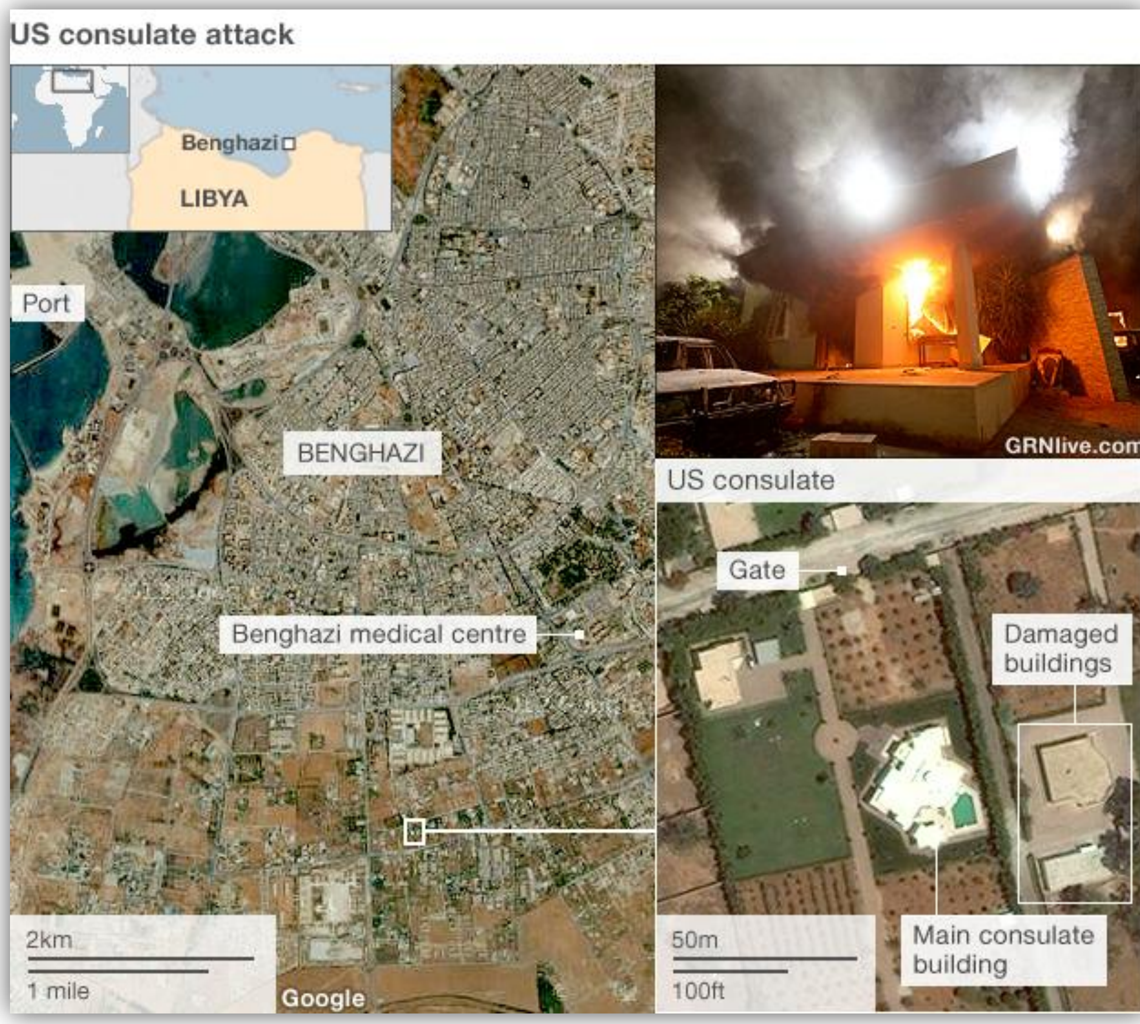

Figure 1: The Benghazi Embassy complex, showing size and location of attacked buildings

For this Project, we will consider the technical aspects associated with the protection of US Embassies and Consulates abroad. The infiltration of the US Consulate in Benghazi on September 11th, 2012 by hostile forces has shown the importance of proper security measures to ensure the safety of the US diplomats held within. Specifically, we will examine the Forced-Entry and Ballistic Resistant Louver (FEBR Louver), and attempt to understand the failure mechanisms of this system through FEA, optimization, video creation, and sensitivity analysis.

Background

On September 11th, 2012 the American diplomatic mission at Benghazi, in Libya, was attacked by a heavily armed group. The attack began during the night at a compound that is meant to protect the consulate building. A second assault in the early morning the next day targeted a nearby CIA annex in a different diplomatic compound. The hostile forces used a combination of weapons to infiltrate the compound, including rocket-propelled grenades, hand grenades, assault rifles, 14.5 mm anti-aircraft machine guns and artillery mounted on gun trucks, diesel canisters, and mortars. Four people were killed, including U.S. Ambassador J Christopher Stevens. The ambassador was suffocated by the inhalation of smoke, as were those around him. Ten others were severely injured. The attack was strongly condemned by the governments of Libya, the United States, and many other countries throughout the world (Wikipedia, 2013).

Typical protection measures of U.S. embassies and consulates have been increased since the 1979 seize of the U.S. embassy in Tehran, Iran, in which 52 U.S. citizens were held hostage for 444 days. These protection measures enacted thereafter, dictated by the federal government, require various levels of protection based upon the occupancy of each floor and office space within these secure environments. Any secure area within requires stringent measures for building equipment, such as heating and cooling systems, plumbing, electrical and telecommunications systems, which pass in and out of the secure area. These measures ensure blast resistance and acoustic dampening, such that any hostile force attempting to infiltrate or obtain information from these areas, according to clearly defined criteria, are minimized. Specific to the MAE 3195/6 project, penetrations including ductwork and passages to and from these areas require 60 minute forced-entry and ballistic resistance (FEBR) measures. This stipulation ensures that U.S. citizens held within these facilities are given protection, as well as adequate time to respond to hostile efforts attempting to cause harm to these citizens. Figures 2 and 3 show a FEBR Louver made by Norshield.

A field of research has been developed to analyze such systems; the analysis of explosions and their effects on buildings is termed “blast analysis”. This field is relatively up-and-coming, and is of great interest to owners and designers of high-profile structures. Blast analysis is useful for various types of buildings, including embassies, public transit centers, and hotels. Blast analysis aims to ensure the safety of the building’s inhabitants, as well as ensure that the occupants have time to respond to hostile actions.

Explosions generate a shock wave (a high-pressure front propagating outward from the point of detonation) that has a pressure that decays with distance. The effect of pressure acting on the surface of a structure has a typical pattern, as shown in Figure 4, which involves a positive pressure period followed by a negative pressure period.

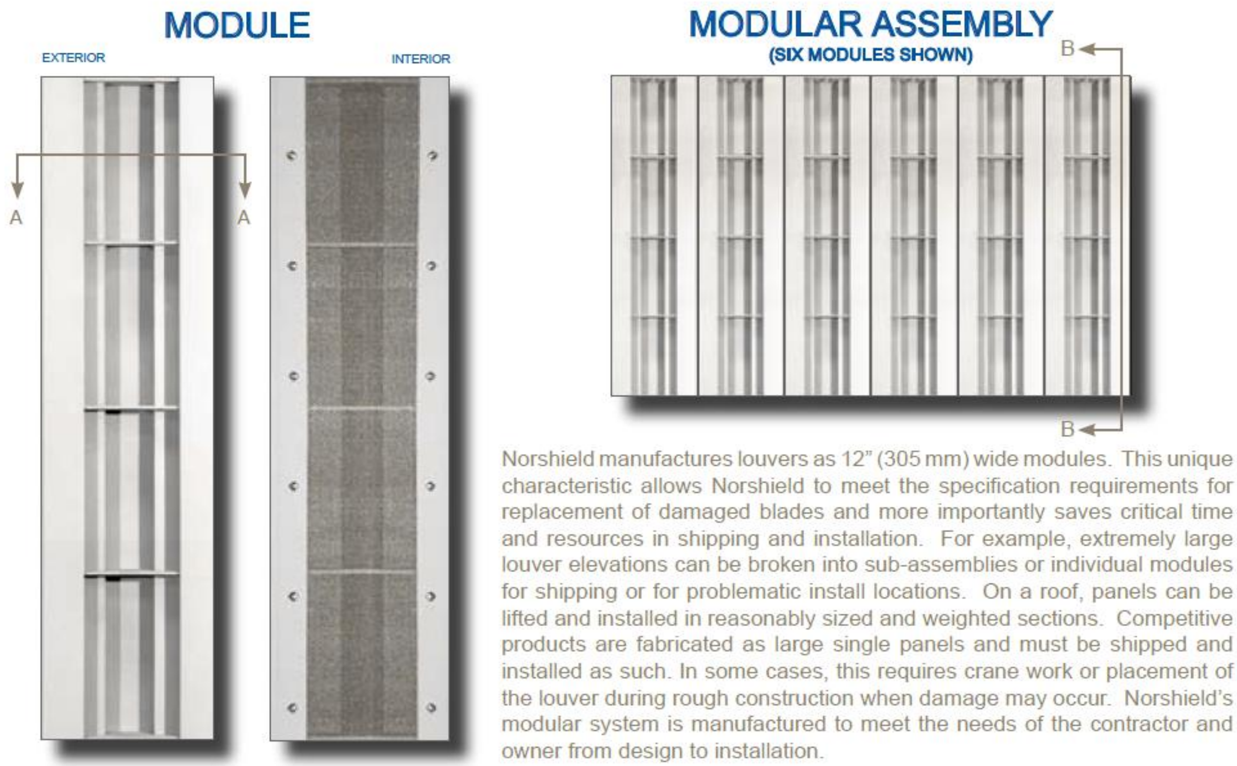

Figure 2: Exterior and interior views of the Norshield FEBR Louver

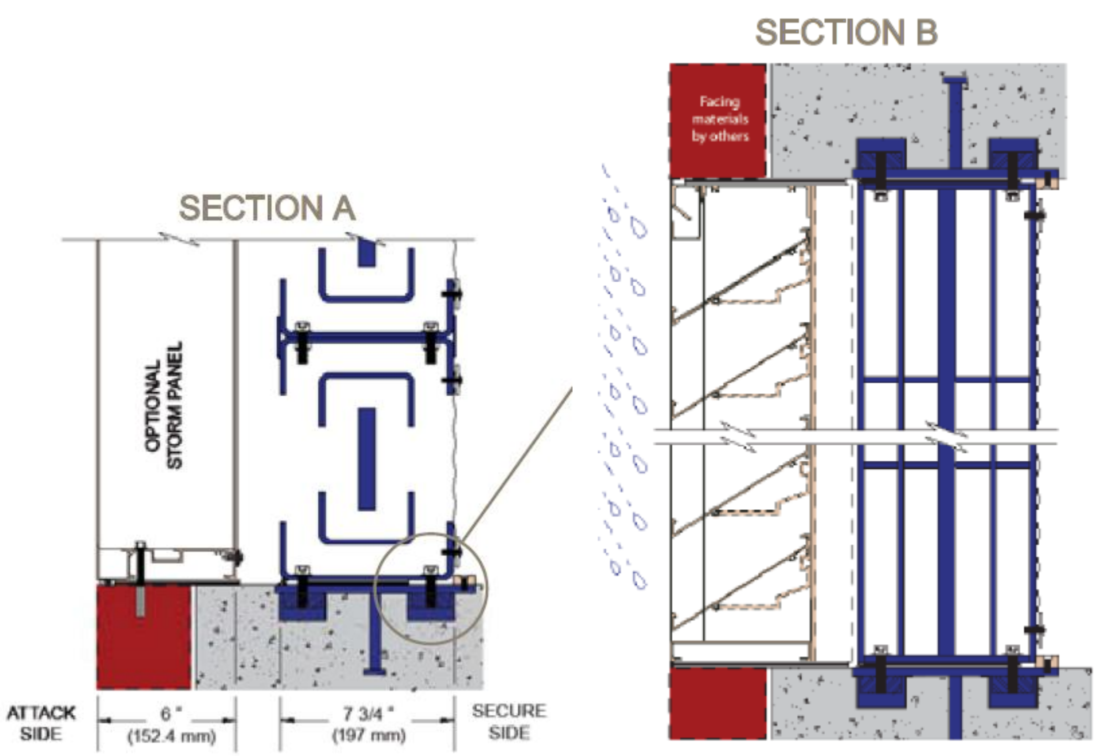

Figure 3: Sections A and B of the FEBR Louver

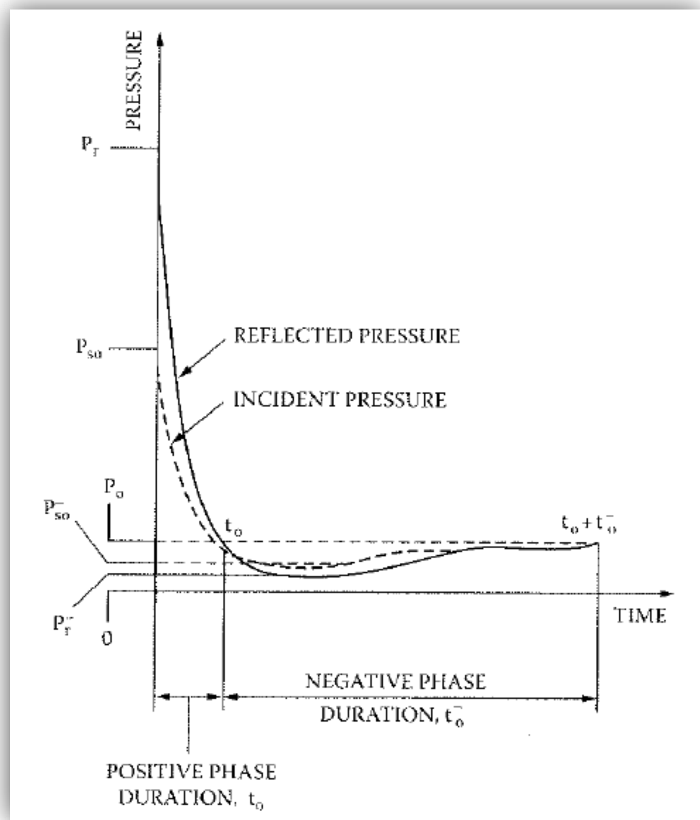

Figure 4: Pressure effects on a structure as a function of time

Blasts that occur directly adjacent to buildings have a pressure distribution as shown in Figure 5, where the transmitted pressure to the surface is greatest at the center and reduces with distance. At sufficient distances the pressure distribution becomes linear.[1]

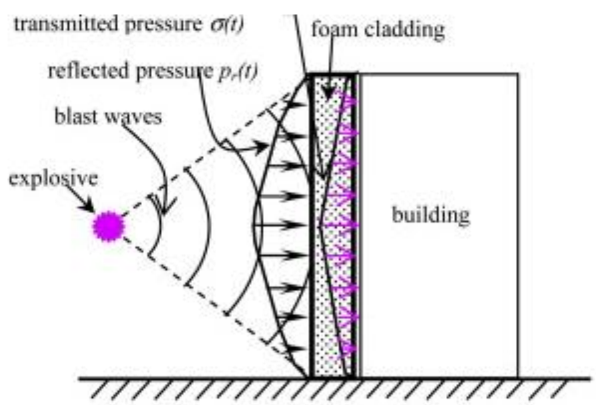

Figure 5: Typical pressure distribution

[1] Krauthammer, Theodor: Modern Protective Structures, 2008. CRC Press.

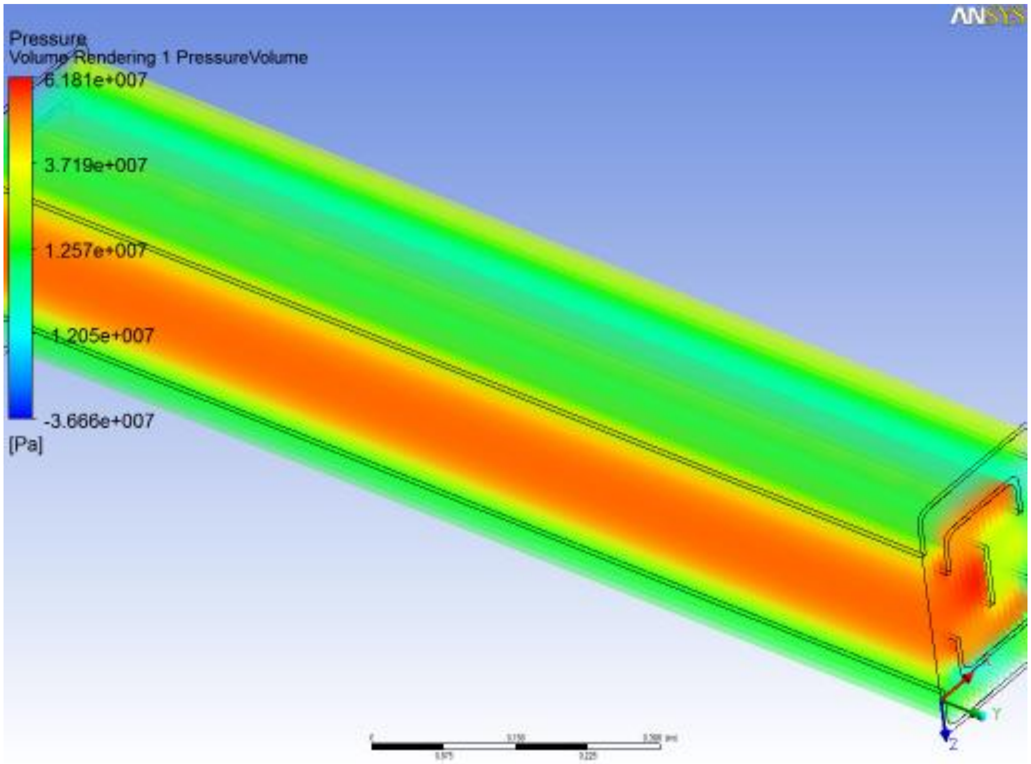

Figure 6: Pressure distribution of air volume within louver

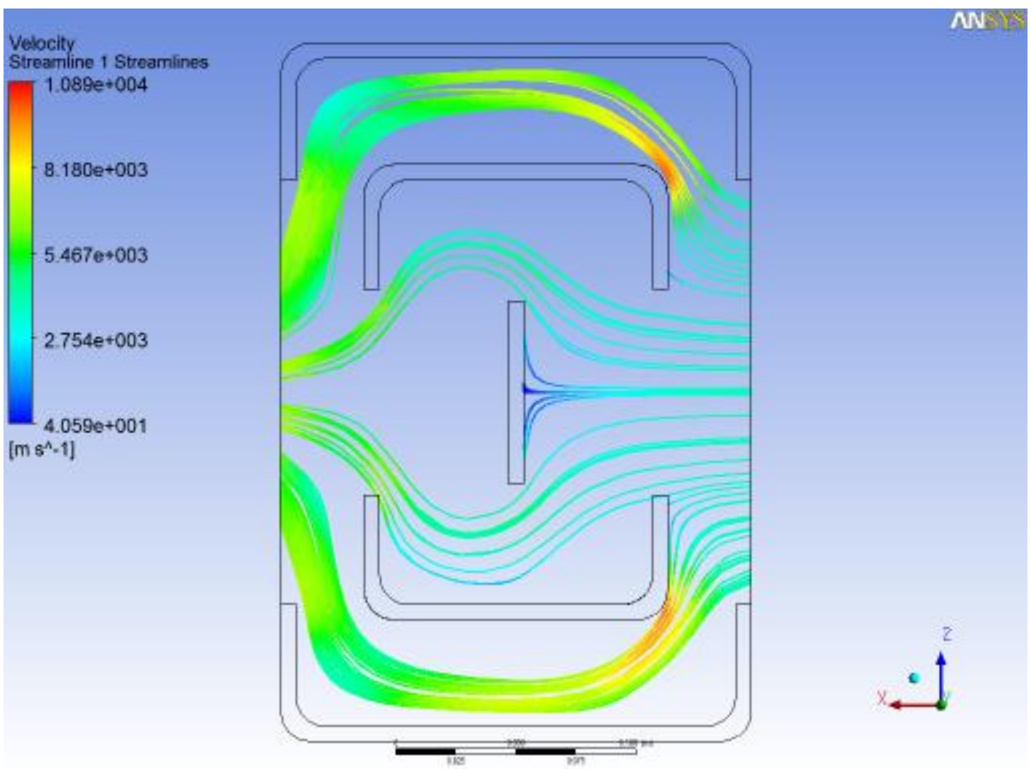

Figure 7: Velocity of streamlines within louver

Overview

The main objective of this project is to demonstrate your proficiency in using the computer aided engineering methods and tools taught in MAE 3195 and/or MAE 3196. A contemporary issue has been selected and defined so that the student can focus his or her efforts on obtaining a unique solution to the problem.

As part of your term project, you are required to:

1. Construct a 3D parametric, feature-based solid model assembly of the Norshield FEBR Louver and storm louver, with geometry that mimics what is shown in Figures 2 and 3 (**Consisting of at least 5-10 individual parts**). As shown in Section B of Figure 3, a storm louver is typically placed in front of the FEBR louver to keep out weather and to shut the opening as required. This louver is an active device that can be remotely opened or closed on demand. Using a geometry of your choosing, you must design a storm louver that reduces closes off the opening, while minimizing the obstruction of the free area when in the open position.
    a. There should be at least one inch of vertical clearance between each component as seen in Fig. 3 Section A.
    b. Assume height of the FERB Louver is 50 inches as seen in Fig 3 Section B.
    c. From the front view, there should be no clearly open sections of the FERB Louver. This is to prevent projectiles from passing through the security wall.
2. Produce a video showing the movement of the storm louver; the video should show movement of the blades starting from an open position and ending in a fully closed position.
3. Analyze the FEBR louver using FEA the following design criteria:
    a. A static pressure distribution on the appropriate faces of 1000 psi.
    b. A pressure distribution on each appropriate face corresponding to a normal (sinuous) distribution 20 inches in diameter with a max pressure of 1000 psi.
    c. A static pressure distribution on an appropriate face corresponding to the impact of a 9mm handgun bullet.
4. Perform an optimization or a sensitivity study to select the best dimensions for the FEBR louver.
    a. Wall thickness of any component should not be less than 1/8 inch.
    b. Minimize mass for each of the pressure distributions while maintaining no more than 0.5 inch deflection.

Report

At the completion of your project, you must submit a set of presentation slides that documents your results. The presentation should include text, equations, tables, and figures as needed to explain and report the details of your project. The following outline is recommended:

1. Introduction:
    a. Describe the purpose of the study, explain briefly the approach, summarize the results
    b. Include assembly views such as isometric, cross-sectional and/or close-ups. An exploded view may also be useful.

2. Parametric design: **Which dimensions did you decide were critical in the development of the design, and why? How do these dimensions relate to design intent?** Describe the construction of your parametric geometric models. It is suggested to use:
    a. Drawings identifying the parameters and dimensions.
    b. Tables of parameter values, including the ranges over which these parameters were allowed to vary.
    c. Images of the geometry at different parameter values.

3. Finite element model:
    a. Justify the simplifications used for the FEA, (e.g. symmetry).
    b. Explain how the mesh and density of elements are controlled.
    c. Describe the element types, loads, boundary conditions.

4. Convergence: demonstrate the convergence of the Finite Element Analysis. Possible methods are:
    a. Stress contours.
    b. Plot of metrics as functions of P-pass.
    c. Fringe plot of P-order.

5. Animation: an animation demonstrating the functionality of the system

6. Results of analysis: describe exemplary results of the analysis used as a basis for sensitivity study/optimization. These results can be displayed as:
    a. Images
    b. Animations
    c. Plots
    d. Tables of values

7. Optimization (or Sensitivity study): describe the how the optimization problem was formulated and its results. These results can be displayed as:
    a. Images
    b. Plots
    c. Tables of values

8. Conclusions: concisely summarize the approach and results

9. Your final report will then be uploaded to blackboard, <u>**ALONG WITH THE ASSOCIATED PROE FILES!**</u>