

# **BLAST RESISTING CONCRETE WALLS**

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## **ABSTRACT**

Today people around the world wake up, eat, live and sleep with terrorism. It has become a global menace. As a citizen lives in a country hit by a civil war for over three decades gave me motive and courage to set off this project. The project was basically planned to carry out in two parts, i.e. the literature survey and the experimental investigation. Initially a comprehensive literature survey was carried out to cover the several areas.

As terrorism is the main reason to for this project to exist, the literature survey was started off with an insight view of terrorism, its motives, methods and objectives of terrorist organisations. Later the survey was expanded to explosives and weapons frequently used by the terrorists. At the next stage of the literature survey, a review was done on the existing knowledge of blast resisting designs followed by a study on the various structural responses to blast loadings. The literature survey was further extended to design of blast resisting structures and finally to design of elements to resist blast loadings was also completed. As a measure to increase the resistance to blast loadings, important characteristics of steel fibre and welded meshes were also studied.

The experimental investigation of the project was directed to find solutions to two situations, in battle field or terrorist attack. First series of tests of the project were concentrated on close range high explosive detonations. Unfortunately, this part of the project had to be abandoned due to unavailability of TNT explosives in slab form. This brought to the abrupt end to the test series one of the project.

The second series of tests were focused more on a military situation, where terrorist fire with RPG 7 at bunkers. After the testing, it was revealed that the designed concrete panel might barely withstand the RPG 7 fire. The reason for this may be the fact that the effects of small steel balls were not considered in the design. Only the amount of explosives and the distance from the centre of the RPG 7 mortar to panel were considered

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Major

Corps of Engineer Services

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## LIST OF NOTATIONS

$a$	acceleration
$A_d$	area of diagonal bars at the support within a width $b$
$A_s$	area of tension reinforcement within a width $b$
$A_s'$	area of compression reinforcement within a width $b$
$A_v$	total area of stirrups in tension within a distance $s$ and a width $b$
$b$	width of flexural member
$d$	depth of beam
$d$	distance from extreme compression fibre to centroid of tension reinforcement
$d'$	distance from extreme compression fibre to centroid of compression reinforcement
$d_c$	distance between the centroids of the compression and tension reinforcement
DIF	dynamic increase factor
$E$	modulus of elasticity
$E_c$	modulus of elasticity of concrete
$E_s$	modulus of elasticity of reinforcement or steel section
$F$	coefficient for moment of inertia of cracked section
$f$	stress
$f_{du}$	dynamic ultimate compressive strength of concrete at 28 days
$F(t)$	blast load from idealized triangular pulse
$f_{cu}$	static ultimate compressive strength of concrete at 28 days
$f_{dc}$	dynamic design stress for concrete
$f_{ds}$	dynamic design stress for reinforcement or steel section
$f_{du}$	dynamic ultimate stress of reinforcement or steel section
$f_{dv}$	dynamic design shear stress for steel section
$f_{dy}$	dynamic yield stress of reinforcement or steel section
$f_u$	static ultimate stress of reinforcement
$f_y$	static yield stress of reinforcement
$H$	span height
$I$	moment of inertia
$i$	unit positive impulse

$I_c$	moment of inertia of cracked concrete section of width $b$
$i_r$	unit positive normal reflected impulse
$K$	stiffness
$K_E$	equivalent elastic unit stiffness
$K_{LM}$	load -- mass factor
$m$	mass of human subject
$M$	mass of the structure
$M_n$	ultimate negative moment capacity
$M_p$	ultimate negative moment capacity
$n$	modular ratio
$p$	pressure
$P$	load
$p_{max}$	peak pressure
$p_r$	peak positive normal reflected pressure
$R$	range from charge centre
$r_u$	ultimate unit resistance
$S$	plastic section modulus
$\beta$	coefficient applied to toilet load $P$ to determine dynamic reaction $V$
$t$	time
$T$	natural period of vibration of structure
$t_d$	duration of idealized blast load
$t_m$	time to reach maximum dynamic displacement
$T_s$	positive phase duration
$V$	support reaction
$v_c$	ultimate shear stress permitted in an unreinforced concrete web
$V_d$	ultimate direct shear capacity of the concrete of width $b$
$V_s$	shear at the support per unit width
$v_u$	ultimate shear stress
$W$	mass of spherical TNT charge
$x$	displacement
$X$	deflection

$x$	depth of neutral axis below extreme compression fibre in a flexural member
$X_e$	equivalent elastic deflection
$X_m$	maximum transient deflection
$X_{max}$	maximum dynamic displacement
$Z$	scaled distance
$Z$	elastic section modulus
$\alpha$	coefficient applied to toilet internal resistance $R$ to determine dynamic reaction $V$
$\gamma_m$	partial safety factor for material
$\delta$	side – sway deflection
$\epsilon$	Strain
$\epsilon$	strain
$\theta$	support rotation angle
$\rho$	density
$\rho_s$	tension reinforcement ratio
$\rho'_s$	compression reinforcement ratio
$\mu$	ductility ratio
$\omega$	natural circular frequency of vibration

