RETROFITTING THE INSTALLATIONS AGAINST MAN-MADE HAZARDS

Analysis and simulation using the AUTODYN simulation package

EHAB HANAFI MAHMOUD*
AMR IBRAHIM FAYID**

ABSTRACT

In the light of recent terrorists bomb attacks on facilities throughout the world, planners, architects and engineers are beginning to re-visit conventional approaches in the design of high-security facilities. Increasingly, existing the stratigic installations, such as the airport installations, are being protected to survive a limited threat. These action is essential to mitigate the hazardous effects of explosions and impact. Important facilities are made to a generally higher degree of robustness than conventional installations.

One of the greatest threats from a terrorist bomb attack comes from fragmentations pieces of walls, windows, fixtures, and equipment flying at high speeds can result in extensive injury and death. A key tactic to defeating this threat is to ensure the exterior wall of a building can survive the bomb blast without breaking apart and contributing to the fragment problem. The usual approach is to add strength and mass to the wall- to “beef” it up, usually with concrete and steel. Such “fortress” approaches are difficult to implement, time-consuming, and prohibitively expensive. An easier, less expensive, and lighter weight solution was needed so this paper looking for ways to introduce ductility and resilience into building walls.

This paper presents the findings from a programe of research, which explores the opportunities offered by an effective an elastomeric polymer coating to prevent fragmentation from concrete structural elements. A group of scenarios simulated and examined by analysis the concept of using new protection techniques, as assessed using the **AUTODYN** softwear simulation package in 2D & 3D V4.1.17.

Keyword

Architecture, Protection, Blast, Structure, Hazard.

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* Permanent staff (PhD) - Architecture Department. Military Technical Collage – Cairo, EGYPT
** Permanent staff (PhD) – Weapons and Ammunitions Department. MTC – Cairo, EGYPT

INTRODUCTION

In 2003, Mahmoud, E. H. [1] explored a class of structure’ elevation with convex elevation technique. This structural form offered a significant reduction for impulse and pressure values, attractive facades and, potentially, good protection levels. This façade will be covered by the elastomer material as an external coating.

The elastomer material is a highly ductile polymer that can be sprayed onto building surfaces. Recent tests indicate [2] the coating applied to the interior surfaces of a lightweight portable building can offer protection for occupants against an explosive charge at a relatively close distance. The polymer bonds to the wall forming a tough elastic skin. Although structural failure of the supporting walls does occur, the elastomer material remains intact and contains the debris.

REFERENCE SCENARIO

The Reference scenario, with which all simulations will be compared, is an explosion in front of a structure. The AUTODYN simulation package 2D & 3D V4 [3] was used to evaluate the pressure and impulse values on the structure and the ConWep program [4] validated these values.

Parameters and limits of simulations

Several scenarios were prepared to represent typical geometries, taking into consideration the following variables: [Figure 1]

1. Distance of the structure from the blast.
2. Target structure height.
3. The convex elevation configuration.

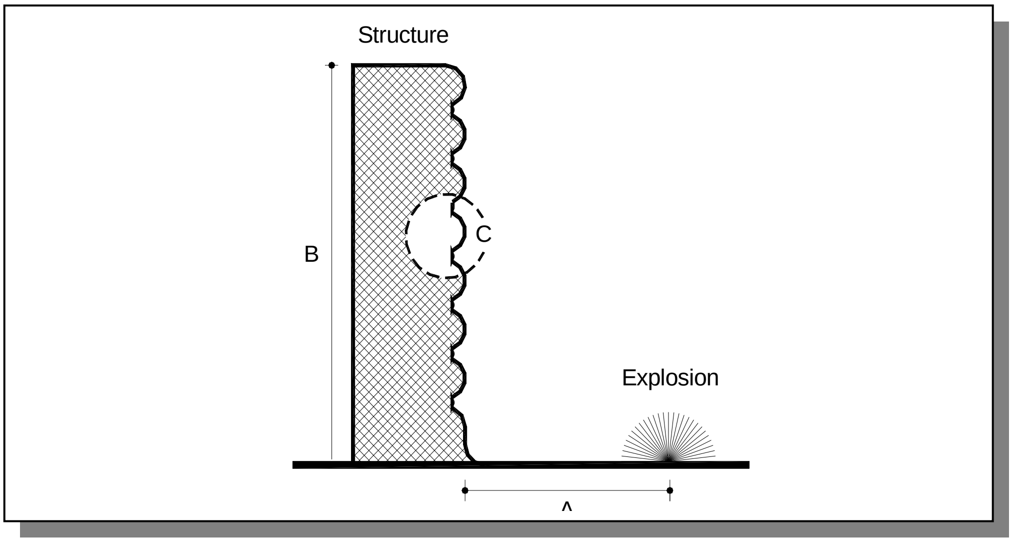

Fig. 1 Parameters and Limits of Simulations.

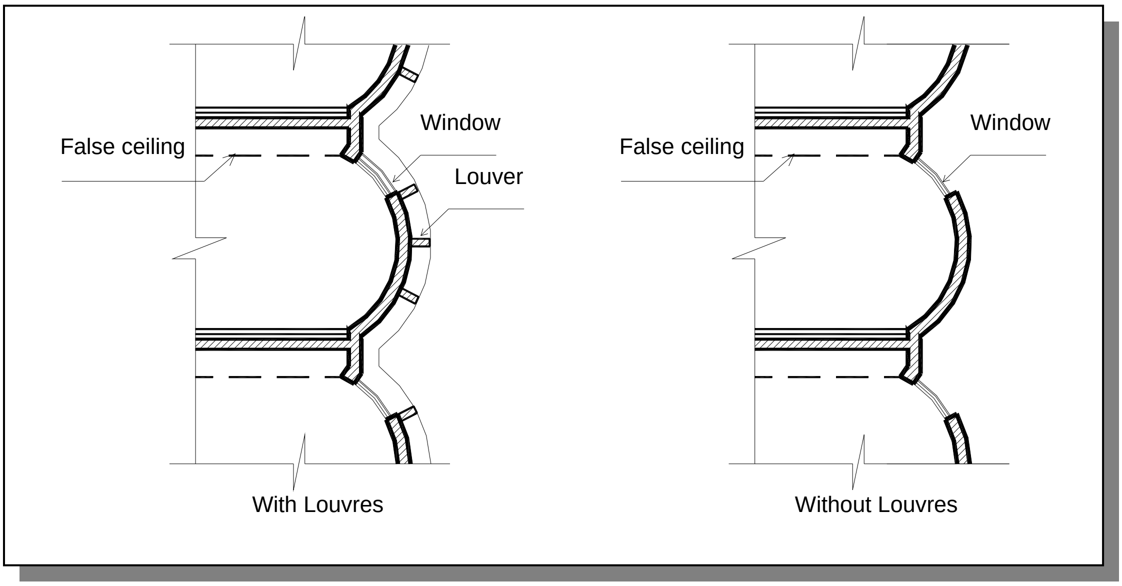

Fig. 2 Curved Elevated Technique.

Distance of the structure from the blast

The worst case scenario was taken to be when a vehicle bomb is located at a stand-off of 5m from the structure, as shown in figure 3. This was based on:

An assumed minimum pedestrian path width of 3m.
An assumed planting zone width of 1m.
1m distance between center of explosion and the planting zone.

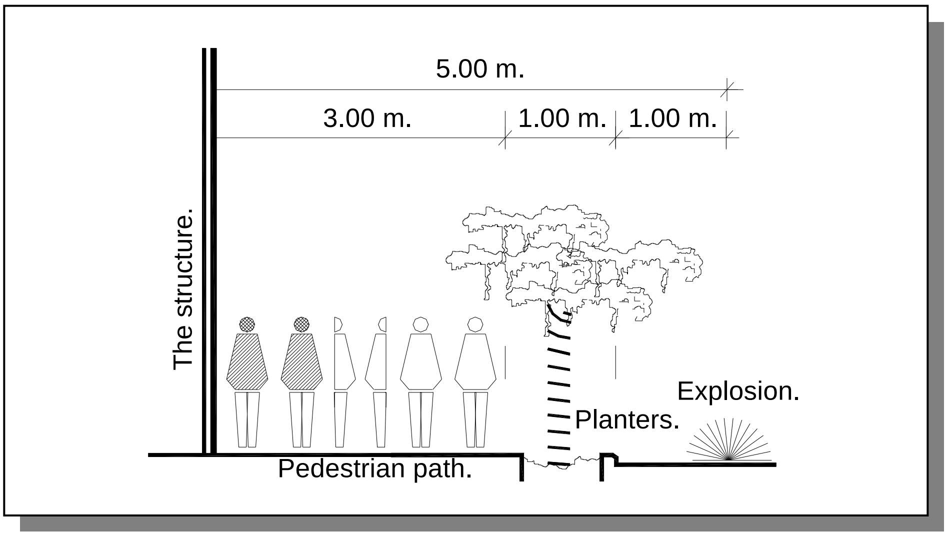

Fig. 3 Distance of the structure from the blast

Target structure height

The simulations are based around a 25m high, 8 - story reinforced concrete structure. The first story is 4m high, all others are 3 m high. These characteristics were chosen to be representative a typical structure in this category.

Coating thickness

Looking at the effect of polymer coating thickness, we were initially interested in the uniformity of the coating and how close the actual thickness was to the target thickness. While the average thickness tended to be slightly less than the target thickness, considerable variability existed.

The reasons for the variability include the inexperience of the technicians [2] with the new application apparatus, plus the high level of difficulty associated with sprayed vertical and overhead surfaces containing joints, angles, and so on. The impact of thickness variability was inconclusive although the tears in the polymer tended to occur in the thinner sections, as expected.

In addition, and during the coating a 1.5 mm layer of this polymer [6] to a special type of weaved arm amid, known as Kevlar textile, for the purpose of ballet proof protection in [7], the average thickness as shown doesn't affect the mechanical properties of whole designed composite.

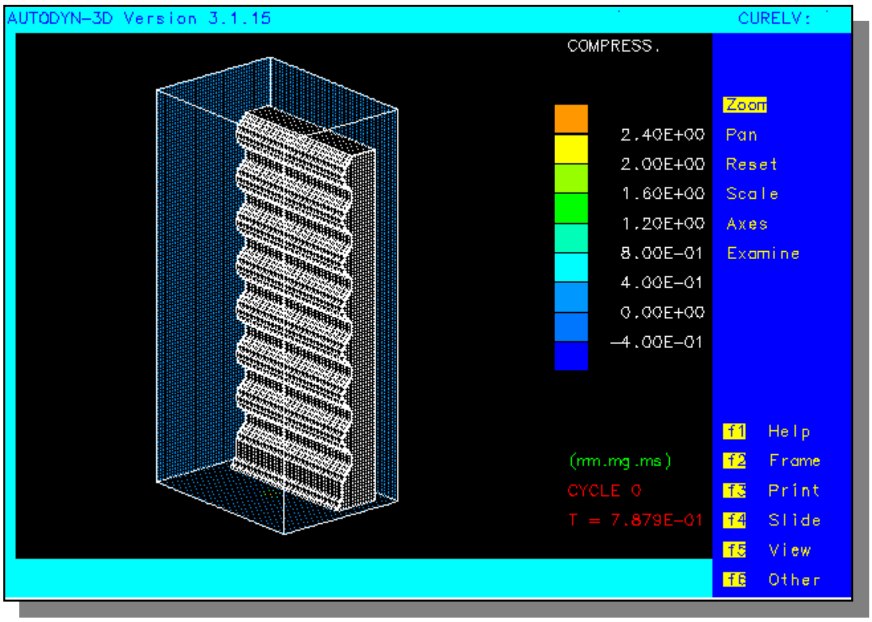

Fig. 4 Autodyn Simulation in 3D

COATING CONFIGURATION

1. Description

The coating is a two-component spray in place flexible 100% solids Thermoplastic Polyurethane (A) and Polyurea (B) system. It is designed for processing through dispensing equipment. It is a fast set, fast cure, and textured surface, multi-purpose material designed for commercial and industrial applications. It exhibits excellent adhesion to most materials including steel, concrete, wood, fiber glass. Both components A & B shall be pumped to the high pressure, preheated spray in place; Mix (3 sec.), Gel (6 sec.) and Cure (24 hours).

2. Features

1. Continuous, seamless and monolithic liner for flat, curved and sharp cornered.
2. Fast set 3-5 sec. at any thickness without intervals.
3. Used with fresh concrete and high humidity.
4. Fast cure for service at ambient temperature after 24 hours.
5. No volatile organic content, 100% solids, environmentally friendly.
6. High resistance to sun UV and severe weather conditions.
7. High resistance to broad range of chemicals, sea water, crude oil and sewage.
8. Outstanding abrasion resistance, impact strength, tensile strength.
9. high eclectic resistance (18 k w @ 1500 u m) [2]

3. Physical properties

Colors: black, natural (creamy) or pigmented.
Surface finish: glossy orange peal or textured.

Table 1. Physical properties for the polymer coating [2]

Properties	Value	Unit
Density	1.123	gm / cm3
Permeability	None	grain / hr. / m2
Hardness	87 / 60	Shore (A) / shore (D)
Abrasion resistance	0.6 %	Per 1000 cycles
Tensile strength	20.4	N / mm2
Shear strength	21.94	N / mm2
Elongation	475 %	Percent
Tear resistance	301.3	Pli
Impact strength	Pass	
Adhesion	25	Mpa
Cathodic disbondment	7.6	mm diam

SIMULATIONS RESULTS

1. Pressure and impulse values.

Simulations were conducted to discover whether the addition of The elastomer material (3mm thickness) has a beneficial effect. Analysis of the simulation output reveals that the The elastomer material offer a reduction in the effects of the blast waves on the structure, as shown in figures 5 (a) and 5 (b).

a) For the curved elevation *without louvers and without The elastomer material,* the **impulse** values were reduced by up to 38 % and the **pressure** values were reduced by up to 62 % when compared with the initial case.
b) For the curved elevation *with louvers and without The elastomer* material, the **impulse** values were reduced by up to 58 % and the **pressure** values were reduced by up to 78 % when compared with the initial case.
c) For the curved elevation *with louvers and The elastomer material*, the **impulse** values were reduced by up to 70 % and the **pressure** values were reduced by up to 86 % when compared with the initial case.

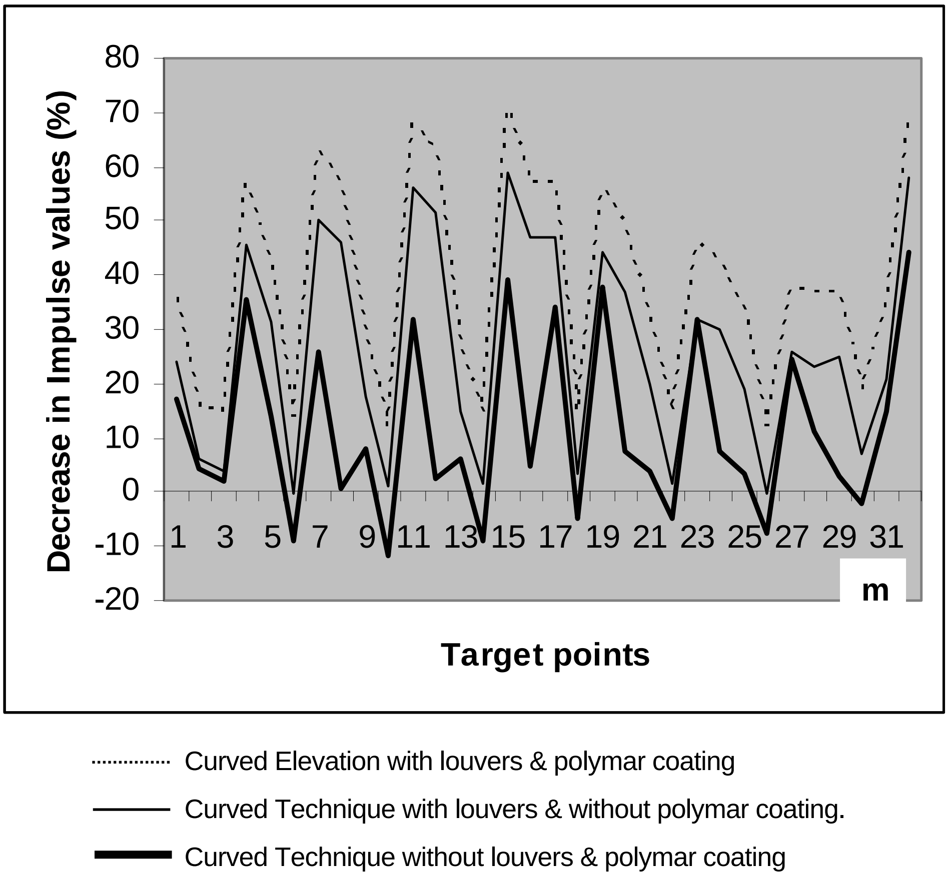

Fig. 5 (a) Decrease in impulse values (%) vs specific target points on structure for the convex elevation technique. (Values compared with reference scenario.

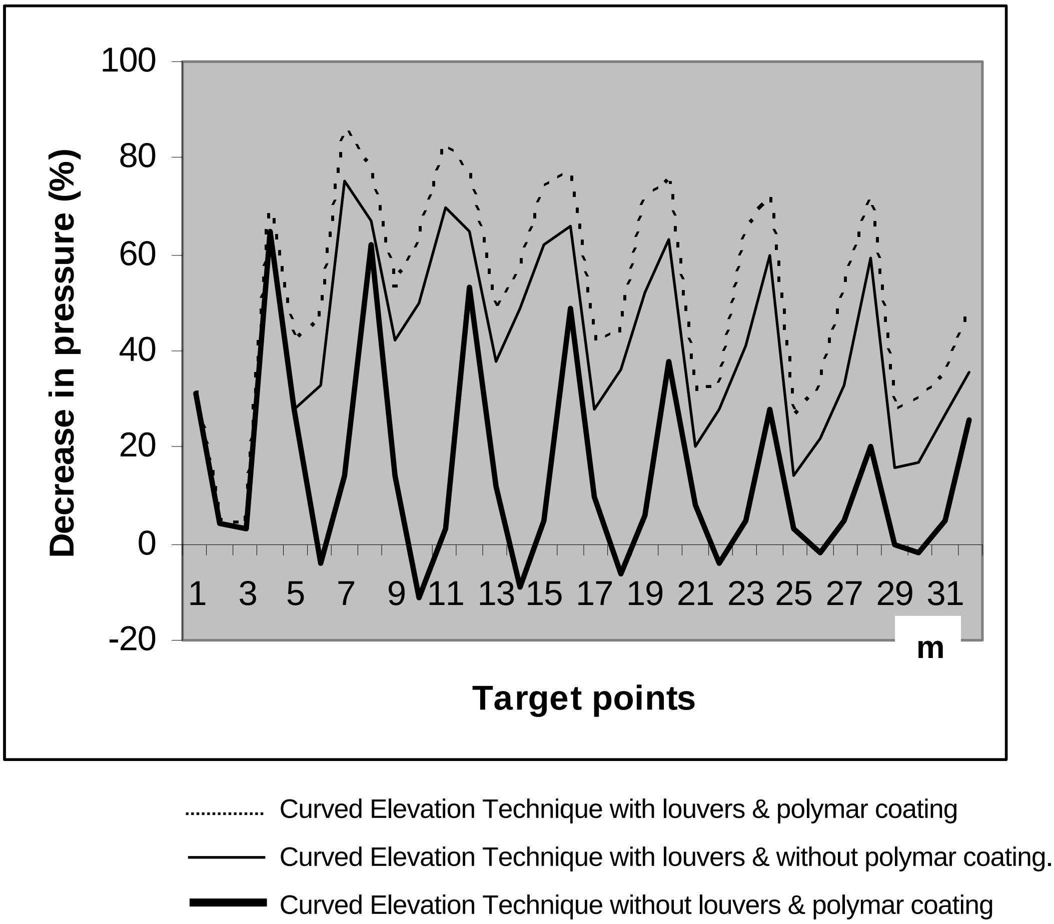

Fig. 5 (b) The decrease in pressure values (%) vs specific target points on structure for the convex elevation technique. (Values compared with reference scenario)

CONCLUSIONS

1. Adding the polymer retrofit technique for the convex elevation form can offer a beneficial reduction in the effects of the blast waves and fragments on the structure.

2. The polymer retrofit technique can reduce the standoffs required to limit damage and casualties by approximately 50%,

3. The polymer retrofit technique can be used without affecting the functionality of the structure or the street.

4. Adding the polymer retrofit technique for the convex elevation can offer benefits of robustness whilst having good aesthetic appeal and other architectural advantages.

5. The polymer retrofit technique is an effective tool in providing military commanders in the field with an expedient method to protect deployed forces from terrorist and enemy bomb attacks.

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