Polymer Composites as Construction Materials

Application Summary Sheet 18

Title: Blast Walls

Target Audience: Civil Engineers, Architects, Structure designers, Specifiers, Government Authorities, Construction Companies.

Keywords: Blast protection, safety, reinforcement, structural strengthening, fire, explosion, energy absorption, impact, resistance, polymer composite.

Overview of application / summary:

Blast walls are separate structural elements known to provide the most effective protection to buildings and structures from various explosions or malicious attack. They are also employed on offshore oilrigs and other potentially hazardous applications, where the main function is to suppress fireballs and fast moving flame fronts. Blast protection is very much seen as a rapidly developing market due to an increase in public safety concerns and a rise in intolerance.

Composite protection elements can consist of sandwich panels, added layers or hybrid structures. The functional requirements of blast wall are that they need to absorb energy rapidly and possess good resistance to buckling along with corrosion resistance. Corrosion is a consistent problem for steel reinforced concrete which has been commonly used until present. The inherent properties of composites ensure that they meet all of these requirements. Continual development of high performance resins and fibres, plus the ability to incorporate extinguishing additives, has lead to widespread uptake in the use of composites for this application.

There are numerous engineering benefits with the use of composites. The higher strength to weight ratio obtainable from FRP's means that less material is required to provide the same degree of protection offered by other materials. Additionally, the features of the structure are not compromised with the need for large volumes of material. Composite panels can function as building materials, decorative facings, linings or wall components. The impact on safety is high: FRP blast walls have been subjected to extensive testing in some of the harshest conditions. They exhibit outstanding characteristics and resistance to blast and impact loading.

The excellent performance of all composite blast walls has lead to the development of composite strengthening techniques. Their flexibility can be utilised to 'retro-fit' existing masonry structures to increase their blast resistance. In the current climate there is high interest in this application of composites - academic Institutions are conducting extensive research, albeit the majority of a sensitive nature.

Impact of application

Engineering:

- The superior mechanical performance of composite or hybrid composite components means that the required level of protection can be achieved with a lower volume and weight of material.
- Modularity of composite components for quick and easy installation of both temporary and permanent protection facilities.
- Composite components are highly machinable – they can be drilled, screwed or cut during installation in field applications.
- The flexibility of composites means they can be combined with other materials to provide the most effective solution for a given level of protection or situation. A recent example shows the combination with ceramics for protection against amour piercing rounds in military applications.
- Composite panels are easy to repair in the field.

Financial:

- Although composite protection components are generally of high initial cost, they bring large potential through life savings due to their low maintenance requirements, inherent corrosion resistance and extended design life in comparison to steel and concrete (conventional materials for this application).
- Increased blast protection to buildings would lead to lower insurance premiums.
- Transportation and installation costs are significantly lower due to the lighter weight and smaller volume of composite protection units.

Environmental:

- Superior protection to buildings and surrounding environments in the event of malicious attack, explosion or fire with the incorporation of composite blast protection components.
- Potential safeguarding of marine environment in offshore applications where the prevention of an explosion or fire which otherwise could have disastrous effects on the surrounding marine environment.
- Composite protection panels do not contain any chemicals and therefore do not pose any leakage or disposal problems.

Social:

- Increased social security with the use of higher performance blast protective components.

Robustness of research

Much of the research carried out in this field is not available publically due to the sensitive nature of many applications. However, numerous prestigious academic institutions such as Cranfield, Cambridge and Liverpool are engaged in cutting edge research into blast wall materials and dynamics. Links to these establishments can be found at the end of this summary.

Future developments

Due to the current climate regarding terrorism, it is anticipated that there will be a rapid uptake in the use of composite materials for blast protection. Increased government spending on National security will encourage this worldwide. Academic institutions will continue to conduct research into this area. At the University of Liverpool, smart structures are being developed which contain Bragg gratings and plastic optical fibres to monitor the behaviour of composite materials. The focus of other research is on the application of numerical simulation software (such as *Finite Element Analysis*) to predict blast wall performance and ultimately increase the accuracy of the design cycle.

Where to get further information

Companies

UK:

BTI - Ballistics Technolgy International:	www.ballisticstech.com
BLASTGARD:	www.blastgard.net/
Permali Gloucester:	www.permali-gloucester.co.uk/def

US:

Kansas Structural Compsites, Inc.	www.ksci.com

Research

Cranfield University:
Engineering Systems Department
Royal Military College of Science
Shrivenham — www.rmcs.cranfield.ac.uk

University of Liverpool:
Impact Research centre — www.dweb.liv.ac.uk/engdept/

University of Cambridge:

Department of Materials Science and Metallurgy
(Composites and Coatings Group) www.msm.cam.ac.uk

“High Strain rate deformation of composite materials subjected to blast and impact”
Simmons, M.J. & Clyne, T.W.