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GENERAL INDEX

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1. INTRODUCTION

The Getrich project includes construction and operation of new grassroots heavy oil production and upgrading facility to be located on the Moose Lake lease, located about 140 km West of Fort McMurray, Alberta. The site is undeveloped other than those associated with testing and exploration.

A 135,000 BPD production facility is planned using steam assisted gravity drainage (SAGD) technology. The produced heavy oil will feed the proposed Upgrader. Additional feedstock will come from offsite sources. The upgrader will receive heavy feedstock and produce synthetic crude oil, capable of being refined into finished products by others. Sulphur will be the main by-product.

This document covers the engineering design and computation for the Man Deluge Building located in 1500 area of the project.

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1.1. REFERENCE

All design calculations for structural steel and reinforced concrete shall be done by the Limit States Design method in SI units.
The calculations themselves are the basis for the minimum design criteria, all information on the drawing shall take precedence. Where the there is a conflict between codes, standards and/or specifications, the most onerous shall apply.

CODES

National Building Code of Canada (NBCC), 1995 & Structural Commentaries
Alberta Building Code 1997

STANDARDS

CAN/CSA-A5-98	Portland cement
CSA-A23.4-00	Precast Concrete Materials and Construction
CAN/CSA-A23.5-M86 (R1992)	Supplementary Cementing Materials
CAN/CSA-S6-00	Design of Highway Bridges
CSA-A23.3-94	Design of Concrete Structures
CSA-S304.1-94	Masonry Design for Buildings
CSA-A23.1-00	Concrete Materials and Methods of Concrete Construction
CSA-A23.2-00	Methods of Test for Concrete
CSA-S16-01	Limit States Design of Steel Structures
CAN/CSA-G40.20/G40.21-98	General Requirements for Rolled or Welded Structural Quality Steel
CAN/CSA-S136-01	Cold Formed Steel Structural Members

SPECIFCATIONS

ASTM A307-02	Specification for Carbon Steel Bolts and Studs
ASTM A320-02	Specification for Alloy Steel Bolting Materials for Low Temperature Service
ASTM A325-02	Specification for Structural Bolts, Steel and Heat Treated joints
ASTM A563-00	Specification for Carbon and Alloy Steel Nuts
F436-02	Specification for Hardened Steel Washers.

PROJECT SPECIFICATIONS

045.215.00001 rev 0A	Structural and Civil Design Criteria and applicable Fluor Practices

PROJECT DESIGN BULLETINS

These are to be observed. They are available electronically in the project directory.

OTHERS

CISC Handbook of Steel Construction
Geotechnical Report – ECA Engineering Consultants Ltd. Phase F and G(0505-5500344 March 2004)

COMPUTER SOFTWARE

For Structural Analysis and Unity code checks to Canadian codes performed using RISA-3D Version 5c

1.2. MATERIALS

Structural steel	CAN/CSA G40.21M, grade 350W for WF and HSS. Grade 300W for angles, channels and plates.
Connection bolts	ASTM A325 ¾" minimum high strength bolts. (in ¼" increments)
Anchor bolts	ASTM A-307 or ASTM A-320 grade L7.
Welding electrodes	CSA W59
Structural Concrete	The specified compressive strength 30 MPa at 28 days
Lean concrete	The specified compressive strength 10 MPa at 28 days
Reinforcing steel	Minimum specified yield strength of 400 MPa.

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1.3. DESIGN LOADS

Refer also to the Civil and Structural Design Criteria for details.

Dead load (D)

Total dead weight of empty equipment and/or structures, including fireproofing, insulation, piping and cable trays. Add 15% for connections (in operation) Weight of backfill to be included in foundation design as appropriate. For empty pipes, assume 1.15 kN/m^2.

Operating Load (D)

This shall be the weight of fluids in equipment and pipes under normal conditions at maximum operating level. For pipes assume 2.0 kN/m^2. This shall be treated as dead load for the load factors in Limit State Design

Test Load (D)

This is the dead load and weight of liquid necessary to pressure test equipment, vessels and piping. This shall be treated as dead load for the load factors in Limit State Design

Live Load (L)

This consists of movable loads, including personnel, snow, equipment, portable machinery, permanently stored materials during maintenance and may be applied at grade or on platforms.

Wind load (W)

Wind Pressures are derived from reference velocity pressure of q = 0.32 kPa. This corresponds to 1/30 year wind. No shielding to be considered. Wind pressures shall be calculated as per NBCC 4.1.8.1:

$$p = q\, C_e\, C_g\, C_p$$

where

- q reference velocity pressure
- C_e Exposure factor
- C_g Gust effect factor
- C_p External pressure coefficient

Maintenance load (L)

This also includes Tube bundle removal. This shall be considered live load in load combinations.

Slug/Thermal forces (T)

This is applied as per Fluor Practice. Not only those due to temperature effects but also anchorage of piping and equipment, sliding and rolling frictional forces and any slug flow conditions must be identified as early as possible.

Thermally, unless provided by piping assume 10% of operating loads.

Friction, unless provided by piping, assume longitudinal friction as 10% of operation loads and for transverse friction stress, assume 5kN at each beam supporting pipes.

For anchor loads, unless provided by piping stress, assume 5 kN at each joint shown on piping stress memo.

Snow load (SL)

Need only apply to the following:

A) electrical cable trays. 50% applied to the top level and the rest distributed equally to the other levels. For single level tray apply 100 % snow load.

B) Platforms constructed with solid floor plate.

Earthquake Load (EQ)

Not applicable

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1.4. LOAD COMBINATIONS

For load combinations, operating loads shall be considered as a dead load. In the case of overturning, uplift and stress reversals only 85% of dead load shall be considered (without the weight of fluid).

For Limit State Design of Strength and Stability

The load combinations shall be taken as

$$\alpha_D D + \gamma \psi [\alpha_L L + \alpha_w W + \alpha_T T]$$

For Limit State Design of Serviceability

The load combinations shall be taken as

$$D + \psi [L + W + T]$$

where α_D = 1.25 or 0.85

α_L = 1.5

α_W = 1.5 and

α_T = 1.25

Load combination factor

ψ = 1.0 when only one of the loads L, W, or T is included

ψ = 0.70 with two

ψ = 0.60 with all three

Importance factor

γ = 1.0

		Erection	Operating			Test
		D+W	D+L	D+L+W	D+L+W+T	D+L+W
	Parameter	Cat. 1	Cat. 2	Cat.3	Cat. 4	Cat. 5
Strength & Stability	α_D	0.85	1.25	1.25	1.25	1.25
	α_L	-	1.5	1.5	1.5	1.50
	α_W	1.5	-	1.5	1.5	0.375
	α_T	-	-	-	1.25	-
	ψ	1.0	1.0	0.7	0.6	0.7
	γ	1.0	1.0	1.0	1.0	1.0
Serviceability	ψ	1.0	1.0	0.7	0.6	0.7

Refer to Structural Job Data book for relevant Load designations and combinations.

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CHECKLIST

	List of Contents	Yes	No	Remarks/References
1.0	Preliminary Engineering			
	Calculations	Yes		
	Sketches	Yes		
	RISA model		No	
2.0	Conceptual Philosophy			
	Fireproofing		No	
	Modules		No	
	Stick built	Yes		
	Other	Yes		Blast-resistant to 3 psi at 100 ms
3.0	Datasheets			
	Process		No	
	Vendor data		No	
	Piping Stress		No	
4.0	Correspondence			
	Client		No	
	Project		No	
	Piping		No	
	Electrical		No	
5.0	Any go-bys	Yes		ASCE method of design
6.0	Status of PDS model			
	Inclusions		N/A	
	Exclusions		N/A	
	Forecasts		N/A	
	Instructions		N/A	

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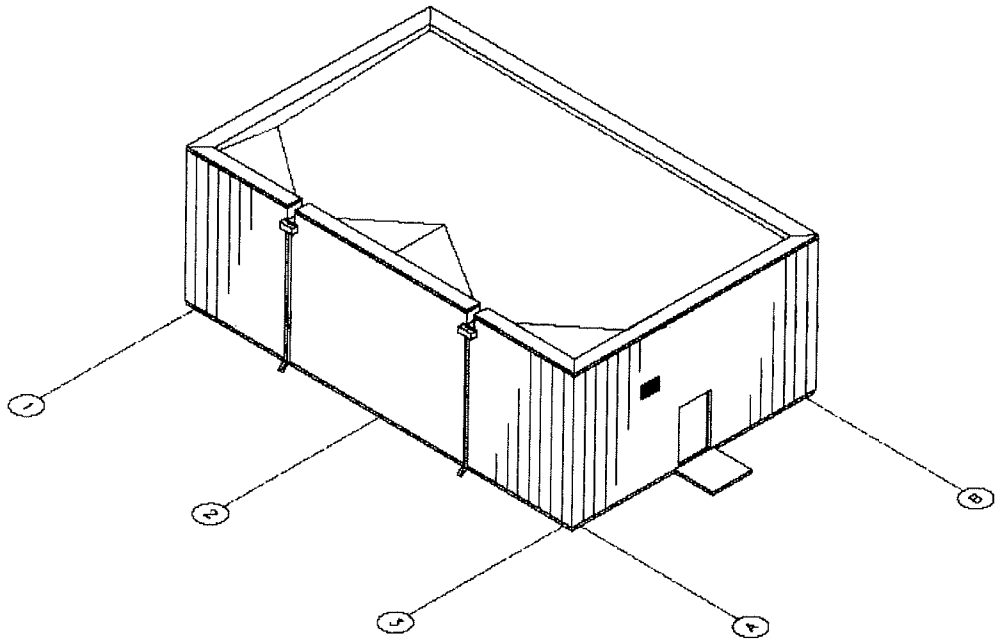
2. DESCRIPTION OF CONSTRUCTION

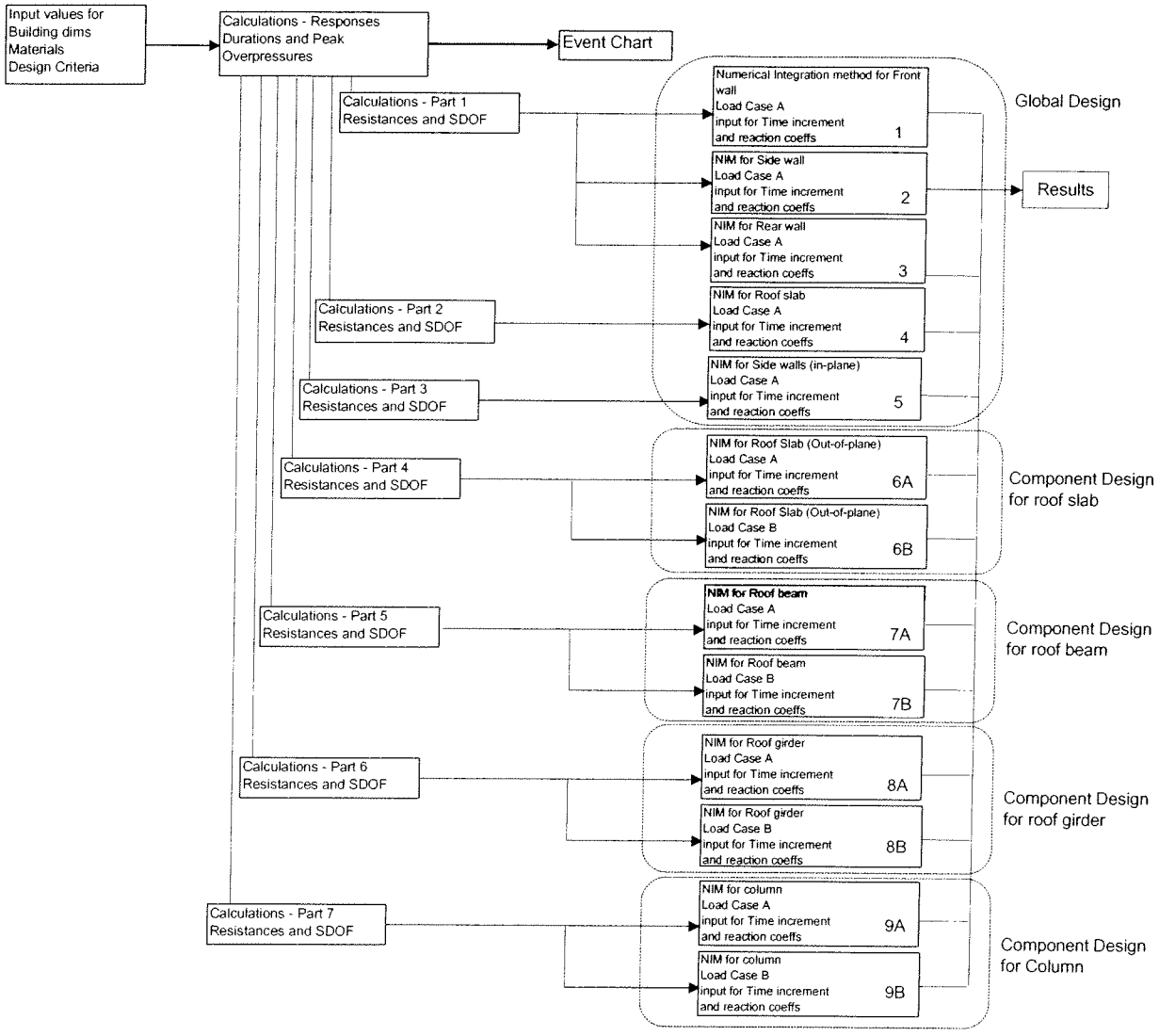
Steel framed building supporting in-situ concrete walls and roof designed to protect the equipment module housed inside the building from a blast load of 3 psi at 0.1 s.

Walls connected directly to steel frames with Nelson studs. Steel frames all bolted to piled foundations, assumed dynamically to be pinned. Roof cast in place with Q-decking.

Low response is assumed thus the building elements will be allowed to yield in the presence of the blast. Analysis is based on the ASCE 1997 Blast resistant design for petrochemical facilities.



2.1. INPUT PARAMETERS



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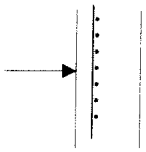
Materials		Imperial	Metric			
Structural Steel	A36	**36** ksi	248 MPa	B	**45.93** ft	14.000 m
Reinforcing Steel	Grade 60	**58** ksi	400 MPa	L	**29.53** ft	9.001 m
Steel Modulus	E_s	**29007400** psi	200000 MPa	H	**18.05** ft	5.502 m
Concrete Modulus	E_c	**3605000** psi	24856 MPa			
Concrete	f'_c	**4000** psi	27.6 MPa			
Transformed modulus	$n = E_s/E_c$	8.05				
Soil density		**115** pcf	**18.1** kN/m^3			
Acceleration of gravity	g	**32.2** ft/sec^2	**9.81** m/sec^2			
Roof dead loads	w	**25** psf	1.2 kPa	LL disregarded		

Check for Case A — Design on Long side of the building
Check for Case B — Design on short side of the building

				Ref
Overpressure	P_{so}	**3** psi	20.7 kPa	Figure 3.3
Duration	t_d	**0.1** sec	0.1	
Building Performance Response		Low	Low	



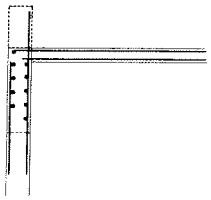
Wall spans			
Span	H_i	**17** ft	5.182 m
Design width	b	**1** ft	0.305 m
Trial size			
Wall thickness	h	**10** in	254 mm
Reinf. Arrangement		**#5 @ 6 in**	**15M @ 150**
	A_s	**0.31** in^2	**200** mm^2

Vertical bars outside of horiz bars

Roof spans			
Span	L	45.1 ft	c/c (For Load Case A)
depth		29.5 ft	outside dims.

Determine width of composite (wall) flange — ACI 318, Section 8.10.3

condition			
	a	=(45.931ft span)/2	22.97 ft
	b	=6 (10 in)/12	5.00 ft
	c	=(17ft wall span)/2	8.50 ft
Effective width	b_f		5.00 ft



Trial size

Concrete slab 5 in thickness plus 2 in steel decking, for an average of 6 in (150 mm)

slab thickness	slab depth	**5** in	**150** mm	
Average thickness		**6** in	**150** mm	
	Roof reinforcing	**#3 @ 7 in**	**#3@180**	
	A_s	**0.11** in^2	**71** mm^2	(as per wall details)
	Chord reinforcing	**10** in	**254** mm	
		10#8 per chord		
	A_s	**7.9** in^2	**5100** mm^2	

Roof beam				
trial size	W14 x 38		**38** lb/ft	
Roof beam span			**15** ft	
Loading span			**5.75** ft	
beam depth	d		**14.1** in	
flange width	b_f		**6.77** in	
flange thickness	t_f		**0.515** in	
web depth	h_c		**11.625** in	
web thickness	t_w		**0.31** n	
		$b_f / 2t_f =$	6.6	
		$h_c / t_w =$	37.5	
Radius of gyration	r_y		**1.55** in	
moment of inertia	I		**385** in^4	
Plastic modulus	Z_x		**61.5** in^3	

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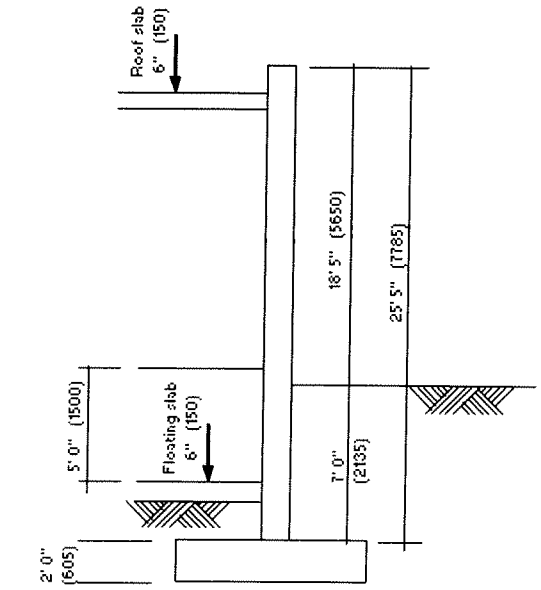
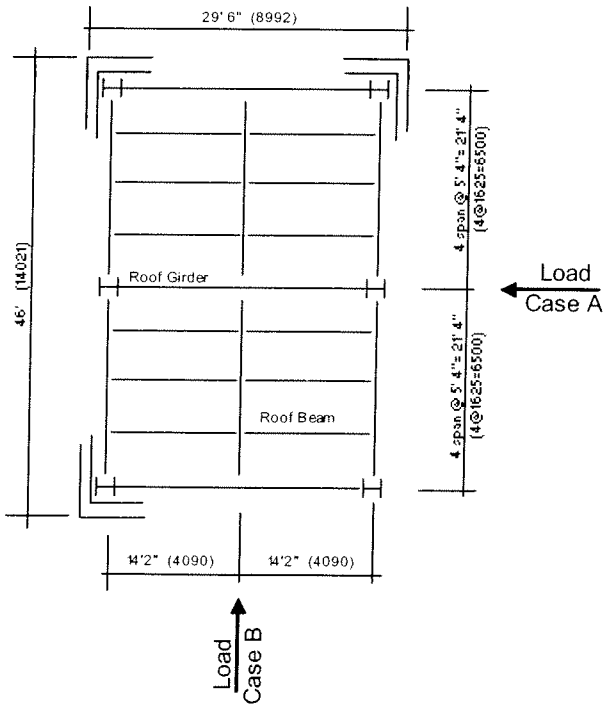
Roof girder

trial size	W21 x 111		**111**	lb/ft
Roof Girder span			**30**	ft
Loading span			**23**	ft
beam depth		d	**21.5**	in
flange width		b_f	**12.3**	in
flange thickness		t_f	**0.875**	in
web depth		h_c	**18**	in
web thickness		t_w	**0.55**	n
		$b_f / 2t_f$ =	7.03	
		h_c / t_w =	32.73	
Radius of gyration		r_y	**2.9**	in
moment of inertia		I	**2670**	in^4
Plastic modulus		Z_x	**279**	in^3

Column

trial size	W10 x 45		**45**	lb/ft
Column height			**13.8**	ft
Loading span			**23**	ft
Area		A	**13.3**	in^2
flange width		b_f	**12.3**	in
flange thickness		t_f	**0.875**	in
web depth		h_c	**18**	in
web thickness		t_w	**0.55**	n
		$b_f / 2t_f$ =	7.03	
		h_c / t_w =	32.73	
Radius of gyration		r_y	**2.01**	in
moment of inertia		I	**2670**	in^4
Plastic modulus		Z_x	**279**	in^3





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Exterior Walls (out of plane loads)

Front Wall Load (for maximum wall response)

Shock front velocity	$U = 1130 (1 + 0.058 P_{so})^{0.5}$			1224 ft/sec	373 m/s	Eqn 3.5
Length of Pressure wave	$L_w = U t_d$			122 ft	37.31 m	Eqn 3.6
Peak dynamic Wind Pressure	$q_o = 0.022 (P_{so})^2$			0.198 psi	1.4 kPa	Eqn 3.4
Magnitude of reflected pressure	$P_r = C_r P_{so}$	where $C_r = (2 + 0.05 P_{so})$		6.45 psi	44.5 kPa	Eqs 3.2 & 3.3
rise time	t_r			0 sec	0 sec	
Clearing distance	S = minimum of H or B/2			18.05 ft	5.50164 m	Section 3.5.1
Reflected overpressure clearing time	$t_c = 3 (S / U) < t_d$	= 3 (18.05) / (1224)		0.044 sec	0.044 sec	Eqn 3.8
Drag Coefficient	C_d			1.00	1.00	Section 3.3.3
Stagnation Pressure	$P_s = P_{so} + C_d (q_o)$	= (3) + (1) (0.198)		3.2 psi	22.0 kPa	Eqn 3.7
Front Wall Impulse	$I_w = 0.5 (P_r - P_s) t_c + 0.5 P_s t_d$	= 0.5 [(6.45) - (3.198)] (0.044) + 0.5 (3.198)(0.1)		0.231 psi-sec	1.6 kPa	Eqn 3.9
Effective Duration	$t_e = 2 I_w / P_r$	= 2 (0.231) / (6.45)		0.072 sec	0.072 sec	Eqn 3.10
Peak load	P_o =	= (216.6)(12)(6.45) / (1000)		15.8 kips	70.3 kN	

Side Wall Load (for maximum wall response)

Drag Coefficient	C_d			-0.40	-0.40	Section 3.3.3
Equivalent load coeff	L_w/L_1	= (29.53) / (1)		29.53	29.53	figure 3.9
			Therefore C_e =	**1.0**	**1.0**	
Equivalent peak overpressure	$Pa = C_e P_{so} + C_d q_o$	= (1)(3) + (-0.4)(0.198)		2.9 psi	20.0 kPa	Eqn 3.11
rise time	$t_r = L_1 / U$	= (1) / (1224)		0.001 sec	0.001 sec	fig 3.8
duration	t_d			0.1 sec	0.1 sec	
Peak load	P_o	=(17 x12)(12)(2.9) / (1000)		7.1 kips	31.6 kN	

Roof Loading

Load Case A, parallel to 5.75 ft span of slab

Spans assumed	L_1			**5.75** ft	1.753 m	
Drag Coefficient	C_d			-0.40	-0.40	Section 3.3.3
Equivalent load coeff	L_w/L_1	= (29.53) / (5.75)		5.14	5.14	figure 3.9
			Therefore C_e =	**0.9**	0.9	
Equivalent peak overpressure	$Pa = C_e P_{so} + C_d q_o$	= (0.9)(3) + (-0.4)(0.198)		2.6 psi	18.1 kPa	Eqn 3.11
rise time	$t_r = L_1 / U$	= (5.75) / (1224)		0.005 sec	0.005 sec	fig 3.8
duration	t_d			0.100 sec	0.100 sec	
Total positive phase duration	$t_o = t_r + t_d$	= (0.005) + (0.1)		0.105 sec	0.105 sec	
Peak load	P_o	= 69 x 12 x 2.6208 / 1000		2.2 kips	9.7 kN	

Load Case B, perpendicular to span

Span assumed	L_1			**1** ft	305 mm	
	L_w/L_1			29.53	29.53	Section 3.3.3
			Therefore C_e =	**1.0**	1.0	figure 3.9
rise time	$t_r = L_1 / U$			0.001 sec	0.001 sec	
Equivalent peak overpressure	$Pa = C_e P_{so} + C_d q_o$	= (1)(3) + (-0.4)(0.198)		2.9 psi	20.1 kPa	Eqn 3.11
Peak load	P_o	= 69 x 12 x 2.92 / 1000		2.4 kips	10.8 kN	

Rear Wall Loading

Spans assumed	L_1			**17.7** ft	5.395 m	
Drag Coefficient	C_d			**-0.40**	-0.40	Section 3.3.3
Equivalent load coeff	L_w/S	= (29.53) / (18.05)		1.64	1.64	figure 3.9
			Therefore C_e =	**0.50**	0.50	
Equivalent peak overpressure	$Pa = C_e P_{so} + C_d q_o$	= (0.5)(3) + (-0.4)(0.198)		1.4 psi	9.7 kPa	Eqn 3.11
Time of arrival	$t_a = L / U$	= (29.53) / (1224)		0.024 sec	0.024 sec	
Rise time	$t_r = S / U$	= (18.05) / (1224)		0.015 sec	0.015 sec	TM5-1300 criteria
Duration	t_d			0.100 sec	0.100 sec	
	$t_1 = t_a$ =			0.024 sec		Figure 3.8
	$t_2 = t_1 + t_r$ =			0.039 sec		
	$t_3 = t_2 + t_d$ =			0.139 sec		
Peak load	P_o	=(204)(12)(1.4)/(1000)		3.43 kips	15.3 kN	

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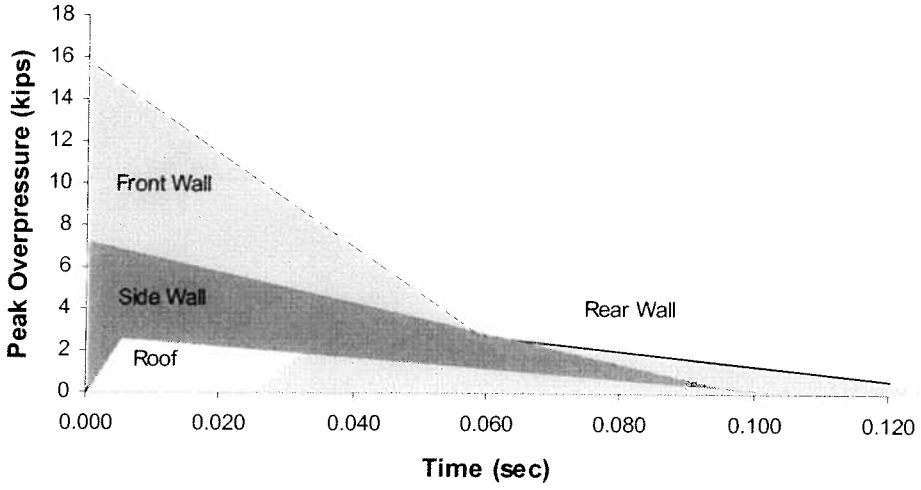

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EXTERIOR WALLS OUT OF PLANE

Bending Resistance

for dynamic bending	f_{dv} = (SIF)(DIF) f_v	= (1.1)(1.17) 58	74.6 ksi	514 MPa	
	f_{dc} = (SIF)(DIF) f_c	= (1.0)(1.19) 4	4.76 ksi	33 MPa	
Effective depth	d	= (10) - (1.5 in) - (0.314)	8.19 in	208.0 mm	
Steel layer per face	A_s (in^2/ft)	= (0.31 x 12)/(6 in bar spacing)	0.62 in^2	400.0 mm^2	
Reinf percentages	$\rho = A_s / bd$	= (0.62) / (12)(8.19)	0.0063 > 200/ f_{dv}		ACI 318, Eqn 10-3
	$a = A_s (f_v)/(0.85f'_{dc})(b)$	= 0.62 x 74.6 /(0.85 x 4.76 x 12)	0.95 in	24.1 mm	
	$M_b = M_n = A_s(f_{dv})[d - a/2]$	= 0.62 x 74.6 [8.19-0.95 / 2]	356.8 in-k	40.3 kNm	
Bending resistance	$R_b = 8M_b/L$	= 8 x 356.8 / (17 x 12)	13.99 kips	62.3 kN	Table 6.1

Shear Resistance

for dynamic shear	f'_{dc}= (SIF)(DIF) f'_c	= (1.0)(1.0) 4	4 ksi	27.6 MPa	Appendix 5.A
	$V_n = 2 (f'_c)^{0.5}$ bd	= 2 x sqrt (4000) x 1 x 12 x 8 19	12.43 kips	55.3 kN	ACI 318, Eqn 11-3
At critical section	$R_s = V_n L/ (0.5L - d)$	= 12.43 x 204 /(0.5 x 17 x 12 - 8.19)	27.03 kips	120.3 kN	

SDOF Equivalent System

because R_b < R_s bending governs

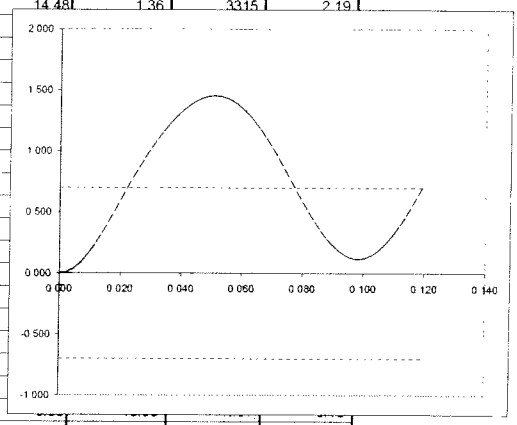
	R_{min}	minimum of R_s and R_b	13.99 kips	62.3 kN	
Allowable response	θ_a		2.0 °		Table 5.B 1
Gross moment of inertia	$I_g = b (h)^3 /12$	= 12 x 10^3 / 12	1000 in^4	41623 cm^4	
	nA_s	= 8.05 x 0.62	4.99 in^2	3219 mm^2	
Depth of uncracked section	$C_n = [(-nA_s)+(nA_s(nA_s+2bd)0.5]/b$	= [-4.99 + sqrt(4.99(4.99 +2 x 12 x 8 19)]/12	2.23 in	56.6 mm	
Cracked moment of inertia	$I_{cr} = b C^3/3 + nA_s (d - C)^2$	= 12 x 2.23^3 / 3 + 4.99(8.19 - 2.23)^2	221.6 in^4	9224 cm^4	
Averaged moment of inertia	$I_a = (I_g + I_{cr}) /2$	= (1000 + 221.6)/2	611 in^4	25432 cm^4	
Effective stiffness	$K = 384EI /5L^3$	= (384 x 3605 x 611) / (5 x 204^3)	19.93 k/in	3491.5 kN/m	
Yield deflection	$y_e = R_u / K$	= 13.99 / 19.93	0.7 in	17.8 mm	
Beam mass	m = (wall weight)/(gravity)	= (0.15 x 0.83 x 1 x 17) / (386.4)	0.0055 k-sec^2/in	0.963530 kNsec^2/m	
Elastic Load Factor	K_{LM}	= 0.5 / 0.64	0.78	0.78	Table 6.1
Plastic Load Factor	K_{LM}	= 0.33 / 0.5	0.66	0.66	
Averaged Load Factor	K_{LM}	= (0.78 + 0.66)/2	0.72	0.72	
Equivalent mass	m_e = (K_{LM}) (beam mass)	= 0.72 x 0.0055	0.00396 k-sec^2/in	0.694 kNsec^2/m	
Period of vibration	$t_n = 2 \pi (m_e / K)^{0.5}$	= 2 x 3.14 x sqrt(0.00396 / 19.93)	0.089 sec	0.089 sec	Eqn 6.8
For Support reactions	V=0.385R+0.115F				Table 6 1

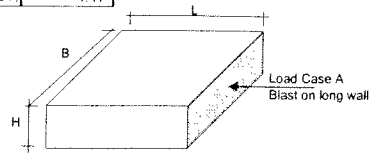
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

FRONT WALL

Equivalent Mass	m_e	0.00396 k-sec^2/in	**Summary**			
Effective Stiffness	K	19.93 k/in	Maximum deflection	ΔD	1.453 in at time	0.050 sec
Peak Overpressure	Fo	15.8 kips	Plastic deformation	yp = ym - ye	0.753 in	
Effective duration	t_e	0.072 sec	ductility ratio		2.08	
Time Increment	Δt	**0.002** sec	Rebound peak deflection	y_m	**0.119** in at time	0.098 sec
Positive Yield Deflection	+ Δy	0.70 in	Rebound elastic deformation	ye = ym - yp	-0.634 in	
Negative Yield Deflection	- Δy	-0.70 in	The peak reaction	R_o	-6.58 kips at time	0.024 sec
Resistance Coefficient	R_{cc}	**0.385**	Peak rebound reaction	R_o	-1.82 kips at time	0.000 sec
Force Coefficient	F_{cc}	**0.115**	Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.82 °	< 2° OK

Time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	15.80	0.00	3990	1.82
0.002	0.008	0.008	0.000	0.000	15.36	0.16	3839	1.83
0.004	0.031	0.031	0.000	0.000	14.92	0.62	3612	1.95
0.006	0.068	0.068	0.000	0.000	14.48	1.36	3315	2.19
0.008	0.118	0.118	0.000	0.000				
0.010	0.180	0.180	0.000	0.000				
0.012	0.252	0.252	0.000	0.000				
0.014	0.332	0.332	0.000	0.000				
0.016	0.418	0.418	0.000	0.000				
0.018	0.508	0.508	0.000	0.000				
0.020	0.600	0.600	0.000	0.000				
0.022	0.691	0.691	0.000	0.000				
0.024	0.779	0.700	0.079	0.000				
0.026	0.864	0.700	0.164	0.000				
0.028	0.945	0.700	0.245	0.000				
0.030	1.022	0.700	0.322	0.000				
0.032	1.094	0.700	0.394	0.000				
0.034	1.161	0.700	0.461	0.000				
0.036	1.222	0.700	0.522	0.000				
0.038	1.277	0.700	0.577	0.000				
0.040	1.325	0.700	0.625	0.000				
0.042	1.366	0.700	0.666	0.000				
0.044	1.400	0.700	0.700	0.000	6.14	13.95	(1971)	6.08
0.046	1.426	0.700	0.726	0.000	5.71	13.95	(2052)	6.03
0.048	1.444	0.700	0.744	0.000	5.27	13.95	(2193)	5.98
0.050	1.453	0.700	0.753	0.000	4.83	13.95	(2394)	5.93
0.052	1.453	0.700	0.753	0.000	4.39	13.95	(2415)	5.88
0.054	1.443	0.690	0.753	0.000	3.95	13.75	(2475)	5.75
0.056	1.423	0.670	0.753	0.000	3.51	13.35	(2485)	5.54
0.058	1.393	0.640	0.753	0.000	3.07	12.76	(2445)	5.26
0.060	1.353	0.600	0.753	0.000	2.63	11.96	(2355)	4.91
0.062	1.304	0.551	0.753	0.000	2.19	10.98	(2219)	4.48
0.064	1.246	0.493	0.753	0.000	1.76	9.83	(2038)	3.98
0.066	1.180	0.427	0.753	0.000	1.32	8.51	(1817)	3.43
0.068	1.107	0.354	0.753	0.000	0.88	7.06	(1560)	2.82
0.070	1.028	0.275	0.753	0.000	0.44	5.48	(1273)	2.16
0.072	0.944	0.191	0.753	0.000	0.00	3.81	(961)	1.47



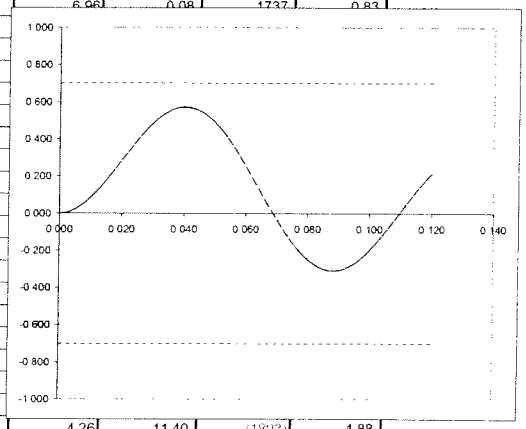


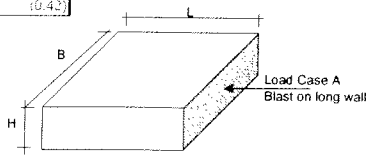
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

SIDE WALL

Equivalent Mass	m_e	0.00396 k-sec^2/in	**Summary**				
Effective Stiffness	K	19.93 k/in	Maximum deflection	ΔD	0.572 in at time	0.040 sec	
Peak Overpressure	Fo	7.1 kips	No plastic deformation				
Effective duration	t_e	0.1 sec					
Time Increment	Δt	**0.002** sec	Rebound peak deflection	y_m	**-0.308** in at time	0.088 sec	
Positive Yield Deflection	$+\Delta y$	0.7 in					
Negative Yield Deflection	$-\Delta y$	-0.7 in	The peak reaction	R_o	-4.88 kips at time	0.040 sec	
Resistance Coefficient	R_{cc}	**0.385**	Peak rebound reaction	R_o	0.01 kips at time	0.070 sec	
Force Coefficient	F_{cc}	**0.115**	Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.32 °	< 2° OK	

Time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	7.10	0.00	1793	0.82
0.002	0.004	0.004	0.000	0.000	6.96	0.08	1737	0.83
0.004	0.015	0.015	0.000	0.000				
0.006	0.033	0.033	0.000	0.000				
0.008	0.057	0.057	0.000	0.000				
0.010	0.086	0.086	0.000	0.000				
0.012	0.120	0.120	0.000	0.000				
0.014	0.158	0.158	0.000	0.000				
0.016	0.199	0.199	0.000	0.000				
0.018	0.242	0.242	0.000	0.000				
0.020	0.286	0.286	0.000	0.000				
0.022	0.330	0.330	0.000	0.000				
0.024	0.373	0.373	0.000	0.000				
0.026	0.414	0.414	0.000	0.000				
0.028	0.452	0.452	0.000	0.000				
0.030	0.486	0.486	0.000	0.000				
0.032	0.515	0.515	0.000	0.000				
0.034	0.539	0.539	0.000	0.000				
0.036	0.557	0.557	0.000	0.000				
0.038	0.568	0.568	0.000	0.000				
0.040	0.572	0.572	0.000	0.000	4.26	11.40	(1803)	4.88
0.042	0.569	0.569	0.000	0.000	4.12	11.34	(1824)	4.84
0.044	0.559	0.559	0.000	0.000	3.98	11.14	(1809)	4.75
0.046	0.542	0.542	0.000	0.000	3.83	10.80	(1760)	4.60
0.048	0.518	0.518	0.000	0.000	3.69	10.32	(1675)	4.40
0.050	0.487	0.487	0.000	0.000	3.55	9.71	(1555)	4.15
0.052	0.450	0.450	0.000	0.000	3.41	8.97	(1404)	3.84
0.054	0.407	0.407	0.000	0.000	3.27	8.11	(1224)	3.50
0.056	0.359	0.359	0.000	0.000	3.12	7.15	(1018)	3.11
0.058	0.307	0.307	0.000	0.000	2.98	6.12	(792)	2.70
0.060	0.252	0.252	0.000	0.000	2.84	5.02	(551)	2.26
0.062	0.195	0.195	0.000	0.000	2.70	3.89	(300)	1.81
0.064	0.137	0.137	0.000	0.000	2.56	2.73	(44)	1.35
0.066	0.079	0.079	0.000	0.000	2.41	1.57	212	0.88
0.068	0.022	0.022	0.000	0.000	2.27	0.44	463	0.43
0.070	-0.033	-0.033	0.000	0.000	2.13	(0.65)	704	(0.01)
0.072	-0.085	-0.085	0.000	0.000	1.99	(1.69)	930	(0.42)



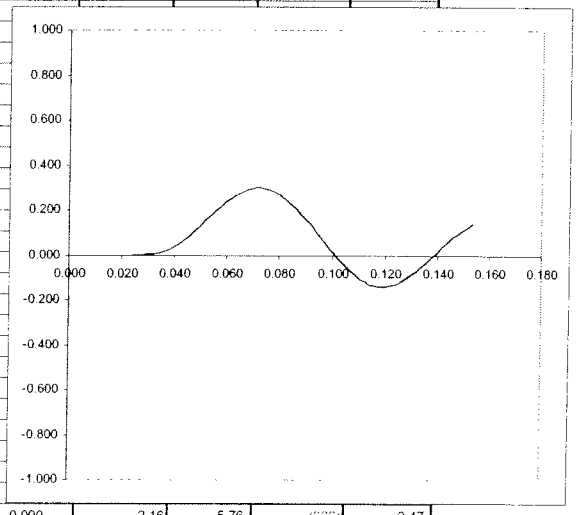


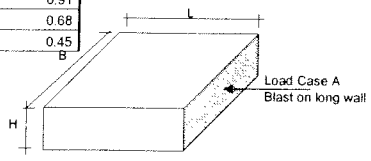
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

REAR WALL

Equivalent Mass	m_e	0.00396 k-sec^2/in	**Summary**				
Effective Stiffness	K	19.93 k/in	Maximum deflection	ΔD	0.297 in at time	0.048	
Peak Overpressure	Fo	3.43 kips	No Plastic Deformation				
Effective duration	t_e	0.1 sec					
Arrival time	t_a	0.024 sec					
Rise time	t_r	0.015 sec					
Time Increment	Δt	**0.002** sec	Rebound Peak Deflection	y_m	**-0.143** in at time	0.094	
Positive Yield Deflection	+ Δy	0.7 in					
Negative Yield Deflection	- Δy	-0.7 in	The peak reaction	R_o	-2.54 kips at time	0.042	
Resistance Coefficient	R_{cc}	**0.385**	Peak Rebound reaction	R_o	0.00 kips at time	#N/A	
Force Coefficient	F_{cc}	**0.115**	Support rotation	$\theta_s = \tan^{-1}(y_m/0.5L)$	0.17 °		

Time (sec)	Actual time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.024	0.000	0.000	0.000	0.000	0.00	0.00	0	0.00
0.002	0.026	0.000	0.000	0.000	0.000	0.46	0.00	115	0.05
0.004	0.028	0.000	0.000	0.000					
0.006	0.030	0.001	0.001	0.000					
0.008	0.032	0.003	0.003	0.000					
0.010	0.034	0.007	0.007	0.000					
0.012	0.036	0.013	0.013	0.000					
0.014	0.038	0.022	0.022	0.000					
0.016	0.040	0.034	0.034	0.000					
0.018	0.042	0.049	0.049	0.000					
0.020	0.044	0.066	0.066	0.000					
0.022	0.046	0.085	0.085	0.000					
0.024	0.048	0.106	0.106	0.000					
0.026	0.050	0.128	0.128	0.000					
0.028	0.052	0.151	0.151	0.000					
0.030	0.054	0.174	0.174	0.000					
0.032	**0.056**	**0.196**	**0.196**	**0.000**					
0.034	0.058	0.217	0.217	0.000					
0.036	0.060	0.236	0.236	0.000					
0.038	0.062	0.253	0.253	0.000					
0.040	0.064	0.268	0.268	0.000					
0.042	0.066	0.280	0.280	0.000					
0.044	0.068	0.289	0.289	0.000					
0.046	0.070	0.295	0.295	0.000					
0.048	0.072	0.297	0.297	0.000					
0.050	0.074	0.295	0.295	0.000					
0.052	0.076	0.289	0.289	0.000	0.000	2.16	5.76	(909)	2.47
0.054	0.078	0.279	0.279	0.000	0.000	2.09	5.56	(876)	2.38
0.056	0.080	0.265	0.265	0.000	0.000	2.02	5.28	(842)	2.27
0.058	0.082	0.248	0.248	0.000	0.000	1.96	4.94	(754)	2.13
0.060	0.084	0.228	0.228	0.000	0.000	1.89	4.54	(671)	1.97
0.062	0.086	0.205	0.205	0.000	0.000	1.82	4.09	(573)	1.78
0.064	0.088	0.180	0.180	0.000	0.000	1.75	3.59	(464)	1.58
0.066	0.090	0.153	0.153	0.000	0.000	1.68	3.05	(345)	1.37
0.068	0.092	0.125	0.125	0.000	0.000	1.61	2.49	(222)	1.14
0.070	0.094	0.096	0.096	0.000	0.000	1.54	1.91	(93)	0.91
0.072	0.096	0.067	0.067	0.000	0.000	1.47	1.34	35	0.68
0.074	0.098	0.038	0.038	0.000	0.000	1.41	0.76	164	0.45





Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

ROOF SLAB DESIGN

Bending Resistance

for dynamic bending	$f_{dy} = (SIF)(DIF)\, f_y$	= (1.1)(1.17) 58	74.6 ksi	514 MPa	
	$f_{dc} = (SIF)(DIF)\, f_c$	= (1.0)(1.19) 4	4.76 ksi	33 MPa	
Effective depth	d	= (354) - (10 in wall / 2)	349 in	8864.6 mm	
Reinf percentages	$\rho = A_s / bd$	= (7.9) / (60)(349)	0.0004 < 200/ f_{dy}		ACI 318, Eqn 10-3
	$a = A_s (f_y)/(0.85f'_{dc})(b)$	= 7.9 x 74.6 /(0.85 x 4.76 x 60)	2.43 in	61.7 mm	
	$M_p = A_s(f_{dy})[d - a/2]$	= 7.9 x 74.6 [349-2.43 / 2]	204964 in-k	23165.7 kNm	
Bending resistance	$R_b = 8(M_{pe}/L + M_{pc}/L)$	= 16 x 204963.6 / (45.1 x 12)	6060 kips	26965.4 kN	Table 6.1

Shear Resistance

for dynamic diagonal shear	$f'_{dc} = (SIF)(DIF)\, f'_c$	= (1.0)(1.0) 4	4 ksi	27.6 MPa	Appendix 5 A
	$f_{dy} = (SIF)(DIF)\, f_y$	= (1.1)(1.0) 58	63.8 ksi	439.9 MPa	
Shear resistance from ACI deep beam criteria, only 50% of slab thickness used for resisting in-plane shear					
	$V_c = 2\,(f'_c)^{0.5}\, bd$	= 2 x sqrt (4000) x 5 x 349/1000	221 kips	983 kN	ACI 318, Eqn 11-29
	$A_v = A_{vh}$		0.11 in^2	71 mm^2	
	$s = s_2$		7 in	178 mm	
	l_n / d	= 541 / 349	1.55	1.55	
Nominal Shear capacity	$V_s = [(A_v(1+l_n/d)/(12s)+A_{vh}(11-l_n/d)/(12s_2)]f_{dy}\, d$				ACI 318, Eqn 11-31
		= [(0.11(1+1.55)/(12 x 7) + 0.11(11 - 1.55)/(12 x7)]63.8 x 349	350 kips	1557 kN	
	$V_n = V_c + V_s$	221 + 350	571 kips	2541 kN	
At critical section (0.15L)	$R_{s1} = 2\, V_n / (0.7)$	= 2 x 571 / 0.7	1631 kips	7258 kN	
Shear resistance from shear friction criteria					
for shear friction	$f_{dy} = (SIF)(DIF)\, f_y$	= (1.1)(1.1) 58	70.18 ksi	484 MPa	Appendix 5.A
Friction coefficient	$\mu = 1.0\ (\lambda) = 1.0$	intentionally roughened surface	1.0	1.0	ACI 318, 11.7.4.3
	A_{vf}	= (0.11)(12 / 7) x 2 x 29.53	11.14 in^2	7187 mm^2	
	$V_n = A_{vf} f_{dy}\, \mu$	= 11.14 x 70.18 x 1	782 kips	3480 kN	
	$R_{s2} = 2V_n$		1564 kips	6959 kN	

SDOF Equivalent System

because $R_{s2} < R_{s1} < R_b$ shear friction governs					
	R_{min}	minimum of R_{s2}, R_{s1} and R_b	1564 kips	6959 kN	
as minimum reinforcement is not provided, μ_s			**1.0**	1.0	Table 5.B.1
Stiffness must include shear deformations Compute midspan deflection for arbitrary load of 1000 lb/in					
Use 50% of roof slab thickness to allow for out-of-plane cracking					
chord height	$d_{ch} = 4b + t$	= 4 x 10 + 5	45 in	1143 mm	
Including chord reinforcing	nA_s	= 8.05 x 7.9	64 in^2	41032 mm^2	
Amplified moment of inertia	$I_a = \Sigma\, b\,(h)^3/12 + \Sigma\, A\, d^2$	= 2 x 45 x 10^3 / 12 + 2.5 x 334^3/12			
		... . + 2 (45 x 10 + 63.6) x 177^2	40,041,701 in^4	17 m^4	
Flexural deflection	$\delta_f = wL^4/384E_cI_a$	= 1000 x 541^4 /(384 x 40041701 x 3605000)	0.0015 in	0.038 mm	AISC LRFD, beam tables
Shear modulus	$G = E_c / 2(1 + v)$	= 3605000 / 2(1+ 0.2)	1502083 psi	10357 MPa	
Shear deflection	$\delta_s = 0.125\, F\, w\, L^2 / A\, G$	= 0.125 x (6 / 5) x 1000541^2 / (5 x 349 x 1502083)	0.0167 in	0.424 mm	Roark p 185
Effective stiffness	$K = w\, L / (\delta_f + \delta_s)$	= 1000 x 541 / (0.0015 + 0.0167)	29725 k/in	5207423 kN/m	
Yield deflection	$y_s = R_u / K$	= 1564 / 29725	0.053 in	1.35 mm	
Include 20% of tributary wall weight with the beam mass					Section 6.4.2
Beam mass	m = (diaphragm wt + 0.2 tributary wall wt)/gravity				
		= 0.15 x [({45.098 x 0.5 x 29.53) + 0.2 (0.833 x 8.5 x 2)] / 386	0.308 k-sec^2/in	54.0 kNsec^2/m	
Elastic Load Factor	K_{LM}	= 0.78	0.78	0.78	Table 6.1
Equivalent mass	$m_e = (K_{LM})$ (beam mass)	= 0.78 x 0.308	0.24 k-sec^2/in	42.0 kNsec^2/m	
Period of vibration	$t_n = 2\,\pi\, (m_e / K)^{0.5}$	= 2 x 3.14 x sqrt(0.24 / 29725)	0.018 sec	0.018 sec	Eqn 6.8
For Support reactions	V=0.36R+0.14F				Table 6.1

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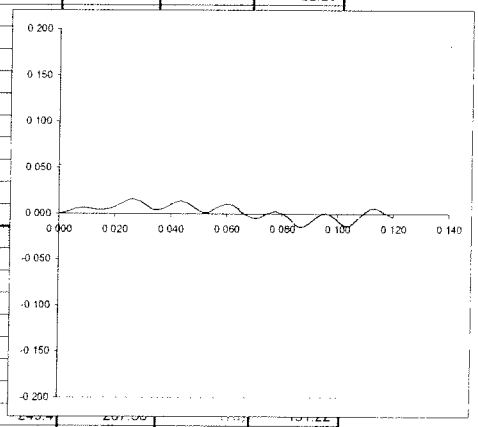
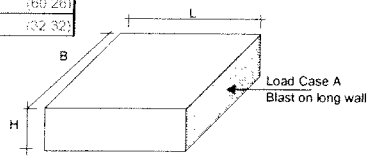
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

ROOF SLAB

Equivalent Mass	m_e	0.24 k-sec^2/in	**Summary**				
Effective Stiffness	K	29725 k/in	Maximum deflection	ΔD	0.015 in at time	0.026 sec	
Use front wall reactions -Rear wall reactions			No plastic deformation				
Period of vibration	t_e	0.072 sec					
Time Increment	Δt	**0.002** sec	Rebound peak deflection	y_m	**0.004** in at time	0.014 sec	
Positive Yield Deflection	$+\Delta y$	0.053 in					
Negative Yield Deflection	$-\Delta y$	-0.053 in	The peak reaction	R_o	-201.43 kips at time	0.024 sec	
Resistance Coefficient	R_{cc}	**0.360**	Peak rebound reaction	R_o	66.61 kips at time	0.068 sec	
Force Coefficient	F_{cc}	**0.140**	Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.01 °	< 2° OK	

Time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	82.1	0.00	342	11.49
0.002	0.001	0.001	0.000	0.000	82.5	29.73	220	22.26
0.004	0.003	0.003	0.000	0.000				
0.006	0.005	0.005	0.000	0.000				
0.008	0.006	0.006	0.000	0.000				
0.010	0.006	0.006	0.000	0.000				
0.012	0.005	0.005	0.000	0.000				
0.014	0.004	0.004	0.000	0.000				
0.016	0.004	0.004	0.000	0.000				
0.018	0.005	0.005	0.000	0.000				
0.020	0.007	0.007	0.000	0.000				
0.022	0.010	0.010	0.000	0.000				
0.024	0.013	0.013	0.000	0.000				
0.026	0.015	0.015	0.000	0.000				
0.028	0.014	0.014	0.000	0.000				
0.030	0.011	0.011	0.000	0.000				
0.032	0.007	0.007	0.000	0.000				
0.034	0.004	0.004	0.000	0.000				
0.036	0.004	0.004	0.000	0.000				
0.038	0.006	0.006	0.000	0.000				
0.040	0.009	0.009	0.000	0.000				
0.042	0.012	0.012	0.000	0.000	242.2	356.70	(477)	162.32
0.044	0.013	0.013	0.000	0.000	234.5	386.43	(633)	171.94
0.046	0.011	0.011	0.000	0.000	225.9	326.98	(421)	149.34
0.048	0.007	0.007	0.000	0.000	216.9	208.08	37	105.28
0.050	0.003	0.003	0.000	0.000	207.5	89.18	493	61.15
0.052	0.001	0.001	0.000	0.000	197.5	29.72	699	38.36
0.054	0.002	0.002	0.000	0.000	184.0	59.45	519	47.16
0.056	0.005	0.005	0.000	0.000	167.3	148.63	78	76.93
0.058	0.008	0.008	0.000	0.000	147.9	237.80	(374)	106.32
0.060	0.010	0.010	0.000	0.000	125.8	297.25	(714)	124.63
0.062	0.009	0.009	0.000	0.000	100.6	267.53	(696)	110.39
0.064	0.005	0.005	0.000	0.000	73.5	148.63	(343)	63.80
0.066	0.000	0.000	0.000	0.000	44.6	(0.00)	186	6.25
0.068	-0.004	-0.004	0.000	0.000	14.4	(118.90)	556	(46.78)
0.070	-0.006	-0.006	0.000	0.000	-17.1	(178.35)	672	(66.61)
0.072	-0.005	-0.005	0.000	0.000	-48.3	(148.63)	418	(60.26)
0.074	-0.002	-0.002	0.000	0.000	-78.0	(59.45)	(77)	(32.32)





Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

SIDE WALLS, IN-PLANE

Bending Resistance

	Height	depth to foundation	**25.5** ft		
	Length		29.53 ft		
for dynamic bending	f_{dy} = (SIF)(DIF) f_y	= (1.1)(1.17) 58	74.6 ksi	514 MPa	
	f_{dc} = (SIF)(DIF) f_c	= (1.0)(1.19) 4	4.76 ksi	33 MPa	
For bending assume 12 no bars at the corner provide the tension component for resisting in-plane moment					
	A_s	= 12 x 0.31	3.72 in^2	2400 mm^2	
	b_w		10 in	254.0 mm	
Effective depth	d	= (354) - (10 in wall) +(1.5 in)+ (0.625 in bar)/2	346 in	8788.4 mm	
Reinf percentages	$\rho = A_s / bd$	= (3.72) / (10)(346)	0.0011 < 200/ f_{dy}		ACI 318, Eqn 10-3
beam flange	b_f		24.0 in	609.6 mm	
	$a = A_s (f_y)/(0.85f_{dc})(b)$	= 3.72 x 74.6 /(0.85 x 4.76 x 24)	2.86 in	72.6 mm	WITHIN THICKNESS OF INTERSECTING WALL
	$M_b = A_s(f_{dy})[d - a/2]$	= 3.72 x 74.6 [346-2.86 / 2]	95622 in-k	10808 kNm	
Bending resistance	$R_b = M_b/L$	= 95622.3 / 306	312 kips	1388.3 kN	Table 6.1

Shear Resistance

for shear friction	f_{dy} = (SIF)(DIF) f_y	= (1.1)(1.1) 58	70.18 ksi	484 MPa	Appendix 5.A
Friction coefficient	μ = 0.6 (λ) = 0.6	not intentionally roughened	0.6	0.6	ACI 318, 11.7.4.3
	A_{vf}	= (0.31)(12 / 6) x 2 x 354	36.62 in^2	23626 mm^2	
	$R_s = V_n = A_{vf} f_{dy} \mu$	= 36.62 x 70.18 x 0.6	1542 kips	6862 kN	

SDOF Equivalent System

because R_b < R_s bending governs

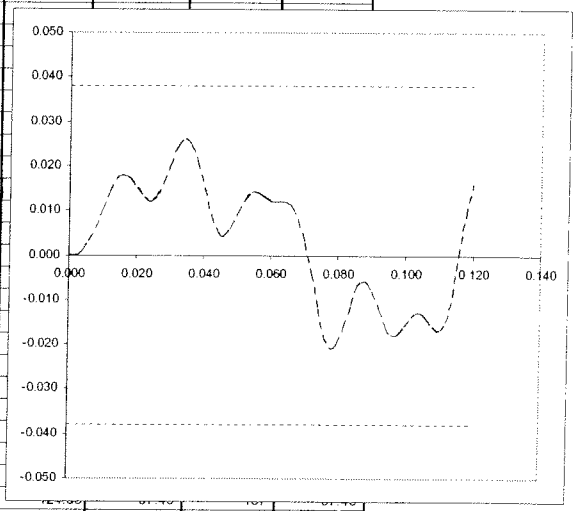
	R_{min}	minimum of R_s and R_b	312 kips	1388 kN	
as minimum reinforcement is not provided, μ_s			**1.5**	1.5	Table 5.B.1
Stiffness must include shear deformations. Compute midspan deflection for arbitrary load of 1000 lb/in					
Use 50% of roof slab thickness to allow for out-of-plane cracking					
chord height	d_{ch} = 4b + t	= 4 x 10 + 10	50 in	1270 mm	
Including chord reinforcing	nA_s	= 8.05 x 3.72	29.95 in^2	19323 mm^2	
Amplified moment of inertia	$I_e = \Sigma b (h)^3/12 + \Sigma A d^2$	= 2 x 50 x 10^3 / 12 + 5 x 334^3/12 . .			
		..... + 2 (50 x 10 + 29.95) x 177^2	48,856,643 in^4	20 m^4	
Flexural deflection	$\delta_f = P H^3 /3E_c I_e$	= 1000 x 306^3 /(3 x 48856643 x 3605000)	0.0542 in	1.377 mm	AISC LRFD, beam tables
Shear modulus	$G = E_c / 2(1 + v)$	= 3605000 / 2(1+ 0.2)	1502083 psi	10357 MPa	
Shear deflection	δ_s = 1.2 H P / A G	= 1.2 x 306 x 1000) / (5 x 346 x 1502083)	0.0690 in	1.753 mm	Roark p 185
Effective stiffness	K = w L / (δ_f + δ_s)	= 1000 / (0.0542 + 0.069)	8117 k/in	1421990 kN/m	
Yield deflection	$y_e = R_u$ / K	= 312 / 8117	0.038 in	0.97 mm	
Tributary front & rear wall wt	w1	= 0.15 x 0.83 x 22.97 x 8.5 x 2	48.6 kips	216 kN	Section 6.4.2
Tributary roof wt	w2	= 0.15 x 0.5 x 29.53 x 45.931 / 2	50.9 kips	226 kN	
Tributary shear wall wt	w3	= 0.15 x 0.83 x 29.53 x 25.5 / 2	46.9 kips	209 kN	
Beam mass	m = (w_3 + 0.2 (w_2 + w_1)/gravity	= (46.9 + 0.2 x (50.9 + 48.6)) / 386	0.173 k-sec^2/in	30.3 kNsec^2/m	
Period of vibration	$t_n = 2\pi (m_e / K)^{0.5}$	= 2 x 3.14 x sqrt(0.173 / 8117)	0.029 sec	0.029 sec	Eqn 6.8
For Support reactions	V=R				Table 6.1

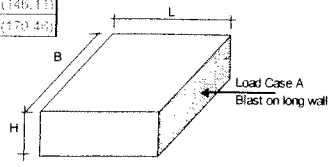
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

SIDE WALL (In-Plane)

Equivalent Mass	m_e	0.173 k-sec^2/in	**Summary**				
Effective Stiffness	K	8117 k/in	Maximum deflection	ΔD	0.026 in at time	0.034 sec	
Use front wall reactions -Rear wall reactions			No plastic deformation				
Period of vibration	t_e	0.029 sec					
Time Increment	Δt	**0.002** sec	Rebound peak deflection	y_m	**-0.026** in at time	#N/A sec	
Positive Yield Deflection	$+\Delta y$	0.038 in					
Negative Yield Deflection	$-\Delta y$	-0.038 in	The peak reaction	R_o	-211.04 kips at time	0.034 sec	
Resistance Coefficient	R_{cc}	**1.000**	Peak rebound reaction	R_o	0.00 kips at time	0.000 sec	
Force Coefficient	F_{cc}	**0.000**	Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.01 °	< 2° OK	

Time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	11.49	0.00	66	0.00
0.002	0.000	0.000	0.000	0.000	22.26	0.00	129	0.00
0.004	0.001	0.001	0.000	0.000	44.41	8.12	210	8.12
0.006	0.003	0.003	0.000	0.000	67.33	24.35	248	24.35
0.008	0.006	0.006	0.000	0.000	80.12	48.70	182	48.70
0.010	0.010	0.010	0.000	0.000	82.83	81.17	10	81.17
0.012	0.014	0.014	0.000	0.000	75.29	113.64	(222)	113.64
0.014	0.017	0.017	0.000	0.000	68.12	137.99	(434)	137.99
0.016	0.018	0.018	0.000	0.000				
0.018	0.017	0.017	0.000	0.000				
0.020	0.015	0.015	0.000	0.000				
0.022	0.013	0.013	0.000	0.000				
0.024	0.012	0.012	0.000	0.000				
0.026	0.013	0.013	0.000	0.000				
0.028	0.016	0.016	0.000	0.000				
0.030	0.020	0.020	0.000	0.000				
0.032	**0.024**	**0.024**	**0.000**	**0.000**				
0.034	0.026	0.026	0.000	0.000				
0.036	0.025	0.025	0.000	0.000				
0.038	0.021	0.021	0.000	0.000				
0.040	0.015	0.015	0.000	0.000				
0.042	0.009	0.009	0.000	0.000				
0.044	0.005	0.005	0.000	0.000				
0.046	0.004	0.004	0.000	0.000				
0.048	0.006	0.006	0.000	0.000				
0.050	0.009	0.009	0.000	0.000				
0.052	0.012	0.012	0.000	0.000				
0.054	0.014	0.014	0.000	0.000				
0.056	0.014	0.014	0.000	0.000				
0.058	0.013	0.013	0.000	0.000				
0.060	0.012	0.012	0.000	0.000				
0.062	0.012	0.012	0.000	0.000	110.39	97.40	75	97.40
0.064	0.012	0.012	0.000	0.000	63.80	97.40	(194)	97.40
0.066	0.011	0.011	0.000	0.000	6.25	89.29	(480)	89.29
0.068	0.008	0.008	0.000	0.000	-40.78	64.94	(611)	64.94
0.070	0.003	0.003	0.000	0.000	-66.61	24.35	(526)	24.35
0.072	-0.004	-0.004	0.000	0.000	-60.26	(32.47)	(161)	(32.47)
0.074	-0.012	-0.012	0.000	0.000	-32.32	(97.40)	376	(97.40)
0.076	-0.018	-0.018	0.000	0.000	-4.26	(146.11)	820	(146.11)
0.078	-0.021	-0.021	0.000	0.000	2.65	(170.46)	1001	(170.46)





Client	Getrich Development		Use in correspondences			
Project	Deepdown Sands	234	010455			
Location	Up in the North	Dept	Job	Reference		
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A		Rev	0

ROOF SLAB, OUT-OF-PLANE

Bending Resistance

for dynamic bending	$f_{dy} = (SIF)(DIF)\ f_y$	= (1.1)(1.17) 58	74.6 ksi	514 MPa	
	$f_{dc} = (SIF)(DIF)\ f_c$	= (1.0)(1.19) 4	4.76 ksi	33 MPa	
Effective depth	d_c	= (5) - (0.75 in clear) - ((0.375 in bar)/2	4.06 in	103.1 mm	
	d_s	= (5) - (0.75 in clear) - ((0.375 in bar)/2+(2 in deck)/2	5.06 in	128.5 mm	
Steel layer per face	A_s (in^2/ft)	= (0.11 x 12)/(7 in bar spacing)	0.189 in^2	121.9 mm^2	
Reinf percentages	$\rho_c = A_s / bd$	= (0.189) / (12)(4.06)	0.0039		
	$\rho_s = A_s / bd$	= (0.189) / (12)(5.06)	0.0031 > 200 / f_{dy} OK		
	$a = A_s (f_y)/(0.85f'_{dc})(b)$	= 0.189 x 74.6 /(0.85 x 4.76 x 12)	0.29 in	7.4 mm	
	$M_{pc} = M_n = A_s(f_{dy})[d - a/2]$	= 0.189 x 74.6 [4.06-0.29 / 2]	55.2 in-k	6.2 kNm	
	$M_{ps} = M_n = A_s(f_{dy})[d - a/2]$	= 0.189 x 74.6 [5.06-0.29 / 2]	69.3 in-k	7.8 kNm	
Bending resistance	$R_b = 8(M_p + M_s)/L$	= 8 x (55.2 + 69.3) / (5.75 x 12)	14.43 kips	64.2 kN	Table 6.1

Shear Resistance

for dynamic shear	$f'_{dc} = (SIF)(DIF)\ f'_c$	= (1.0)(1.0) 4	4 ksi	27.6 MPa	Appendix 5.A
	$V_n = 2 (f'_c)^{0.5} bd$	= 2 x sqrt (4000) x 1 x 12 x 5.06	7.68 kips	34.2 kN	ACI 318, Eqn 11-3
At critical section	$R_s = V_n L/ (0.5L - d)$	= 7.68 x 69 /(0.5 x 5.75 x 12 - 5.06)	18 kips	80.1 kN	

SDOF Equivalent System

because $R_b < R_s$ bending governs

	R_{min}	minimum of R_s and R_b	14.43 kips	64.2 kN	
Allowable response	θ_a		**2.0** °		Table 5.B.1
slab weight	w	= 0.15 x 0.5	0.075 ksf		
Static load	W	= 5.75 x 1 x (0.075 + 0.025 DL)	0.575 kips	2.6 kN	
Positive R_u	$R_u = R_b - W$	= 14.43 - 0.575	13.855 kips	61.7 kN	
Negative R_u	$R_u = R_b + W$	= - (14.43 + 0.575)	-15.005 kips	-66.8 kN	
Use average	r	= (0.0039 + 0.0031) / 2	0.0035		
Gross moment of inertia	$I_g = b (h)^3 /12$	= 12 x 5^3 / 12	125 in^4	5203 cm^4	
	nA_s	= 8.05 x 0.189	1.52 in^2	981 mm^2	
Depth of uncracked section	$C_n = [(-nA_s)+(nA_s(nA_s+2bd)0.5]/b$	= [-1.52 + sqrt(1.52(1.52 +2 x 12 x 4.06)]/12	0.90 in	22.9 mm	
Cracked moment of inertia	$I_{cr} = b C^3/3 + nA_s (d - C)^2$	= 12 x 0.9^3 / 3 + 1.52(4.06 - 0.9)^2	18.1 in^4	753 cm^4	
Averaged moment of inertia	$I_a = (I_g + I_{cr}) /2$	= (125 + 18.1)/2	71.6 in^4	2978 cm^4	
Effective stiffness	$K = 307\ E\ I / L^3$	= (307 x 3605 x 71.55) / (69^3)	241.05 k/in	42229 kN/m	Biggs Table 5.2
Positive yield deflection	$y_e = R_u / K$	= 13.855 / 241.05	0.06 in	1.5 mm	
Negative yield deflection	$y_e = R_u / K$	= -15.005 / 241.05	-0.06 in	-1.5 mm	
Beam mass	m = (beam weight)/(gravity)	= (0.15 x 0.5 x 1 x 5.75) / (386.4)	0.0011 k-sec^2/in	0.193 kNsec^2/m	
Elastic Load Factor	K_{LM}	= 0.41 / 0.53	0.77	0.77	Table 6.1
Plastic Load Factor	K_{LM}	= 0.33 / 0.5	0.66	0.66	
Averaged Load Factor	K_{LM}	= (0.77 + 0.66)/2	0.715	0.715	
Equivalent mass	$m_e = (K_{LM})$ (beam mass)	= 0.715 x 0.0011	0.0008 k-sec^2/in	0.140 kNsec^2/m	
Period of vibration	$t_n = 2\ \pi\ (m_e / K)^{0.5}$	= 2 x 3.14 x sqrt(0.0008 / 241.05)	0.011 sec	0.011 sec	Eqn 6.8
For Support reactions	V=0.37R+0.13F				Table 6.1

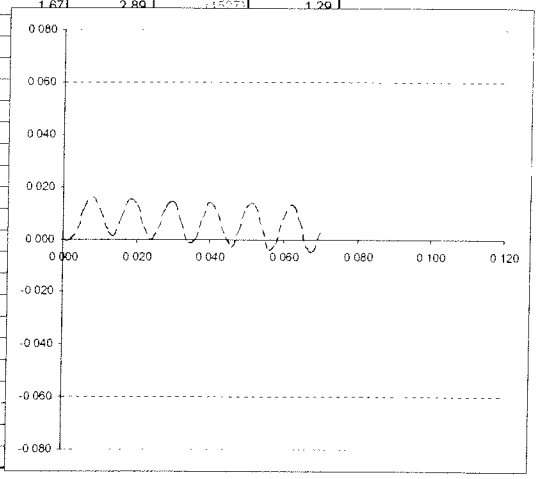
Average of elastic and plastic conditions

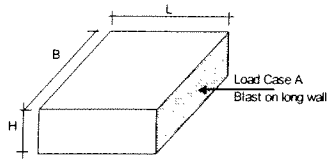
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

ROOF SLAB (out of plane)

Equivalent Mass	m_e	0.0008 k-sec^2/in	**Summary**				
Effective Stiffness	K	241.05 k/in	Maximum deflection	ΔD	0.016 in at time	0.008 sec	
Peak Overpressure	Fo	2.17 kips	No Plastic Deformation				
Effective duration	t_e	0.1 sec					
Arrival time	t_a	0 sec					
Rise time	t_r	0.005 sec					
Time Increment	Δt	**0.002** sec	Rebound Peak Deflection	y_m	**0.001** in at time	0.014 sec	
Positive Yield Deflection	+ Δy	0.06 in					
Negative Yield Deflection	- Δy	-0.06 in	The peak reaction	R_o	-1.70 kips at time	0.008 sec	
Resistance Coefficient	R_{cc}	**0.370**	Peak Rebound reaction	R_o	0.34 kips at time	0.068 sec	
Force Coefficient	F_{cc}	**0.130**	Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.03 °	< 2° OK	

Time (sec)	Actual time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0	0.00
0.002	0.002	0.000	0.000	0.000	0.000	0.87	0.00	1085	0.11
0.004	0.004	0.004	0.004	0.000	0.000	1.74	0.96	965	0.58
0.006	0.006	0.012	0.012	0.000	0.000	2.15	2.89	(958)	1.35
0.008	0.008	0.016	0.016	0.000	0.000	2.10	3.86	(2190)	1.70
0.010	0.010	0.011	0.011	0.000	0.000	2.06	2.65	(728)	1.25
0.012	0.012	0.003	0.003	0.000	0.000	2.02	0.72	1619	0.53
0.014	0.014	0.001	0.001	0.000	0.000	1.97	0.24	2167	0.35
0.016	0.016	0.008	0.008	0.000	0.000	1.93	1.93	4	0.96
0.018	0.018	0.015	0.015	0.000	0.000	1.89	3.62	(2160)	1.58
0.020	0.020	0.013	0.013	0.000	0.000	1.84	3.13	(1611)	1.40
0.022	0.022	0.005	0.005	0.000	0.000	1.80	1.21	745	0.68
0.024	0.024	0.000	0.000	0.000	0.000	1.76	(0.00)	2197	0.23
0.026	0.026	0.004	0.004	0.000	0.000	1.71	0.96	938	0.58
0.028	0.028	0.012	0.012	0.000	0.000	1.67	2.89	(1507)	1.29
0.030	0.030	0.014	0.014	0.000	0.000				
0.032	0.032	0.007	0.007	0.000	0.000				
0.034	0.034	-0.001	-0.001	0.000	0.000				
0.036	0.036	0.000	0.000	0.000	0.000				
0.038	0.038	0.008	0.008	0.000	0.000				
0.040	0.040	0.014	0.014	0.000	0.000				
0.042	0.042	0.010	0.010	0.000	0.000				
0.044	0.044	0.001	0.001	0.000	0.000				
0.046	0.046	-0.003	-0.003	0.000	0.000				
0.048	0.048	0.003	0.003	0.000	0.000				
0.050	0.050	0.012	0.012	0.000	0.000				
0.052	0.052	0.013	0.013	0.000	0.000				
0.054	0.054	0.004	0.004	0.000	0.000				
0.056	0.056	-0.004	-0.004	0.000	0.000				
0.058	0.058	-0.002	-0.002	0.000	0.000				
0.060	0.060	0.008	0.008	0.000	0.000				
0.062	0.062	0.013	0.013	0.000	0.000				
0.064	0.064	0.007	0.007	0.000	0.000				
0.066	0.066	-0.003	-0.003	0.000	0.000				
0.068	0.068	-0.005	-0.005	0.000	0.000				
0.070	0.070	0.003	0.003	0.000	0.000				



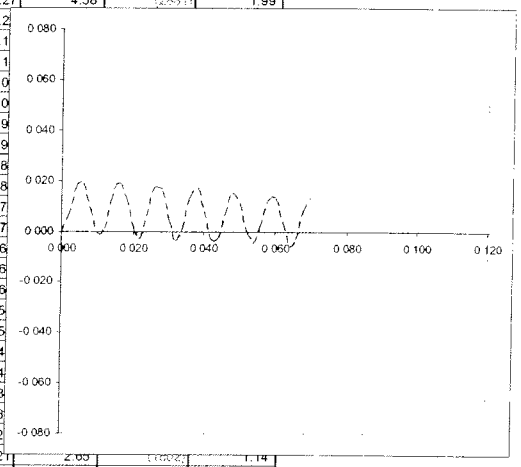


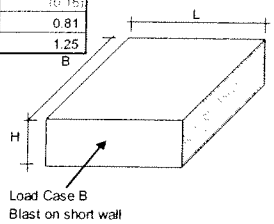
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

ROOF SLAB (out of plane)

Equivalent Mass	m_e	0.0008 k-sec^2/in	**Summary**				
Effective Stiffness	K	241.05 k/in	Maximum deflection	ΔD	0.019 in at time	0.006 sec	
Peak Overpressure	Fo	2.42 kips	No Plastic Deformation				
Effective duration	t_e	0.1 sec					
Arrival time	t_a	0 sec					
Rise time	t_r	0 sec					
Time Increment	Δt	**0.002** sec	Rebound Peak Deflection	y_m	**-0.001** in at time	0.010 sec	
Positive Yield Deflection	$+\Delta y$	0.06 in					
Negative Yield Deflection	$-\Delta y$	-0.06 in	The peak reaction	R_o	-1.99 kips at time	0.006 sec	
Resistance Coefficient	R_{cc}	**0.370**	Peak Rebound reaction	R_o	0.42 kips at time	0.064 sec	
Force Coefficient	F_{cc}	**0.130**	Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.03 ^{o}		

Time (sec)	Actual time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	0.000	2.42	0.00	3025	0.31
0.002	0.002	0.006	0.006	0.000	0.000	2.37	1.45	1157	0.84
0.004	0.004	0.017	0.017	0.000	0.000	2.32	4.10	(2,215)	1.82
0.006	0.006	0.019	0.019	0.000	0.000	2.27	4.58	(2,853)	1.99
0.008	0.008	0.009	0.009	0.000	0.000	2.2			
0.010	0.010	-0.001	-0.001	0.000	0.000	2.1			
0.012	0.012	0.001	0.001	0.000	0.000	2.1			
0.014	0.014	0.012	0.012	0.000	0.000	2.0			
0.016	0.016	0.019	0.019	0.000	0.000	2.0			
0.018	0.018	0.013	0.013	0.000	0.000	1.9			
0.020	0.020	0.001	0.001	0.000	0.000	1.9			
0.022	0.022	-0.003	-0.003	0.000	0.000	1.8			
0.024	0.024	0.006	0.006	0.000	0.000	1.8			
0.026	0.026	0.017	0.017	0.000	0.000	1.7			
0.028	**0.028**	**0.016**	**0.016**	**0.000**	**0.000**	1.7			
0.030	0.030	0.004	0.004	0.000	0.000	1.6			
0.032	0.032	-0.004	-0.004	0.000	0.000	1.6			
0.034	0.034	0.001	0.001	0.000	0.000	1.6			
0.036	0.036	0.013	0.013	0.000	0.000	1.5			
0.038	0.038	0.017	0.017	0.000	0.000	1.5			
0.040	0.040	0.008	0.008	0.000	0.000	1.4			
0.042	0.042	-0.003	-0.003	0.000	0.000	1.4			
0.044	0.044	-0.003	-0.003	0.000	0.000	1.3			
0.046	0.046	0.007	0.007	0.000	0.000	1.3			
0.048	0.048	0.015	0.015	0.000	0.000	1.2			
0.050	0.050	0.011	0.011	0.000	0.000	1.21	2.65	(1,082)	1.14
0.052	0.052	0.000	0.000	0.000	0.000	1.16	0.00	1452	0.15
0.054	0.054	-0.005	-0.005	0.000	0.000	1.11	(1.21)	2898	(0.30)
0.056	0.056	0.002	0.002	0.000	0.000	1.06	0.48	728	0.32
0.058	0.058	0.012	0.012	0.000	0.000	1.02	2.89	(2,345)	1.20
0.060	0.060	0.013	0.013	0.000	0.000	0.97	3.13	(2,707)	1.29
0.062	0.062	0.003	0.003	0.000	0.000	0.92	0.72	246	0.39
0.064	0.064	-0.006	-0.006	0.000	0.000	0.87	(1.45)	2897	(0.42)
0.066	0.066	-0.003	-0.003	0.000	0.000	0.82	(0.72)	1932	(0.16)
0.068	0.068	0.008	0.008	0.000	0.000	0.77	1.93	(1443)	0.81
0.070	0.070	0.013	0.013	0.000	0.000	0.73	3.13	(3010)	1.25





Load Case B
Blast on short wall

Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

ROOF BEAM

Bending Resistance

for dynamic bending	f_{dv} = (SIF)(DIF) f_v	= (1.1)(1.29) 36	51.1 ksi	352 MPa	
check flange	$\lambda_p = 65/(F_y)^{0.5}$	= 65 / 7.15	9.09 > 6.57 OK		AISC LRFD Table B5.1
check web	$\lambda_p = 640/(F_y)^{0.5}$	= 640 / 7.15	89.53 > 37.5 OK		AISC LRFD Table B5.1
Unbraced lengh for plastic design	$L_{pd} = (3600 + 2200\ M_1/M_p)\ r_y/f_{dy}$	= (3600 + 0) (1.55)/51.1	109.20 in	2773.6 mm	AISC LRFD Eqn F1-1
Plastic moment capacity	$M_p = Z\ f_{dy}$	= 61.5 x 51.1	3143 in-k	355.2 kNm	
	$R_b = 8\ (M_p) / L$	= (8 x 3143)/(15 x 12)	139.7 kips	621.6 kN	

Shear Resistance

for dynamic shear	f_{dc}= (SIF)(DIF) f_v	= (1.1)(1.29) 36	51.1 ksi	352.3 MPa	Appendix 5.A
	$V_n = 0.6\ f_{dy}\ d\ t_w$	= 0.6 x 51.1 x 14.1 x 0.31	134.0 kips	596.3 kN	ACI 318, Eqn 11-3
At critical section	$R_s = 2\ V_n$	= 2 x 134	268.0 kips	1192.5 kN	

SDOF Equivalent System

because R_b < R_s bending governs

	R_{min}	minimum of R_s and R_b	139.7 kips	621.6 kN	
Allowable response	θ_a		**2.0** °		Table 5.B.3
Allowable ductility	μ_a		**3.0**		LOW RESPONSE
slab weight	w	= 0.15 x 0.5	0.075 ksf		
Static load	W	= 38 x 15 + 15 x 5.75 x (0.075 + 0.025 DL)	9.2 kips	40.9 kN	
Positive R_u	$R_u = R_b$ - W	= 139.7 - 9.2	130.5 kips	580.7 kN	
Negative R_u	$R_u = R_b$ + W	= - (139.7 + 9.2)	-148.9 kips	-662.6 kN	
Effective stiffness	$K = 384\ E\ I / 5L^3$	= (384 x 29007.4 x 385) / (5 x 180^3)	147.1 k/in	25770 kN/m	Biggs Table 5.2
Positive yield deflection	$y_e = R_u / K$	= 130.5 / 147.1	0.89 in	22.6 mm	
Negative yield deflection	$y_e = R_u / K$	= -148.9 / 147.1	-1.01 in	-25.7 mm	
Beam mass	m = (beam wt + 20% slab)/(gravity)	= 0.57 + 0.2 x (14.4) / (386.4)	0.0089 k-sec^2/in	1.56 kNsec^2/m	
Elastic Load Factor	K_{LM}	= 0.5 / 0.64	0.78	0.78	Table 6.1
Plastic Load Factor	K_{LM}	= 0.33 / 0.5	**0.66**	**0.66**	
Averaged Load Factor	K_{LM}	= (0.78 + 0.66)/2	0.72	0.72	
Equivalent mass	$m_e = (K_{LM})$ (beam mass)	= 0.72 x 0.0089	0.0064 k-sec^2/in	1.121 kNsec^2/m	
Period of vibration	$t_n = 2\ \pi\ (m_e / K)^{0.5}$	= 2 x 3.14 x sqrt(0.0064 / 147.1)	0.041 sec	0.041 sec	Eqn 6.8
For Support reactions	V=0.385R+0.115F				Table 6.1

Average of elastic and plastic conditions

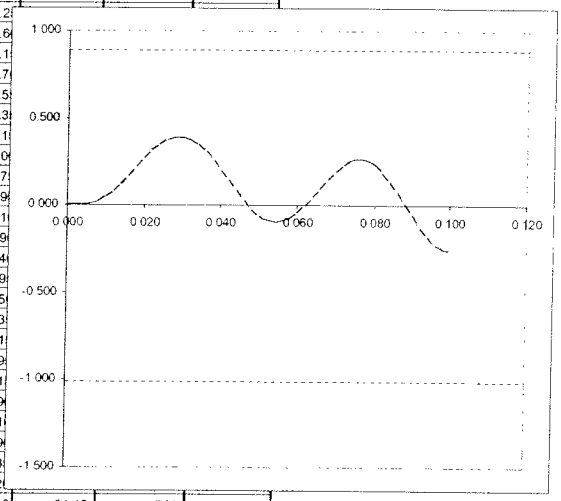
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

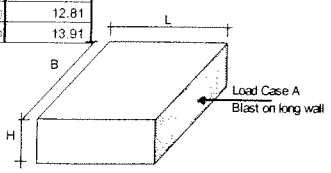
Roof Beam

Equivalent Mass	m_e	0.0089 k-sec^2/in	**Summary**				
Effective Stiffness	K	147.1 k/in	Maximum deflection	ΔD	0.387 in at time	0.030 sec	
Peak Overpressure	Fo	2.17 kips	No Plastic Deformation				
Effective duration	t_e	0.1 sec					
Arrival time	t_a	0 sec					
Rise time	t_r	0.005 sec					
Time Increment	Δt	**0.002** sec	Rebound Peak Deflection	y_m	**-0.096** in at time	0.054 sec	
Positive Yield Deflection	+ Δy	0.89 in					
Negative Yield Deflection	- Δy	-1.01 in	The peak reaction	R_o	-25.26 kips at time	0.020 sec	
Resistance Coefficient	R_{cc}	**0.385**	Peak Rebound reaction	R_o	3.83 kips at time	0.046 sec	
Force Coefficient	F_{cc}	**0.115**	Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.25 °	< 2° OK	

Load = beam span x [(slab reactions) + (slab reaction to 0.006 sec delay)]

Time (sec)	Actual time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0	0.00
0.002	0.002	0.000	0.000	0.000	0.000	1.65	0.00	185	0.19
0.004	0.004	0.001	0.001	0.000	0.000	8.70	0.15	961	1.06
0.006	0.006	0.006	0.006	0.000	0.000	20.25	0.88	2176	2.67
0.008	0.008	0.020	0.020	0.000	0.000	27.15	2.94	2720	4.25
0.010	0.010	0.045	0.045	0.000	0.000	27.45	6.62	2341	5.71
0.012	0.012	0.079	0.079	0.000	0.000	28.20	11.62	1863	7.72
0.014	0.014	0.120	0.120	0.000	0.000	30.75	17.65	1472	10.33
0.016	0.016	0.167	0.167	0.000	0.000	33.15	24.57	965	13.27
0.018	0.018	0.218	0.218	0.000	0.000	31.65	32.07	(47)	15.99
0.020	0.020	0.269	0.269	0.000	0.000	26.2			
0.022	0.022	0.314	0.314	0.000	0.000	24.6			
0.024	0.024	0.349	0.349	0.000	0.000	27.1			
0.026	0.026	0.373	0.373	0.000	0.000	29.7			
0.028	0.028	0.386	0.386	0.000	0.000	29.5			
0.030	0.030	0.387	0.387	0.000	0.000	25.3			
0.032	0.032	0.374	0.374	0.000	0.000	21.1			
0.034	0.034	0.346	0.346	0.000	0.000	21.0			
0.036	0.036	0.305	0.305	0.000	0.000	24.7			
0.038	0.038	0.255	0.255	0.000	0.000	25.9			
0.040	0.040	0.200	0.200	0.000	0.000	23.1			
0.042	0.042	0.142	0.142	0.000	0.000	18.9			
0.044	0.044	0.083	0.083	0.000	0.000	17.4			
0.046	0.046	0.026	0.026	0.000	0.000	19.9			
0.048	0.048	-0.024	-0.024	0.000	0.000	22.5			
0.050	0.050	-0.062	-0.062	0.000	0.000	22.3			
0.052	0.052	-0.086	-0.086	0.000	0.000	18.1			
0.054	0.054	-0.096	-0.096	0.000	0.000	13.9			
0.056	0.056	-0.093	-0.093	0.000	0.000	15.1			
0.058	0.058	-0.077	-0.077	0.000	0.000	18.9			
0.060	0.060	-0.047	-0.047	0.000	0.000	20.1			
0.062	0.062	-0.005	-0.005	0.000	0.000	15.9			
0.064	0.064	0.044	0.044	0.000	0.000	10.3			
0.066	0.066	0.095	0.095	0.000	0.000	10.2			
0.068	0.068	0.144	0.144	0.000	0.000	14.10	21.18	(708)	9.78
0.070	0.070	0.190	0.190	0.000	0.000	16.65	27.95	(1270)	12.68
0.072	0.072	0.231	0.231	0.000	0.000	-2.40	33.98	(4966)	12.81
0.074	0.074	0.256	0.256	0.000	0.000	-5.10	37.66	(4804)	13.91



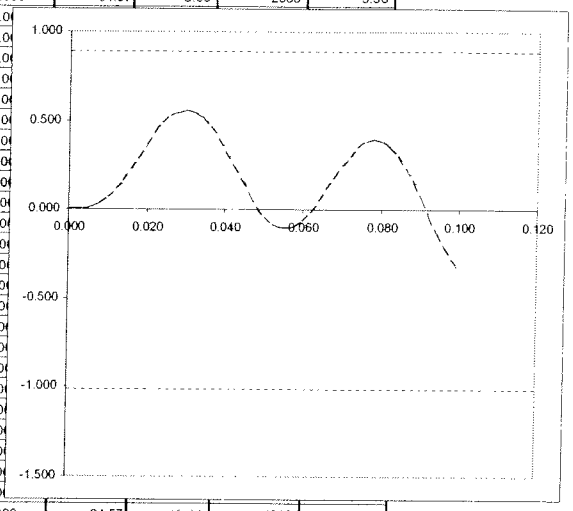


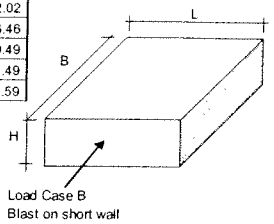
Roof Beam

Equivalent Mass	m_e	0.0089 k-sec^2/in	**Summary**				
Effective Stiffness	K	147.1 k/in	Maximum deflection	ΔD	0.554 in at time	0.030 sec	
Peak Overpressure	Fo	2.42 kips	No Plastic Deformation				
Effective duration	t_e	0.1 sec					
Arrival time	t_a	0 sec					
Rise time	t_r	0.001 sec					
Time increment	Δt	**0.002** sec	Rebound Peak Deflection	y_m	**-0.106** in at time	0.056 sec	
Positive Yield Deflection	+ Δy	0.89 in					
Negative Yield Deflection	- Δy	-1.01 in	The peak reaction	R_u	-36.45 kips at time	0.020 sec	
Resistance Coefficient	R_{cc}	**0.385**	Peak Rebound reaction	R_o	3.95 kips at time	0.048 sec	
Force Coefficient	F_{cc}	**0.115**	Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.35 °	< 2° OK	

Load = beam span x [average of delayed slab reaction to 0.014 sec] x 2 sides

Time (sec)	Actual time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	0.000	1.62	0.00	182	0.19
0.002	0.002	0.000	0.000	0.000	0.000	6.00	0.00	674	0.69
0.004	0.004	0.003	0.003	0.000	0.000	15.50	0.44	1692	1.95
0.006	0.006	0.013	0.013	0.000	0.000	25.88	1.91	2693	3.71
0.008	0.008	0.034	0.034	0.000	0.000	31.57	5.00	2985	5.56
0.010	0.010	0.067	0.067	0.000	0.0				
0.012	0.012	0.110	0.110	0.000	0.0				
0.014	0.014	0.161	0.161	0.000	0.0				
0.016	0.016	0.220	0.220	0.000	0.0				
0.018	0.018	0.287	0.287	0.000	0.0				
0.020	0.020	0.359	0.359	0.000	0.0				
0.022	0.022	0.428	0.428	0.000	0.0				
0.024	0.024	0.484	0.484	0.000	0.0				
0.026	0.026	0.523	0.523	0.000	0.0				
0.028	0.028	0.546	0.546	0.000	0.0				
0.030	0.030	0.554	0.554	0.000	0.0				
0.032	0.032	0.545	0.545	0.000	0.0				
0.034	0.034	0.515	0.515	0.000	0.0				
0.036	0.036	0.463	0.463	0.000	0.0				
0.038	0.038	0.395	0.395	0.000	0.0				
0.040	0.040	0.320	0.320	0.000	0.0				
0.042	0.042	0.243	0.243	0.000	0.0				
0.044	0.044	0.165	0.165	0.000	0.0				
0.046	0.046	0.087	0.087	0.000	0.0				
0.048	0.048	0.014	0.014	0.000	0.0				
0.050	0.050	-0.045	-0.045	0.000	0.0				
0.052	0.052	-0.084	-0.084	0.000	0.0				
0.054	0.054	-0.103	-0.103	0.000	0.0				
0.056	0.056	-0.106	-0.106	0.000	0.0				
0.058	0.058	-0.094	-0.094	0.000	0.000	24.57	(13.83)	4315	(2.50)
0.060	0.060	-0.065	-0.065	0.000	0.000	31.77	(9.56)	4644	(0.93)
0.062	0.062	-0.017	-0.017	0.000	0.000	29.69	(2.56)	3617	2.45
0.064	0.064	0.045	0.045	0.000	0.000	19.67	6.62	1466	4.81
0.066	0.066	0.113	0.113	0.000	0.000	12.89	16.62	(430)	7.88
0.068	0.068	0.179	0.179	0.000	0.000	16.33	26.33	(1124)	12.02
0.070	0.070	0.241	0.241	0.000	0.000	24.42	35.45	(1249)	16.46
0.072	0.072	0.298	0.298	0.000	0.000	22.75	43.84	(2089)	19.49
0.074	0.074	0.346	0.346	0.000	0.000	16.49	50.90	(2966)	21.49
0.076	0.076	0.379	0.379	0.000	0.000	9.76	55.75	(3168)	22.59





Load Case B
Blast on short wall

Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

ROOF GIRDER

Bending Resistance

for dynamic bending	$f_{dv} = (SIF)(DIF)\, f_y$	= (1.1)(1.29) 36	51.1 ksi	352 MPa	
check flange	$\lambda_p = 65 / (F_{yf})^{0.5}$	= 65 / 7.15	9.09 > 7.03 OK		AISC LRFD Table B5.1
check web	$\lambda_p = 640 / (F_y)^{0.5}$	= 640 / 7.15	89.53 > 32.73 OK		AISC LRFD Table B5.1
Unbraced lengh for plastic design	$L_{pd} = (3600 + 2200\, M_1/M_p)\, r_y/f_{dy}$	= (3600 + 0) (2.9)/51.1	204.31 in	5189.4 mm	AISC LRFD Eqn F1-1
Plastic moment capacity	$M_p = Z\, f_{dy}$	= 61.5 x 51.1	14257 in-k	1611.4 kNm	
	$R_b = 8\,(M_p) / L$	= 8 x 14257)/(30 x 12)	316.8 kips	1409.7 kN	

Shear Resistance

for dynamic shear	$f'_{dc} = (SIF)(DIF)\, f_y$	= (1.1)(1.29) 36	51.1 ksi	352.3 MPa	Appendix 5.A
	$V_n = 0.6\, f_{dy}\, d\, t_w$	= 0.6 x 51.1 x 21.5 x 0.55	362.6 kips	1613.5 kN	ACI 318, Eqn 11-3
At critical section	$R_s = 2\, V_n$	= 2 x 362.6	725.2 kips	3227.0 kN	

SDOF Equivalent System

because $R_b < R_s$ bending governs

	R_{min}	minimum of R_s and R_b	316.8 kips	1409.7 kN	
Allowable response	θ_a		**2.0** °		Table 5.B.3
Allowable ductility	μ_a		**3.0**		LOW RESPONSE
slab weight	w	= 0.15 x 0.5	0.075 ksf		
Static load	W	= 3 x 38 x 15 + 111 x 30+			
		.....30 x 23 x (0.075 + 0.025 DL)	74 kips	329.3 kN	NB:3 beams incoming
Positive R_u	$R_u = R_b - W$	= 316.8 - 74	242.8 kips	1080.4 kN	
Negative R_u	$R_u = R_b + W$	= - (316.8 + 74)	-390.8 kips	-1739.0 kN	
Effective stiffness	$K = 384\, E\, I / 5L^3$	= (384 x 29007.4 x 2670) / (5 x 360^3)	127.5 k/in	22336 kN/m	Biggs Table 5.2
Positive yield deflection	$y_e = R_u / K$	= 242.8 / 127.5	1.9 in	48.3 mm	
Negative yield deflection	$y_e = R_u / K$	= -390.8 / 127.5	-3.07 in	-78.0 mm	
Beam mass	m = (girder wt + 20% slab)/(gravity)	= (3.33 + 0.2 x (69+1.71)) / (386.4)	0.045 k-sec^2/in	7.94 kNsec^2/m	
Elastic Load Factor	K_{LM}	= 0.5 / 0.64	0.78	0.78	Table 6.1
Plastic Load Factor	K_{LM}	= 0.33 / 0.5	0.66	0.66	
Averaged Load Factor	K_{LM}	= (0.78 + 0.66)/2	0.72	0.72	
Equivalent mass	$m_e = (K_{LM})$ (beam mass)	= 0.72 x 0.0453	0.0326 k-sec^2/in	5.71 kNsec^2/m	
Period of vibration	$t_n = 2\,\pi\,(m_e / K)^{0.5}$	= 2 x 3.14 x sqrt(0.0326 / 127.5)	0.1 sec	0.1 sec	Eqn 6.8
For Support reactions	V=0.39R+0.11F				Table 6.1

Average of elastic and plastic conditions

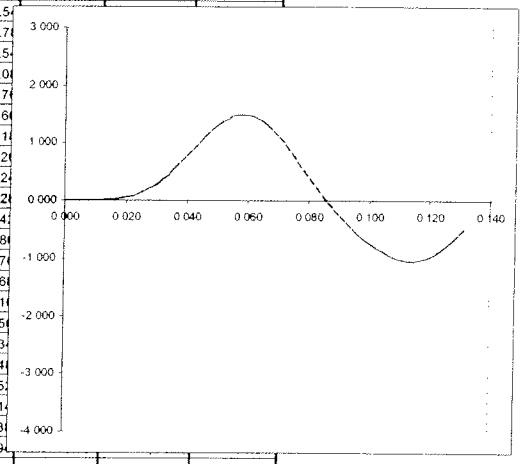
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

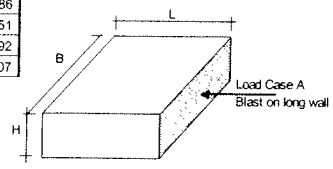
ROOF GIRDER

Equivalent Mass	m_e	0.0326 k-sec^2/in	**Summary**				
Effective Stiffness	K	127.5 k/in	Maximum deflection	ΔD	1.490 in at time	0.058	sec
Peak Overpressure	Fo	2.17 kips	No Plastic Deformation				
Effective duration	t_e	0.1 sec					
Arrival time	t_a	0 sec					
Rise time	t_r	0.005 sec					
Time Increment	Δt	**0.002** sec	Rebound Peak Deflection	y_m	**-1.051** in at time	0.114	sec
Positive Yield Deflection	+ Δy	1.9 in					
Negative Yield Deflection	- Δy	-3.07 in	The peak reaction	R_o	-73.84 kips at time	0.048	sec
Resistance Coefficient	R_{cc}	**0.390**	Peak Rebound reaction	R_o	55.04 kips at time	0.104	sec
Force Coefficient	F_{cc}	**0.110**	Support rotation	$\theta_o = \tan^{-1}(y_m/0.5L)$	0.47 °	< 2° OK	

Load = 2 sides x [beam reaction + beam reaction with 0.006 sec delay + beam reaction with 0.012 sec delay]

Time (sec)	Actual time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0	0.00
0.002	0.002	0.000	0.000	0.000	0.000	0.38	0.00	12	0.04
0.004	0.004	0.000	0.000	0.000	0.000	2.12	0.00	65	0.23
0.006	0.006	0.000	0.000	0.000	0.000	5.34	0.00	164	0.59
0.008	0.008	0.001	0.001	0.000	0.000	8.88	0.13	268	1.03
0.010	0.010	0.003	0.003	0.000	0.000	13.54			
0.012	0.012	0.007	0.007	0.000	0.000	20.76			
0.014	0.014	0.013	0.013	0.000	0.000	29.54			
0.016	0.016	0.022	0.022	0.000	0.000	40.08			
0.018	0.018	0.036	0.036	0.000	0.000	52.76			
0.020	0.020	0.056	0.056	0.000	0.000	65.64			
0.022	0.022	0.083	0.083	0.000	0.000	79.14			
0.024	0.024	0.118	0.118	0.000	0.000	93.24			
0.026	0.026	0.163	0.163	0.000	0.000	106.24			
0.028	0.028	0.218	0.218	0.000	0.000	118.26			
0.030	0.030	0.284	0.284	0.000	0.000	127.44			
0.032	0.032	0.361	0.361	0.000	0.000	132.84			
0.034	0.034	0.449	0.449	0.000	0.000	135.76			
0.036	0.036	0.547	0.547	0.000	0.000	135.66			
0.038	0.038	0.653	0.653	0.000	0.000	131.16			
0.040	0.040	0.765	0.765	0.000	0.000	122.56			
0.042	0.042	0.880	0.880	0.000	0.000	110.34			
0.044	0.044	0.995	0.995	0.000	0.000	95.44			
0.046	0.046	1.106	1.106	0.000	0.000	79.52			
0.048	0.048	1.209	1.209	0.000	0.000	63.14			
0.050	0.050	1.301	1.301	0.000	0.000	46.30			
0.052	0.052	1.378	1.378	0.000	0.000	29.94			
0.054	0.054	1.437	1.437	0.000	0.000	15.24	183.22	(8153)	73.13
0.056	0.056	1.475	1.475	0.000	0.000	4.48	188.06	(5631)	73.84
0.058	0.058	1.490	1.490	0.000	0.000	-2.40	189.98	(5491)	73.83
0.060	0.060	1.481	1.481	0.000	0.000	-5.90	188.83	(5573)	72.99
0.062	0.062	1.448	1.448	0.000	0.000	-5.82	184.62	(5842)	71.36
0.064	0.064	1.392	1.392	0.000	0.000	-2.58	177.48	(5523)	68.93
0.066	0.066	1.314	1.314	0.000	0.000	4.74	167.54	(4904)	65.86
0.068	0.068	1.216	1.216	0.000	0.000	15.62	155.04	(4277)	62.18
0.070	0.070	1.101	1.101	0.000	0.000	28.34	140.38	(3437)	57.86
0.072	0.072	0.972	0.972	0.000	0.000	38.02	123.93	(2695)	52.51
0.074	0.074	0.832	0.832	0.000	0.000	50.48	106.08	(1766)	46.92
0.076	0.076	0.685	0.685	0.000	0.000	63.68	87.34	(726)	41.07



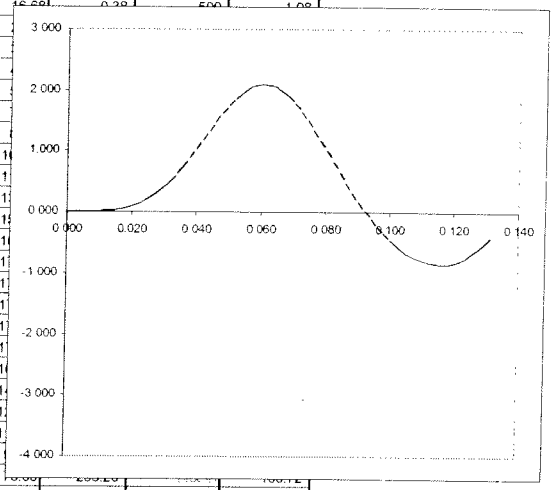


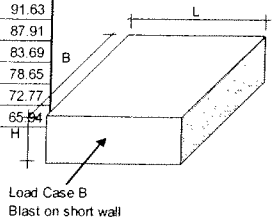
ROOF GIRDER

Equivalent Mass	m_e	0.0326 k-sec^2/in	**Summary**				
Effective Stiffness	K	127.5 k/in	Maximum deflection	ΔD	2.084 in at time	0.060 sec	
Peak Overpressure	Fo	2.17 kips	Plastic Deformation	yp = ym - ye	0.184 in		
Effective duration	t_e	0.1 sec	ductility ratio		1.1		
Arrival time	t_a	0 sec					
Rise time	t_r	0.005 sec					
Time Increment	Δt	**0.002** sec	Rebound Peak Deflection	y_m	**-0.855** in at time	0.116 sec	
Positive Yield Deflection	+ Δy	1.9 in	Rebound elastic Deformation	ye = ym - yp	-1.039 in		
Negative Yield Deflection	- Δy	-3.07 in	The peak reaction	R_e	-100.93 kips at time	0.046 sec	
Resistance Coefficient	R_{cc}	**0.390**	Peak Rebound reaction	R_o	57.37 kips at time	0.106 sec	
Force Coefficient	F_{cc}	**0.110**	Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.66 °	< 2° OK	

Load = 3 beams x [beam reaction + beam reaction with 0.014 sec delay]

Time (sec)	Actual time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	0.000	0.57	0.00	17	0.06
0.002	0.002	0.000	0.000	0.000	0.000	2.07	0.00	63	0.23
0.004	0.004	0.000	0.000	0.000	0.000	5.85	0.00	179	0.64
0.006	0.006	0.001	0.001	0.000	0.000	11.13	0.13	338	1.27
0.008	0.008	0.003	0.003	0.000	0.000				
0.010	0.010	0.007	0.007	0.000	0.000				
0.012	0.012	0.014	0.014	0.000	0.000				
0.014	0.014	0.025	0.025	0.000	0.000				
0.016	0.016	0.041	0.041	0.000	0.000				
0.018	0.018	0.063	0.063	0.000	0.000				
0.020	0.020	0.093	0.093	0.000	0.000				
0.022	0.022	0.132	0.132	0.000	0.000				
0.024	0.024	0.181	0.181	0.000	0.000				
0.026	0.026	0.241	0.241	0.000	0.000				
0.028	0.028	0.314	0.314	0.000	0.000				
0.030	0.030	0.401	0.401	0.000	0.000				
0.032	0.032	0.502	0.502	0.000	0.000				
0.034	0.034	0.616	0.616	0.000	0.000				
0.036	0.036	0.742	0.742	0.000	0.000				
0.038	0.038	0.878	0.878	0.000	0.000				
0.040	0.040	1.022	1.022	0.000	0.000				
0.042	0.042	1.171	1.171	0.000	0.000				
0.044	0.044	1.322	1.322	0.000	0.000				
0.046	0.046	1.470	1.470	0.000	0.000				
0.048	0.048	1.611	1.611	0.000	0.000				
0.050	0.050	1.740	1.740	0.000	0.000				
0.052	0.052	1.853	1.853	0.000	0.000				
0.054	0.054	1.947	1.900	0.047	0.000	58.68	242.25	(5831)	100.93
0.056	0.056	2.018	1.900	0.118	0.000	40.71	242.25	(6182)	98.96
0.058	0.058	2.064	1.900	0.164	0.000	28.68	242.25	(6551)	97.63
0.060	0.060	2.084	1.900	0.184	0.000	23.22	242.25	(6719)	97.03
0.062	0.062	2.077	1.893	0.184	0.000	21.21	241.36	(6753)	96.46
0.064	0.064	2.043	1.859	0.184	0.000	19.77	237.02	(6664)	94.61
0.066	0.066	1.982	1.798	0.184	0.000	20.19	229.25	(6413)	91.63
0.068	0.068	1.895	1.711	0.184	0.000	25.77	218.15	(6061)	87.91
0.070	0.070	1.784	1.600	0.184	0.000	37.53	204.00	(5106)	83.69
0.072	0.072	1.653	1.469	0.184	0.000	50.97	187.30	(4182)	78.65
0.074	0.074	1.505	1.321	0.184	0.000	64.38	168.43	(3162)	72.77
0.076	0.076	1.344	1.160	0.184	0.000	75.12	147.90	(2233)	65.64





Load Case B
Blast on short wall

Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

COLUMN

Compression Resistance

for dynamic bending	$f_{dv} = (SIF)(DIF)\, f_y$	= (1.1)(1.19) 36	47.1 ksi	325 MPa	
check compression	$\lambda_c = K\, L\, (F_{yf} / E)^{0.5} / \pi\, (r)$	= 12 x 13.8 x K x 0.0403/ (3.142 x 2.01)	1.06 K < 1.5 K OK		AISC LRFD Eqn E2-4
	$f_{cr} = (0.658)^{\wedge}(\lambda_c)^2\, (f_y)$	= (0.658) ^ (1.06) ^ 2 x 47.1	29.4 ksi	203 MPa	AISC LRFD Eqn E2-2
Compression capacity	$P_n = A_g\, f_{dv}$	= 29.4 x 13.3	391 kips	1740 kN	AISC LRFD Eqn E2-1

Tension Resistance

for dynamic shear	$f'_{dv} = (SIF)(DIF)\, f_v$	= (1.1)(1.19) 36	47.1 ksi	325 MPa	Appendix 5.A
	$P_n = A_g\, f_{dv}$	= 47.1 x 13.3	626.4 kips	2787 kN	ACI 318, Eqn 11-3

SDOF Equivalent System

for compression	$R_u = P_n$		391 kips	1740 kN	
for tension	$R_u = P_n$		626 kips	2787 kN	
	R_{min}	minimum of R_s and R_b	0.0 kips	0.0 kN	
Allowable ductility	μ_a		**1.0**		LOW RESPONSE
slab weight	w_1	= (0.075+0.025) x 30 x 23	69 ksf	307.0 kN	
beam weight	w_2	= 3 x 15 x 38	1.7 kips	7.6 kN	
girder weight	w_3	= 111 x 30	3.3 kips	14.7 kN	
column weight	w_4	= 45 x 13.8 / 2	0.3 kips	1.4 kN	
Static load	ΣW	= 69 + 1.7 + 3.3 + 0.3105	74.3 kips	330.6 kN	NB:3 beams incoming
Positive R_u	$R_u = R_b - W$	= 391.02 - 74.3	316.7 kips	1409.3 kN	
Negative R_u	$R_u = R_b + W$	= - (626.4 + 74.3)	-701 kips	-3117.9 kN	
Effective stiffness	K = A E / L	= (13.3 x 29007.4) / (165.6)	2329.7 k/in	408132 kN/m	Biggs Table 5.2
Positive yield deflection	$y_e = R_u / K$	= 316.72 / 2329.7	0.14 in	3.6 mm	
Negative yield deflection	$y_e = R_u / K$	= -700.7 / 2329.7	-0.3 in	-7.6 mm	
Include 20% of weight of supported components					Section 6.4.2
Beam mass	M = (girder wt + 20% roof)/(gravity)	= (0.3105 + 0.2 x (69 + 1.7 + 3.3) / (386.4)	0.039 k-sec^2/in	6.85 kNsec^2/m	
Period of vibration	$t_n = 2\, \pi\, (M / K)^{0.5}$	= 2 x 3.14 x sqrt(0.0391 / 2329.7)	0.026 sec	0.026 sec	Eqn 6.8
For Support reactions	V = R				

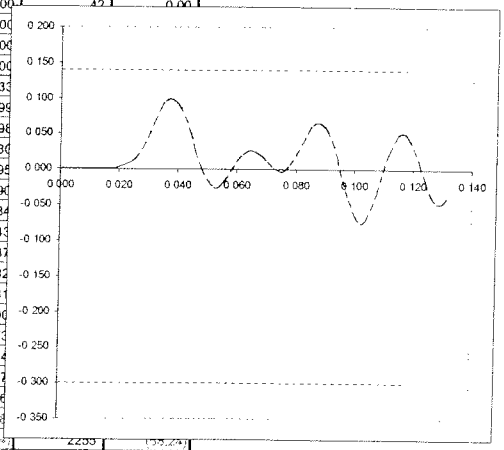
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

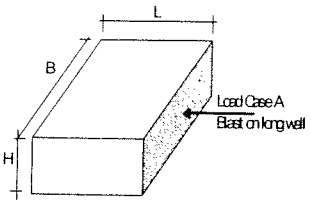
COLUMN

Equivalent Mass	m_e	0.0391 k-sec^2/in	**Summary**				
Effective Stiffness	K	2329.7 k/in	Maximum deflection	ΔD	0.098 in at time	0.038 sec	
Peak Overpressure	Fo	2.17 kips	No Plastic Deformation				
Effective duration	t_e	0.1 sec					
Arrival time	t_a	0 sec					
Rise time	t_r	0.005 sec					
Time Increment	Δt	**0.002** sec	Rebound Peak Deflection	y_m	**-0.025** in at time	0.052 sec	
Positive Yield Deflection	$+\Delta y$	0.14 in					
Negative Yield Deflection	$-\Delta y$	-0.3 in	The peak reaction	R_o	-228.31 kips at time	0.030 sec	
Resistance Coefficient	R_{cc}	**1.000**	Peak Rebound reaction	R_o	174.73 kips at time	0.094 sec	
Force Coefficient	F_{cc}	**0.000**	Support rotation	$\theta_a = \tan^{-1}(y_m/0.5L)$	0.03 °	< 2° OK	

Load =girder reaction + 2 each (beam reaction with 0.012 sec delay) + girder reaction with 0.024 sec delay

Time (sec)	Actual time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	0.000	0.00	0.00	0	0.00
0.002	0.002	0.000	0.000	0.000	0.000	0.04	0.00	1	0.00
0.004	0.004	0.000	0.000	0.000	0.000	0.23	0.00	6	0.00
0.006	0.006	0.000	0.000	0.000	0.000	0.59	0.00	15	0.00
0.008	0.008	0.000	0.000	0.000	0.000	1.03	0.00	26	0.00
0.010	0.010	0.000	0.000	0.000	0.000	1.64	0.00	42	0.00
0.012	0.012	0.000	0.000	0.000	0.000	2.63	0.00		
0.014	0.014	0.000	0.000	0.000	0.000	4.28	0.00		
0.016	0.016	0.000	0.000	0.000	0.000	7.62	0.00		
0.018	0.018	0.001	0.001	0.000	0.000	12.93	2.33		
0.020	0.020	0.003	0.003	0.000	0.000	18.51	6.99		
0.022	0.022	0.006	0.006	0.000	0.000	24.26	13.98		
0.024	0.024	0.010	0.010	0.000	0.000	31.56	23.30		
0.026	0.026	0.015	0.015	0.000	0.000	106.24	34.95		
0.028	0.028	0.027	0.027	0.000	0.000	118.28	62.90		
0.030	0.030	0.045	0.045	0.000	0.000	127.42	104.84		
0.032	0.032	0.065	0.065	0.000	0.000	132.80	151.43		
0.034	0.034	0.083	0.083	0.000	0.000	135.76	193.37		
0.036	0.036	0.095	0.095	0.000	0.000	135.68	221.32		
0.038	0.038	0.098	0.098	0.000	0.000	131.16	228.31		
0.040	0.040	0.091	0.091	0.000	0.000	122.50	212.00		
0.042	0.042	0.075	0.075	0.000	0.000	110.34	174.73		
0.044	0.044	0.052	0.052	0.000	0.000	95.48	121.14		
0.046	0.046	0.026	0.026	0.000	0.000	79.52	60.57		
0.048	0.048	0.002	0.002	0.000	0.000	63.14	4.66		
0.050	0.050	-0.016	-0.016	0.000	0.000	46.38	(37.26)		
0.052	0.052	-0.025	-0.025	0.000	0.000	29.94	(56.24)	2235	(56.24)
0.054	0.054	-0.025	-0.025	0.000	0.000	15.24	(56.24)	1879	(56.24)
0.056	0.056	-0.017	-0.017	0.000	0.000	4.48	(39.50)	1127	(39.50)
0.058	0.058	-0.004	-0.004	0.000	0.000	-2.40	(9.32)	177	(9.32)
0.060	0.060	0.010	0.010	0.000	0.000	-5.90	23.30	(747)	23.30
0.062	0.062	0.021	0.021	0.000	0.000	-5.82	48.92	(1480)	48.92
0.064	0.064	0.026	0.026	0.000	0.000	-2.58	60.57	(1815)	60.57
0.066	0.066	0.025	0.025	0.000	0.000	4.74	58.24	(1363)	58.24
0.068	0.068	0.019	0.019	0.000	0.000	15.62	44.26	(737)	44.26
0.070	0.070	0.010	0.010	0.000	0.000	28.34	23.30	129	23.30
0.072	0.072	0.002	0.002	0.000	0.000	38.02	4.66	853	4.66





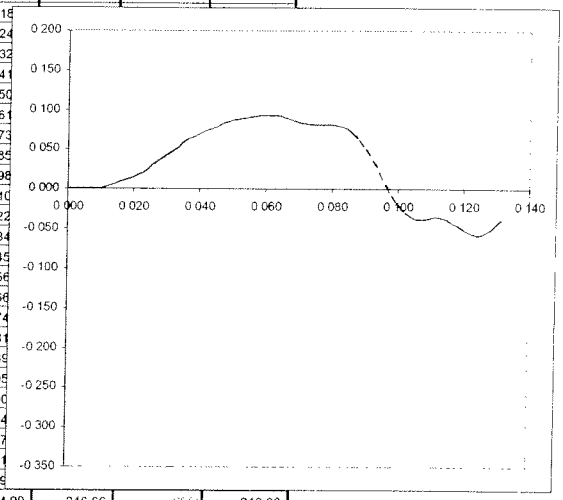
Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

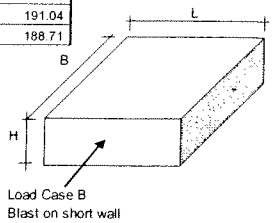
COLUMN

Equivalent Mass	m_e	0.0391 k-sec^2/in	**Summary**				
Effective Stiffness	K	2329.7 k/in	Maximum deflection	ΔD	0.093 in at time	0.060 sec	
Peak Overpressure	Fo	2.17 kips	No Plastic Deformation				
Effective duration	t_e	0.1 sec					
Arrival time	t_a	0 sec					
Rise time	t_r	0.005 sec					
Time Increment	Δt	**0.002** sec	Rebound Peak Deflection	y_m	**-0.058** in at time	0.124 sec	
Positive Yield Deflection	+ Δy	0.14 in					
Negative Yield Deflection	- Δy	-0.3 in	The peak reaction	R_o	-216.66 kips at time	0.052 sec	
Resistance Coefficient	R_{cc}	**1.000**	Peak Rebound reaction	R_o	135.12 kips at time	0.116 sec	
Force Coefficient	F_{cc}	**0.000**	Support rotation	$\theta_o = \tan^{-1}(y_m/0.5L)$	0.03 °	< 2° OK	

Load =beam reaction + 2 each (girder reaction with 0.007 sec delay) + beam reaction with 0.014 sec delay

Time (sec)	Actual time (sec)	Deflection (in)	Elastic (in)	Plastic +ve (in)	Plastic -ve (in)	Load (kips)	Resistance (kips)	Acceleration (in/sec^2)	Reaction (kips)
0.000	0.000	0.000	0.000	0.000	0.000	0.19	0.00	5	0.00
0.002	0.002	0.000	0.000	0.000	0.000	0.69	0.00	18	0.00
0.004	0.004	0.000	0.000	0.000	0.000	1.95	0.00	50	0.00
0.006	0.006	0.000	0.000	0.000	0.000	3.83	0.00	98	0.00
0.008	0.008	0.000	0.000	0.000	0.000	6.02	0.00	154	0.00
0.010	0.010	0.001	0.001	0.000	0.000	8.82	2.33	166	2.33
0.012	0.012	0.003	0.003	0.000	0.000	12.74	6.99	147	6.99
0.014	0.014	0.006	0.006	0.000	0.000	18			
0.016	0.016	0.009	0.009	0.000	0.000	24			
0.018	0.018	0.012	0.012	0.000	0.000	32			
0.020	0.020	0.015	0.015	0.000	0.000	41			
0.022	0.022	0.019	0.019	0.000	0.000	50			
0.024	0.024	0.024	0.024	0.000	0.000	61			
0.026	0.026	0.030	0.030	0.000	0.000	73			
0.028	0.028	0.036	0.036	0.000	0.000	85			
0.030	**0.030**	**0.042**	**0.042**	**0.000**	**0.000**	98			
0.032	0.032	0.048	0.048	0.000	0.000	110			
0.034	0.034	0.054	0.054	0.000	0.000	122			
0.036	0.036	0.060	0.060	0.000	0.000	134			
0.038	0.038	0.065	0.065	0.000	0.000	145			
0.040	0.040	0.069	0.069	0.000	0.000	156			
0.042	0.042	0.073	0.073	0.000	0.000	166			
0.044	0.044	0.077	0.077	0.000	0.000	174			
0.046	0.046	0.080	0.080	0.000	0.000	181			
0.048	0.048	0.083	0.083	0.000	0.000	189			
0.050	0.050	0.086	0.086	0.000	0.000	195			
0.052	0.052	0.088	0.088	0.000	0.000	200			
0.054	0.054	0.090	0.090	0.000	0.000	204			
0.056	0.056	0.091	0.091	0.000	0.000	207			
0.058	0.058	0.092	0.092	0.000	0.000	211			
0.060	0.060	0.093	0.093	0.000	0.000	209			
0.062	0.062	0.093	0.093	0.000	0.000	204.99	216.66	(259)	216.66
0.064	0.064	0.092	0.092	0.000	0.000	201.85	214.33	(319)	214.33
0.066	0.066	0.090	0.090	0.000	0.000	200.79	209.67	(227)	209.67
0.068	0.068	0.087	0.087	0.000	0.000	201.51	202.68	(33)	202.68
0.070	0.070	0.084	0.084	0.000	0.000	201.73	195.69	154	195.69
0.072	0.072	0.082	0.082	0.000	0.000	200.25	191.04	236	191.04
0.074	0.074	0.081	0.081	0.000	0.000	197.28	188.71	219	188.71



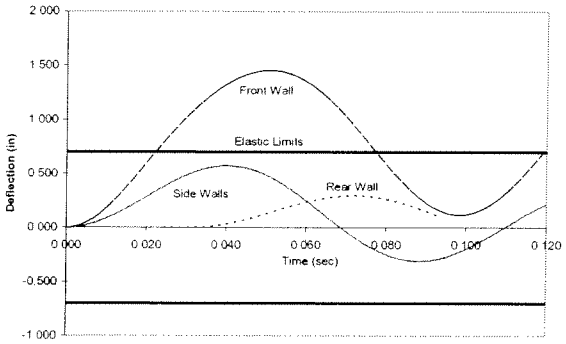


Load Case B
Blast on short wall

Client	Getrich Development		Use in correspondences			
Project	Deepdown Sands	234	010455			
Location	Up in the North	Dept	Job	Reference		
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A		Rev	0

2.2. RESULTS

		Front Wall	Side Wall	Rear Wall	Roof Slab Load A	Side Wall (In-plane)	Roof Slab OOP (A)	Roof Slab OOP (B)	Roof beam Load A	Roof beam Load B	Roof Girder Load A	Roof Girder Load B	Column Load A	Column Load B
		CALC PART 1			CALC PART 2	CALC PART 3	CALC PART 4		CALC PART 5		CALC PART 6		CALC PART 7	
		NIM-1	NIM-2	NIM-3	NIM-4	NIM-5	NIM-4A	NIM-4B	NIM-7A	NIM-7B	NIM-8A	NIM-8B	NIM-9A	NIM-9B
Maximum deflection	ΔD	1 453	0 572	0 297	0 015	0 026	0 016	0 019	0 387	0 554	1 49	2 084	0 098	0 093
	at time (sec)	0.05	0 040	0 072	0 040	0 034	0 008	0 006	0 03	0 03	0 058	0 06	0 038	0 06
Plastic deformation	$y_p = y_m - y_e$	0 753										0 184		
ductility ratio	μ_d	2 08										1 1		
Rebound peak deflection	y_m	0 119	-0 308	-0 143	0 004	-0 021	0 001	-0 001	-0.096	-0.106	-1 051	-0 855	-0 025	-0 855
	at time (sec)	0 098	0 088	0 118	0 014	0 078	0 014	0 010	0 054	0.056	0 114	0 116	0 052	0 124
Rebound elastic deformation	$y_e = y_m - y_p$	-0 634										-1 039		
The peak reaction	R_o	-6 58	-4 88	-2.54	-201 43	-211 04	-1 70	-1 99	-25 26	-36 45	-73 84	-100 9	-228 31	-216 7
		0 024	0 04	0 066	0 024	0 034	0 008	0 006	0 02	0 02	0 048	0 106	0 03	0 116
Peak rebound reaction	R_o	-1 82	0 01	0 00	66 61	0 00	0 34	0 42	3 83	3 95	55 04	57 37	174 73	135 12
		0	0 07	#N/A	0 068	0	0 068	0 064	0 046	0 048	0 104	0 106	0 094	0 116
Support rotation	$\theta_d = \tan^{-1}(y_m/0.5L)$	0.82	0 32	0.17	0 01	0.01	0 03	0 03	0.25	0.35	0 47	0.66	0 03	0.03
Design status		OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK



Client	Getrich Development		Use in correspondences		
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Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

Foundation Loading, dynamic response (in Kips)

Allowing for time phasing

0.002

Time	NIM-1	NIM-3	(NIM-1 + NIM-3) x L	NIM-5	NIM-5 x 2	Total
0.000	1.82	0.00	83.6	0.00	0	83.6
0.002	1.83	0.00	84.1	0.00	0	84.1
0.004	1.95	0.00	89.6	8.12	16.24	105.8
0.006	2.19	0.00	100.6	24.35	48.7	149.3
0.008	2.52	0.00	115.7	48.70	97.4	213.1
0.01	2.95	0.00	135.5	81.17	162.34	297.8
0.012	3.45	0.00	158.5	113.64	227.28	385.7
0.014	4.01	0.00	184.2	137.99	275.98	460.2
0.016	4.62	0.00	212.2	146.11	292.22	504.4
0.018	5.26	0.00	241.6	137.99	275.98	517.6
0.02	5.92	0.00	271.9	121.76	243.52	515.4
0.022	6.56	0.00	301.3	105.52	211.04	512.3
0.024	6.58	1.17	356.0	97.40	194.8	550.8
0.026	6.53	1.33	361.0	105.52	211.04	572.1
0.028	6.48	1.50	366.5	129.87	259.74	626.3
0.03	6.43	1.67	372.0	162.34	324.68	696.7
0.032	6.38	1.83	377.1	194.81	389.62	766.7
0.034	6.33	1.98	381.7	211.04	422.08	803.8
0.036	6.28	2.12	385.8	202.93	405.86	791.7
0.038	6.23	2.25	389.5	170.46	340.92	730.4
0.04	6.18	2.35	391.8	121.76	243.52	635.3
0.042	6.13	2.44	393.6	73.05	146.1	539.7
0.044	6.08	2.50	394.1	40.59	81.18	475.3
0.046	6.03	2.54	393.6	32.47	64.94	458.6
0.048	5.98	2.54	391.3	48.70	97.4	488.7
0.05	5.93	2.52	388.1	73.05	146.1	534.2
0.052	5.88	2.47	383.5	97.40	194.8	578.3
0.054	5.75	2.38	373.4	113.64	227.28	600.7
0.056	5.54	2.27	358.7	113.64	227.28	586.0
0.058	5.26	2.13	339.4	105.52	211.04	550.5
0.06	4.91	1.97	316.0	97.40	194.8	510.8
0.062	4.48	1.78	287.5	97.40	194.8	482.3
0.064	3.98	1.58	255.4	97.40	194.8	450.2
0.066	3.43	1.37	220.5	89.29	178.58	399.0

Client	Getrich Development		Use in correspondences		
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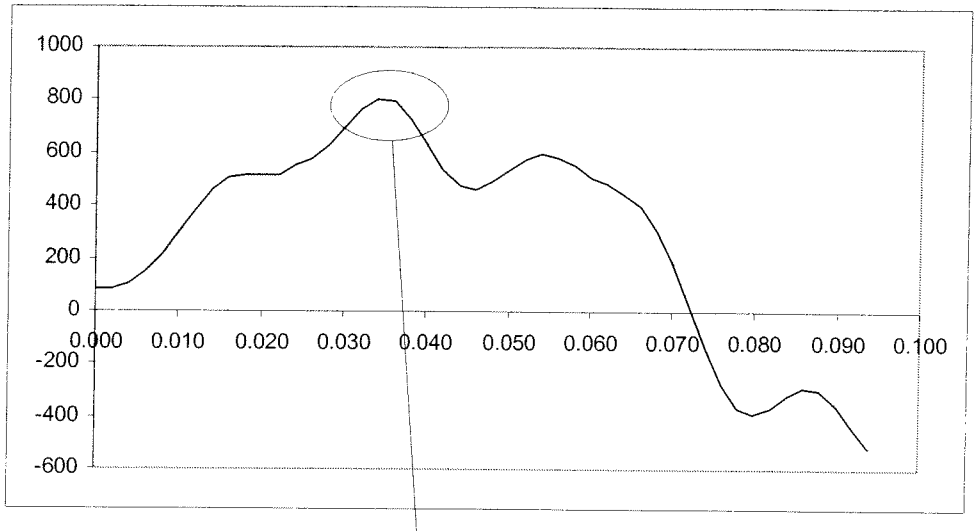
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0



Total Lateral forces
Design load 800 kips 3558 kN

Assumptions :

pile capacities are doubled for dynamic events
1.75 m spacing

Check for 36 piles
Per pile H = 98.8 kN

Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
Location	Up in the North	Dept	Job	Reference	
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

Appendix A

Table 5.A.1 Strength Increase Factors (SIF)

Material	SIF
Structural Steel (fy < 50 ksi)	1.10
Structural Steel (fy < 60 ksi)	1.10
Cold-formed steel	1.21
Concrete	1.00

Table 5.A.2 Dynamic Increase Factors (DIF)

Stress Type	Reinforcing bars		Concrete
	F_{dy}/F_y	F_{du}/F_u	f_{dc}/f'_c
Flexure	1.17	1.05	1.19
Compression	1.10	1.00	1.12
Diagonal Tension	1.00	1.00	1.00
Direct Shear	1.10	1.00	1.10
Bond	1.17	1.05	1.00

Table 5.A.3 Dynamic Increase Factors(DIF)

	Yield Stress		Ultimate Stress
	Bending / Shear	Tension / Compression	
Material	F_{dy}/F_y	F_{dy}/F_y	F_{du}/F_u
A36	1.29	1.19	1.10
A588	1.19	1.12	1.05
A514	1.09	1.05	1.00
A446	1.10	1.10	1.00
Stainless Steel Type 304	1.18	1.15	1.00
Aluminium 6061-T6	1.02	1.00	1.00

Table 5.A.4 Dynamic Design Stress for Reinforced Concrete

Type of Stress	Type of reinforcement	Maximum Support rotation	Dynamic Design Stress F_{ds}
Bending	Tension	$0 < \theta < 2$	F_{dy}
	Compression	$2 < \theta < 5$	$F_{dy} + (F_{du} - F_{dy})/4$
		$5 < \theta < 12$	$(F_{dy} + F_{du})/2$
Diagonal tension	Stirrups		F_{dy}
Direct Shear	Diagonal bars	$0 < \theta < 2$	F_{dy}
		$2 < \theta < 5$	$F_{dy} + (F_{du} - F_{dy})/4$
		$5 < \theta < 12$	$(F_{dy} + F_{du})/2$
Compression	Columns	all	F_{dy}

Table 5.A.5 Dynamic Design Stress for Structural Steel

Type of stress	Maximum Ductility ratio	Dynamic Design Stress F_{ds}
All	$\theta < 10$	F_{dy}
All	$\theta > 10$	$F_{dy} + (F_{du} - F_{dy})/4$

Client	Getrich Development		Use in correspondences		
Project	Deepdown Sands	234	010455		
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Table 5.B.1 Response Criteria for Reinforced Concrete

Element Type	Controlling Stress	μ_a	Support Rotation θ_a, (2)		
			Low	Medium	High
Beams	Flexure	N/A	1	2	4
	Shear (1)				
	Concrete only	1.3			
	Concrete + stirrups	1.6			
	stirrups only	3			
	Compression	1.3			
Slabs	Flexure	N/A	2	4	8
	Shear (1)				
	Concrete only	1.3			
	Concrete + stirrups	1.6			
	stirrups only	3			
	Compression	1.3			
Beam / Columns	Flexure		1	2	4
	Compression (C)	1.3			
	Tension (T)	(3)			
	Between C & T	10			
	Shear	1.3			
Shear walls	Flexure	3	1	1.5	2
Diaphragms	Shear (1)	1.5			

(1) Shear controls when shear resistance is less than 120% of fexural resistance
(2) Stirrups are required for support rotations greater than 2 degrees
(3) Ductility ratio = 0.05 (μ - μ') < 10

Table 5.B.3 Response Criteria for Structural Steel

Element Type	Response range					
	Low		Medium		High	
	μ_a	θ_a	μ_a	θ_a	μ_a	θ_a
Beams, girts, Purlins	3	2	10	6	20	12
Frame Members (1)	1.5	1	2	1.5	3	2
Cold-formed panels	1.75	1.25	3	2	6	4
Open web joists	1	1	2	1.5	4	2
Plates	5	3	10	6	20	12

(1) Sidesway limits for frames

Low	H/50
medium	H/35
high	H25

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Project	Deepdown Sands	234	010455		
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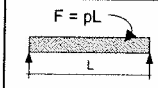
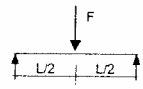
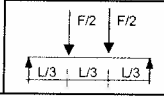
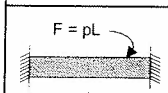
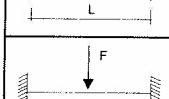
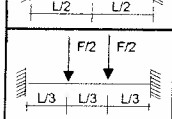
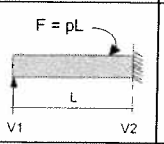
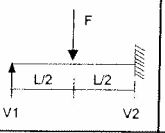
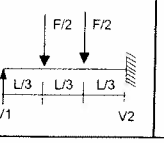
Subject	Deluge Building 1500 Blast Resistance Design	Doc No	P23-00445-C101A	Rev	0

	Loading diagram	Strain range	Load Factor K_L	Lumped Mass Factor K_M	Uniform Mass Factor K_M	Bending Resistance R_b	Spring Constant K x EI/L^3	Dynamic Reaction V
Simply Supported Boundary Conditions		Elastic Plastic	0.64 0.50		0.50 0.33	8 M_{pc} / L 8 M_{pc} / L	384 / 5 0	0.39 R + 0.11 F 0.38 R_u + 0.12 F
		Elastic Plastic	1.00 1.00	1.00 1.00	0.49 0.33	4 M_{pc} / L 4 M_{pc} / L	48 0	0.78 R - 0.28 F 0.75 R_u - 0.25 F
		Elastic Plastic	0.87 1.00	0.76 1.00	0.52 0.56	6 M_{pc} / L 6 M_{pc} / L	56.4 0	0.52 R - 0.025 F 0.52 R_u - 0.02 F

	Loading diagram	Strain range	Load Factor K_L	Lumped Mass Factor K_M	Uniform Mass Factor K_M	Bending Resistance R_b	Spring Constant K x EI/L^3	Dynamic Reaction V
Fixed Ends Boundary Conditions		Elastic E/P Plastic	0.53 0.64 0.50		0.41 0.50 0.33	12 M_{ps} / L 8 (M_{ps} + M_{pc}) / L 8 (M_{ps} + M_{pc}) / L	384 384 /5 0	0.36 R + 0.14 F 0.39 R + 0.11 F 0.38 R_u + 0.12 F
		Elastic Plastic	1.00 1.00	1.00 1.00	0.37 0.33	4 (M_{ps} + M_{pc}) / L 4 (M_{ps} + M_{pc}) / L	192 0	0.71 R - 0.21 F 0.75 R_u - 0.25 F
		Elastic Plastic	0.87 1.00	0.76 1.00	0.52 0.56	6 M_{pc} / L 6 M_{pc} / L	56.4 0	0.53 R - 0.03 F 0.52 R_u - 0.02 F

	Loading diagram	Strain range	Load Factor K_L	Lumped Mass Factor K_M	Uniform Mass Factor K_M	Bending Resistance R_b	Spring Constant K x EI/L^3	Dynamic Reactions V
Simple-Fixed Boundary Conditions		Elastic E/P Plastic	0.58 0.64 0.50		45 0.50 0.33	8 M_{pc} / L 4 (M_{ps} + 2M_{pc}) / L 8 (M_{ps} + 2M_{pc}) / L	185 384/5 0	V1 0.26 R + 0.12 F V2 0.43 R + 0.19 F 0.39 R + 0.11 F ± M_{ps}/L 0.38 R_u + 0.12 F ± M_{ps}/L
		Elastic E/P Plastic	1.00 1.00 1.00	1.00 1.00 1.00	0.37 0.49 0.33	16 M_{pc} / L 2 (M_{ps} + 2M_{pc}) / L 2 (M_{ps} + 2M_{pc}) / L	107 48 0	V1 0.25 R + 0.07 F V2 0.54 R + 0.14 F 0.78 R - 0.28 F ± M_{ps}/L 0.75 R_u - 0.25 F ± M_{ps}/L
		Elastic E/P Plastic	0.81 0.87 1.00	0.67 0.76 1.00	0.45 0.52 0.56	6 M_{pc} / L 2 (M_{ps} + 3M_{pc}) / L 2 (M_{ps} + 3M_{pc}) / L	132 56 0	V1 0.17 R + 0.17 F V2 0.33 R + 0.33 F 0.525 R - 0.025 F ± M_{ps}/L 0.52 R_u - 0.02 F ± M_{ps}/L

M_{pc} is the ultimate moment capacity midspan

M_{ps} is the ultimate moment capacity at the support