Seismic Restraint of Non –Structural Elements

Based on AS1170.4:2007

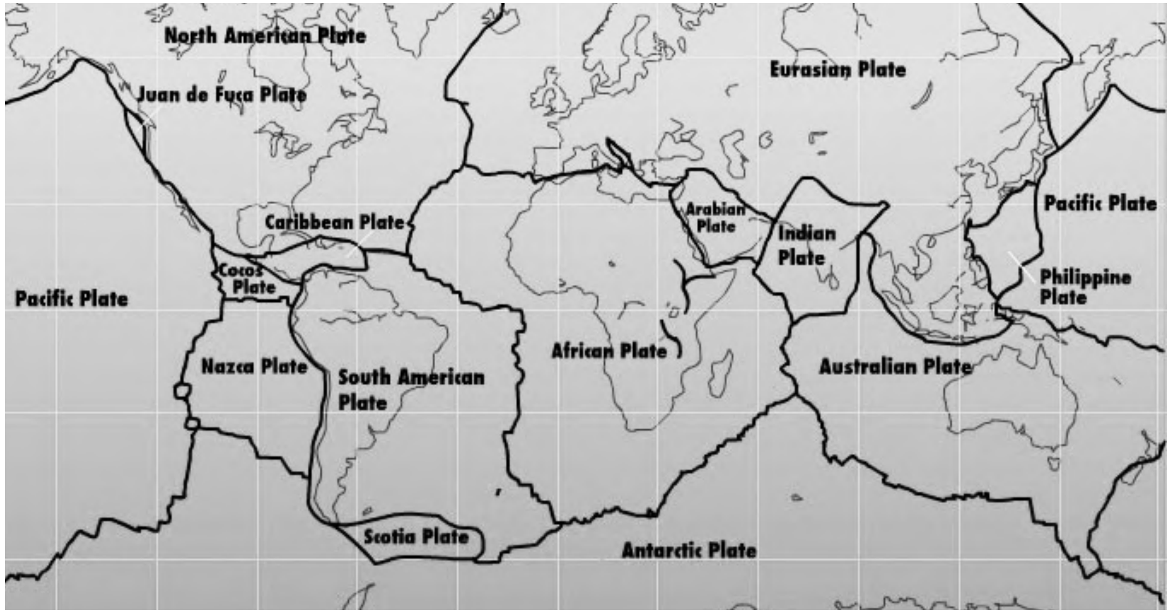
Mason Mercer

What is an Earthquake?

Vibration caused by rocks breaking under stress

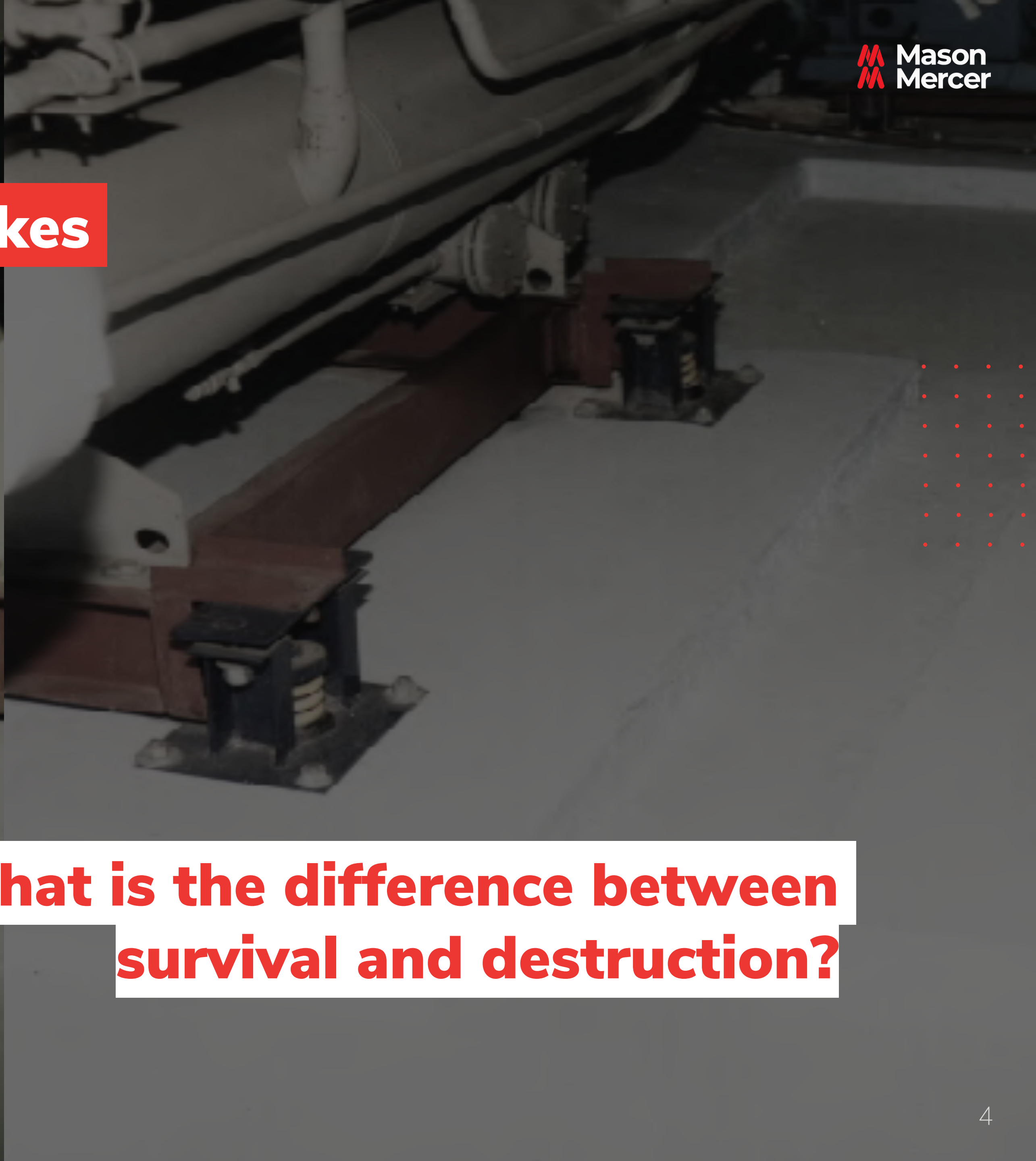
Railway line deformed by magnitude 6.8 – Meckering WA - 1968

Australian Earthquakes

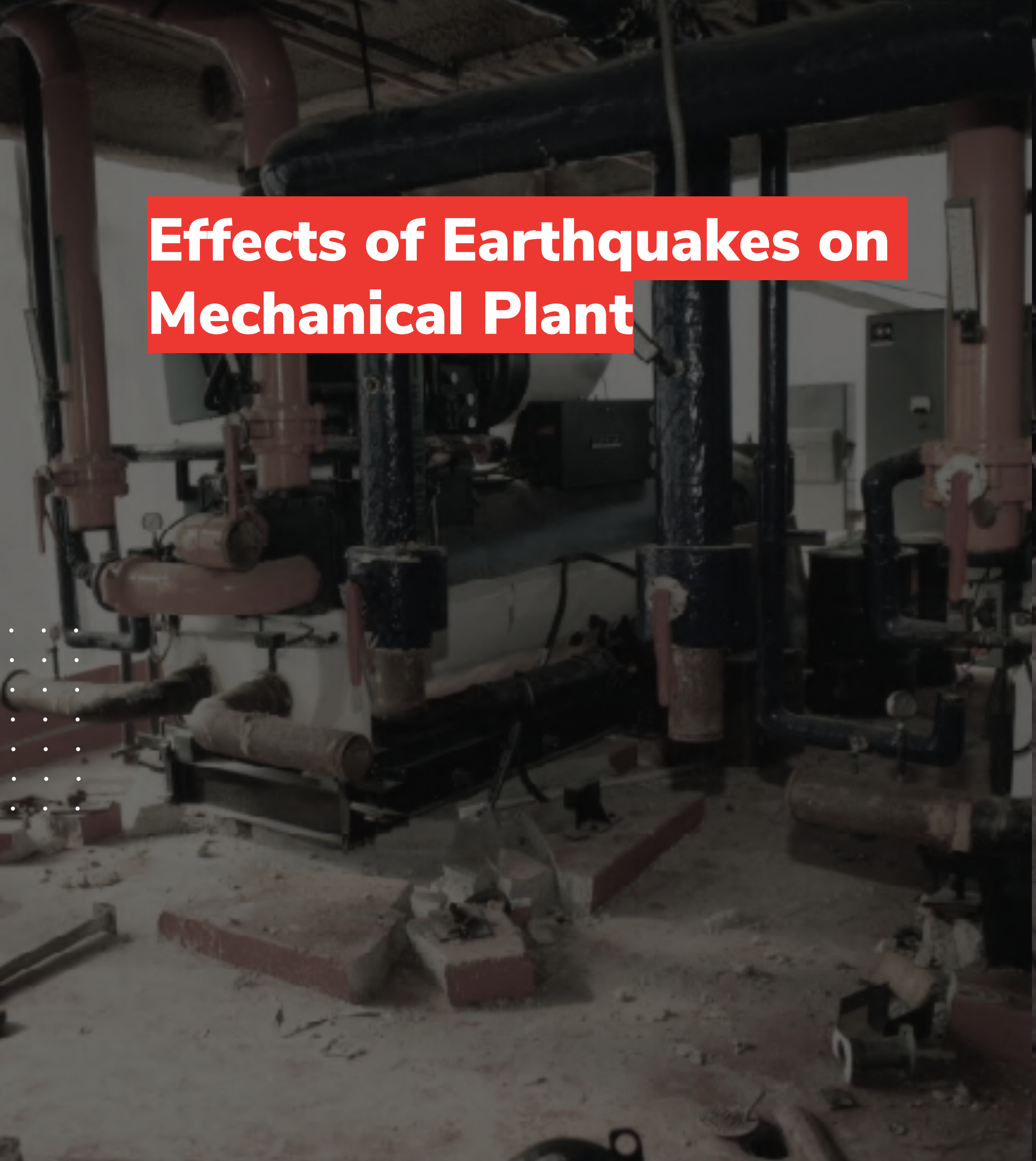


- All earthquakes that do not occur on plate margins are called intraplate earthquakes.
- Given our location, all earthquakes on mainland Australia are intraplate.
- Intraplate earthquakes are not as common as those on plate margins, however major earthquakes with magnitudes of 7.0 or more do happen.

Potential effects of Earthquakes on Mechanical Plant



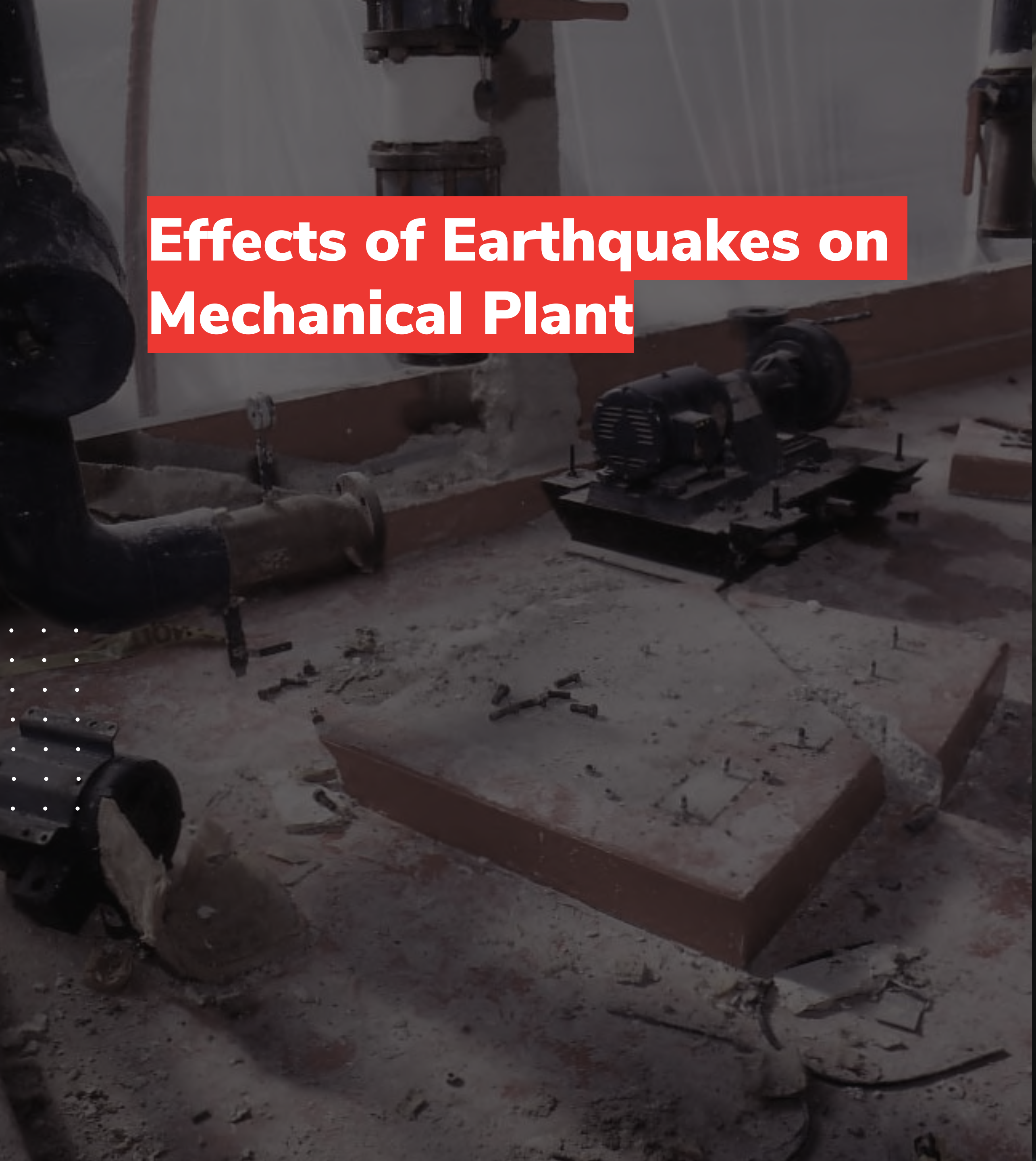
What is the difference between survival and destruction?



Effects of Earthquakes on Mechanical Plant

Potential modes of failure that are overlooked

Effects of Earthquakes on Mechanical Plant



Strong mounts require strong anchor points

This all raises **questions** such as:

- Why did the systems in the previous pictures fail?
- When is Seismic Restraint Required?
- Where do we start?

This all raises questions such as:

- **Why did the systems in the previous pictures fail?**
  - Fortunately, people were asking the same questions many years ago.
- **When is Seismic Restraint Required?**
  - After many years of failure mode analysis, guidelines were developed.
  - Now dependent on the Earthquake Design Category (EDC) according to AS1170.4 (Earthquake actions in Australia)
- **Where do we start?**
  - By determining what is required on a job-by-job basis.
  - How is this determined?

Where do we start?

- We can see that there is potential for damage.
- How do we assess what measures need to be put in place to avoid damage?
- The ultimate goal is to ensure that all components remain anchored and plant remains operational after an event
- The next question is: how do we ensure that they won't move?

Earthquake Design Categories & Design Accelerations

- The Australian Standard for Earthquake actions provides equations that take many factors regarding the component location into account.
- The result of working through the tables is a designated earthquake design category (EDC) for the job and ultimately a design acceleration to work with.
- Step 1 is to determine the EDC for the job (this should be pre-defined for each job)

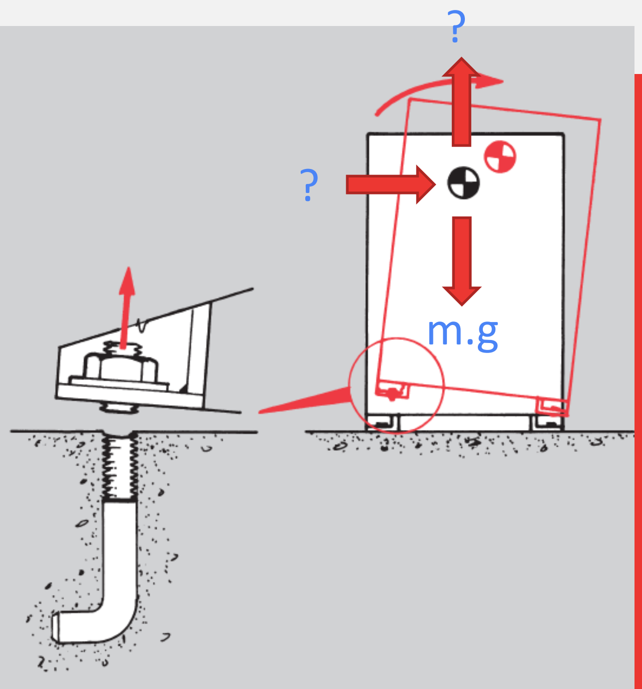


Figure 9. ROTATIONAL TENSILE FAILURE

Earthquake Design Categories (EDC)

Dependant on:

- Design working life of the structure
- Importance level of the structure
- Annual probability of exceedance (design working life & importance)
- Hazard factor for the specific geographic location
- Site sub-soil class
- Structure height

- "No requirement", EDC I, EDC II or EDC III

How is the EDC determined?

TABLE 2.1

SELECTION OF EARTHQUAKE DESIGN CATEGORIES

Importance level, type of structure (see Clause 2.2)	(k_pZ) for site sub-soil class				Structure height, h_n (m)	Earthquake design category
	E_e or D_e	C_e	B_e	A_e		
1	—				—	Not required to be designed for earthquake actions
Domestic structure (housing)	—				Top of roof ≤8.5	Refer to Appendix A
					Top of roof >8.5	Design as importance level 2
2	≤0.05	≤0.08	≤0.11	≤0.14	≤12 >12, <50 ≥50	I II III
	>0.05 to ≤0.08	>0.08 to ≤0.12	>0.11 to ≤0.17	>0.14 to ≤0.21	<50 ≥50	II III
	>0.08	>0.12	>0.17	>0.21	<25 ≥25	II III
3	≤0.08	≤0.12	≤0.17	≤0.21	<50 ≥50	II III
	>0.08	>0.12	>0.17	>0.21	<25 ≥25	II III
4	—				<12 ≥12	II III

NOTES:

1 Values for k_p and Z are given in Section 3. Site sub-soil class are given in Section 4.

2 A higher earthquake design category or procedure may be used in place of that specified.

3 Height (h_n) is defined in Clause 1.5. For domestic structures refer to Appendix A.

4 In addition to the above, a special study is required for importance level 4 structures to demonstrate they remain serviceable for immediate use following the design event for importance level 2 structures.

Class A_e—Strong rock.

Class B_e—Rock.

Class C_e—Shallow soil.

Class D_e—Deep or soft soil.

Class E_e—Very soft soil.

This is what we want to know

TABLE F1

STRUCTURE TYPES FOR IMPORTANCE LEVELS

Consequences of failure	Description	Importance level	Comment
Low	**Low** consequence for loss of human life, *or* **small or moderate** economic, social or environmental consequences	1	Minor structures (failure not likely to endanger human life)
Ordinary	**Medium** consequence for loss of human life, *or* **considerable** economic, social or environmental consequences	2	Normal structures and structures not falling into other levels
High	**High** consequence for loss of human life, *or* **very great** economic, social or environmental consequences	3	Major structures (affecting crowds)
		4	Post-disaster structures (post disaster functions or dangerous activities)
Exceptional	Circumstances where reliability must be set on a case by case basis	5	Exceptional structures

AS/NZS 1170.0-2002 pg.31

Mason Mercer

TABLE F2

ANNUAL PROBABILITY OF EXCEEDANCE OF THE DESIGN EVENTS FOR ULTIMATE LIMIT STATES

Design working life	Importance level	Design events for safety in terms of annual probability of exceedance			
		Wind		Snow	Earthquake
		Cyclonic	Non-cyclonic		
Construction equipment, e.g., props, scaffolding, braces and similar	2	1/250	1/100	1/50	1/100 *
Less than 6 months	1	1/250	1/25	1/25	1/25 * †
	2	1/250	1/100	1/50	1/100 *
	3	1/500	1/250	1/100	1/250 *
	4	1/1000	1/1000	1/250	1/1000
5 years	1	1/250	1/25	1/25	1/25 †
	2	1/250	1/250	1/50	1/250 *
	3	1/500	1/500	1/100	1/500
	4	1/1000	1/1000	1/250	1/1000
25 years	1	1/250	1/50	1/25	1/50 * †
	2	1/250	1/250	1/50	1/250 *
	3	1/500	1/500	1/100	1/500
	4	1/1000	1/1000	1/250	1/1000
50 years	1	1/250	1/100	1/50	1/100 *
	2	1/500	1/500	1/150	1/500
	3	1/1000	1/1000	1/250	1/1000
	4	1/2500	1/2500	1/500	1/2500
100 years or more	1	1/500	1/250	1/100	1/250
	2	1/1000	1/1000	1/250	1/1000
	3	1/2500	1/2500	1/500	1/2500
	4	‡	‡	‡	‡

* For Australia, earthquake loads for these annual probabilities are low and unlikely to control the design, but it is important to provide appropriate detailing to achieve the performance required.

† Structures for primary produce with low human occupancy need not be designed for earthquakes.

‡ For importance level 4 structures with design working life of 100 years or more, the design events are determined by a risk analysis but need to have probabilities less than or equal to those for importance level 3.

AS/NZS 1170.0-2002 pg.32

Mason Mercer

TABLE 3.1

PROBABILITY FACTOR (k_p)

Annual probability of exceedance P	Probability factor k_p
1/2500	1.8
1/2000	1.7
1/1500	1.5
1/1000	1.3
1/800	1.25
1/500	1.0
1/250	0.75
1/200	0.7
1/100	0.5
1/50	0.35
1/25	0.25
1/20	0.20

NOTE: The annual probability of exceedance in Table 3.1 is taken from the BCA and AS/NZS 1170.0.

AS/NZS 1170.0-2002 pg.18

TABLE 3.2

HAZARD FACTOR (Z) FOR SPECIFIC AUSTRALIAN LOCATIONS

Location	Z	Location	Z	Location	Z
Adelaide	0.10	Geraldton	0.09	Port Augusta	0.11
Albany	0.08	Gladstone	0.09	Port Lincoln	0.10
Albury/Wodonga	0.09	Gold Coast	0.05	Port Hedland	0.12
Alice Springs	0.08	Gosford	0.09	Port Macquarie	0.06
Ballarat	0.08	Grafton	0.05	Port Pirie	0.10
Bathurst	0.08	Gippsland	0.10	Robe	0.10
Bendigo	0.09	Goulburn	0.09	Rockhampton	0.08
Brisbane	0.05	Hobart	0.03	Shepparton	0.09
Broome	0.12	Karratha	0.12	Sydney	0.08
Bundaberg	0.11	Katoomba	0.09	Tamworth	0.07
Burnie	0.07	Latrobe Valley	0.10	Taree	0.08
Cairns	0.06	Launceston	0.04	Tennant Creek	0.13
Camden	0.09	Lismore	0.05	Toowoomba	0.06
Canberra	0.08	Lorne	0.10	Townsville	0.07
Carnarvon	0.09	Mackay	0.07	Tweed Heads	0.05
Coffs Harbour	0.05	Maitland	0.10	Uluru	0.08
Cooma	0.08	Melbourne	0.08	Wagga Wagga	0.09
Dampier	0.12	Mittagong	0.09	Wangaratta	0.09
Darwin	0.09	Morisset	0.10	Whyalla	0.09
Derby	0.09	Newcastle	0.11	Wollongong	0.09
Dubbo	0.08	Noosa	0.08	Woomera	0.08
Esperance	0.09	Orange	0.08	Wyndham	0.09
Geelong	0.10	Perth	0.09	Wyong	0.10
Meckering region				**Islands**	
Ballidu	0.15	Meckering	0.20	Christmas Island	0.15
Corrigin	0.14	Northam	0.14	Cocos Islands	0.08
Cunderdin	0.22	Wongan Hills	0.15	Heard Island	0.10
Dowerin	0.20	Wickepin	0.15	Lord Howe Island	0.06
Goomalling	0.16	York	0.14	Macquarie Island	0.60
Kellerberrin	0.14			Norfolk Island	0.08

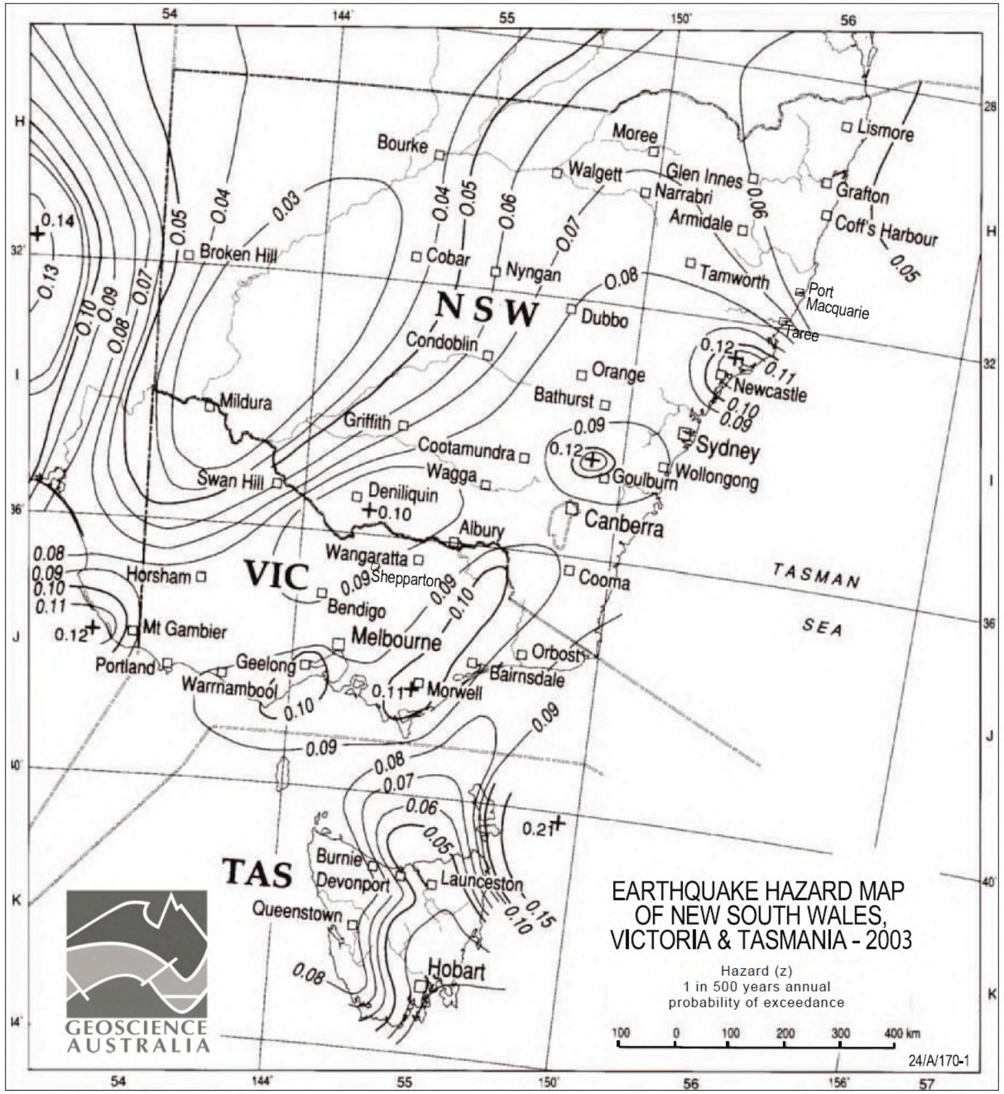


FIGURE 3.2(A) HAZARD FACTOR (Z) FOR NEW SOUTH WALES, VICTORIA AND TASMANIA

TABLE 2.1

SELECTION OF EARTHQUAKE DESIGN CATEGORIES

Importance level, type of structure (see Clause 2.2)	**($k_p Z$) for site sub-soil class**				**Structure height, h_n (m)**	**Earthquake design category**
	E_e or D_e	**C_e**	**B_e**	**A_e**		
1	—				—	Not required to be designed for earthquake actions
Domestic structure (housing)	—				Top of roof ≤8.5	Refer to Appendix A
					Top of roof >8.5	Design as importance level 2
2	≤0.05	≤0.08	≤0.11	≤0.14	≤12 >12, <50 ≥50	I II III
	>0.05 to ≤0.08	>0.08 to ≤0.12	>0.11 to ≤0.17	>0.14 to ≤0.21	<50 ≥50	II III
	>0.08	>0.12	>0.17	>0.21	<25 ≥25	II III
3	≤0.08	≤0.12	≤0.17	≤0.21	<50 ≥50	II III
	>0.08	>0.12	>0.17	>0.21	<25 ≥25	II III
4	—				<12 ≥12	II III

NOTES:

1 Values for k_p and Z are given in Section 3. Site sub-soil class are given in Section 4.

2 A higher earthquake design category or procedure may be used in place of that specified.

3 Height (h_n) is defined in Clause 1.5. For domestic structures refer to Appendix A.

4 In addition to the above, a special study is required for importance level 4 structures to demonstrate they remain serviceable for immediate use following the design event for importance level 2 structures.

Class A_e—Strong rock.

Class B_e—Rock.

Class C_e—Shallow soil.

Class D_e—Deep or soft soil.

Class E_e—Very soft soil.

This is what we want to know

Earthquake design category consistent throughout a given project.

We know the EDC for the job... Now what?

- What forces do we need to account for to conform?
- In other words, how strong do the restraints need to be?

- EDC I - Clause 5.3
- EDC II - Clause 5.4 or Section 8 (depending on situation)
- EDC III - Section 8

EDC I – Clause 5.3

- Cannot be applied to structures with height over 12m.
- Fi=0.1Wi hence horizontal force = 10% of component mass

0.1G

EDC II – Clause 5.4

- Structures not exceeding 15m with importance level 2 or 3: "parts and components of non-brittle construction may be attached using connectors designed for horizontal capacity of 10% of the seismic weight of the part"
- All others are designed to Section 8 … Same as EDC III

0.1G

or more

EDC III – Section 8

- Earthquake forces…
- Fc = Horizontal force applied to the component at its centre of mass.
- Fcv = Vertical force (50% of Fc)
- Fc is calculated from the **probability factor, hazard factor, spectral shape factor, height amplification factor, component importance factor, component amplification factor and the component ductility factor.**
- Up to a maximum of Fc = 0.5Wc… ie. max design acceleration 0.5G

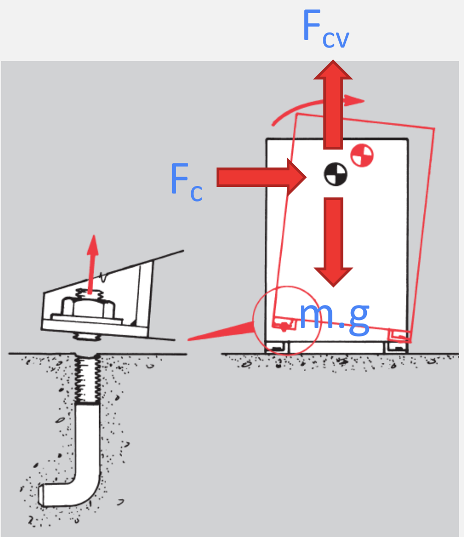
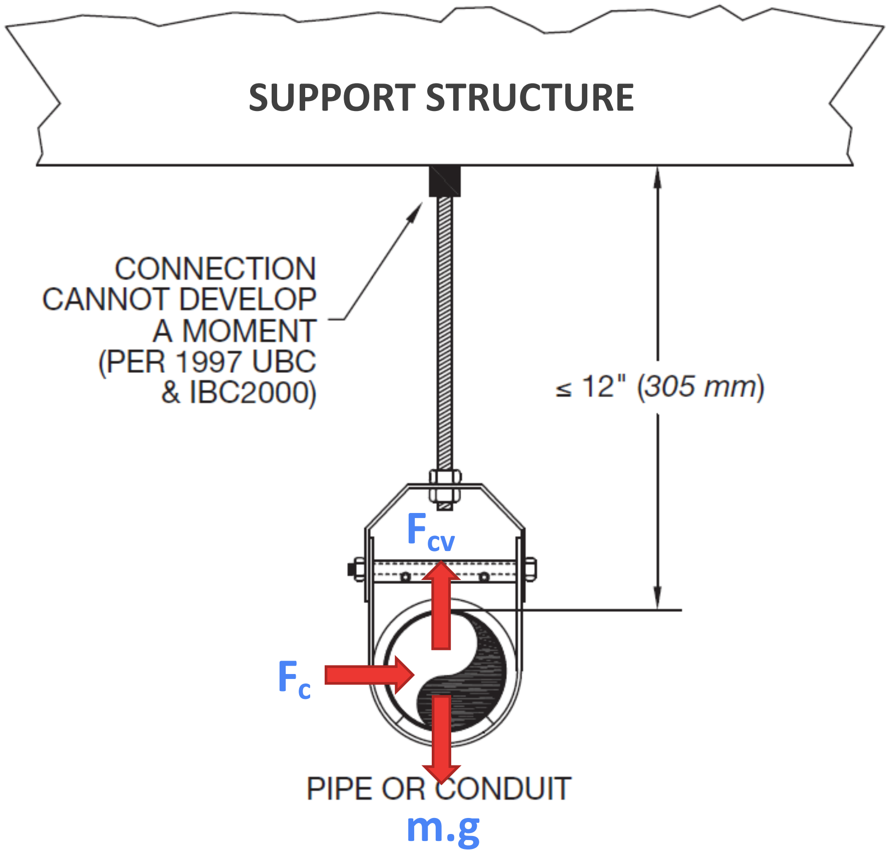


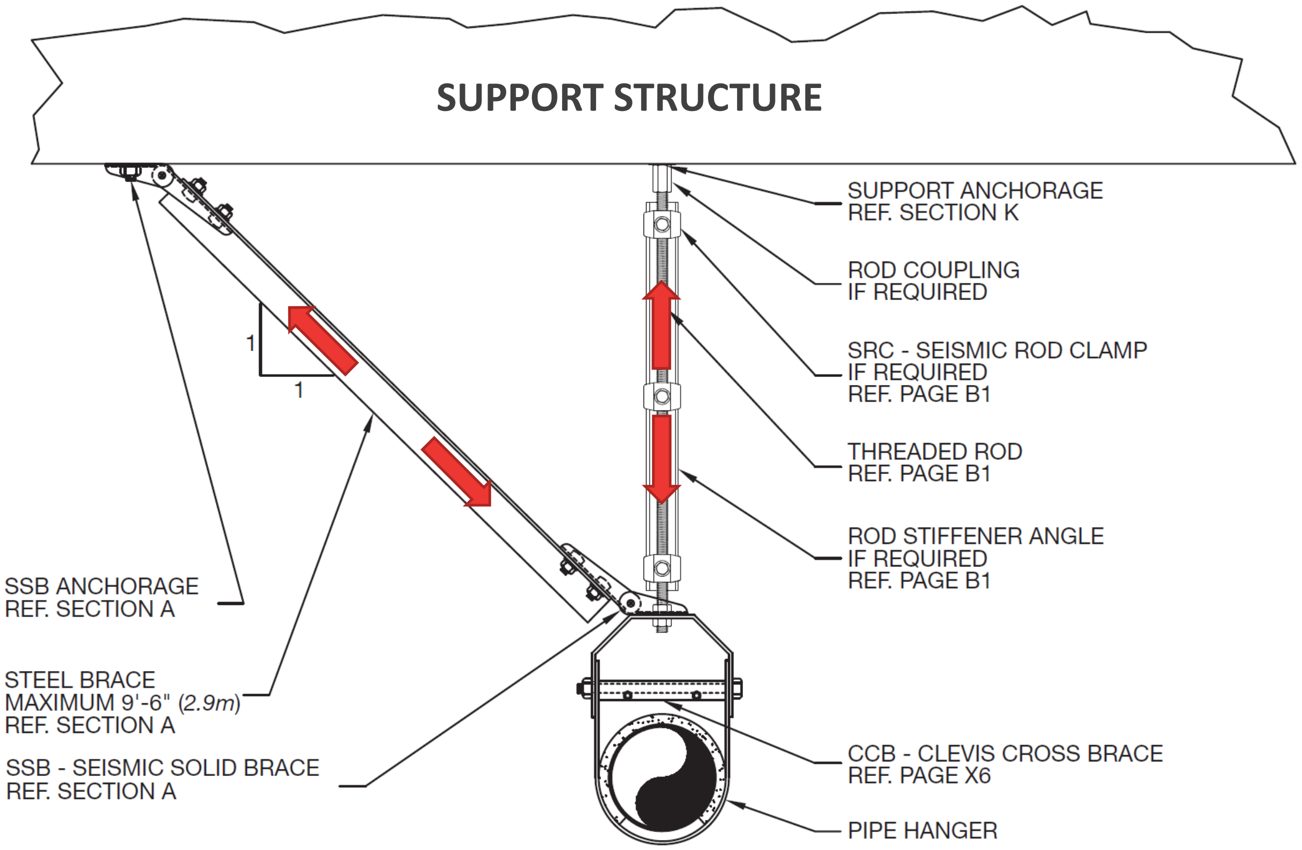
Figure 9. ROTATIONAL TENSILE FAILURE

up to

0.5G

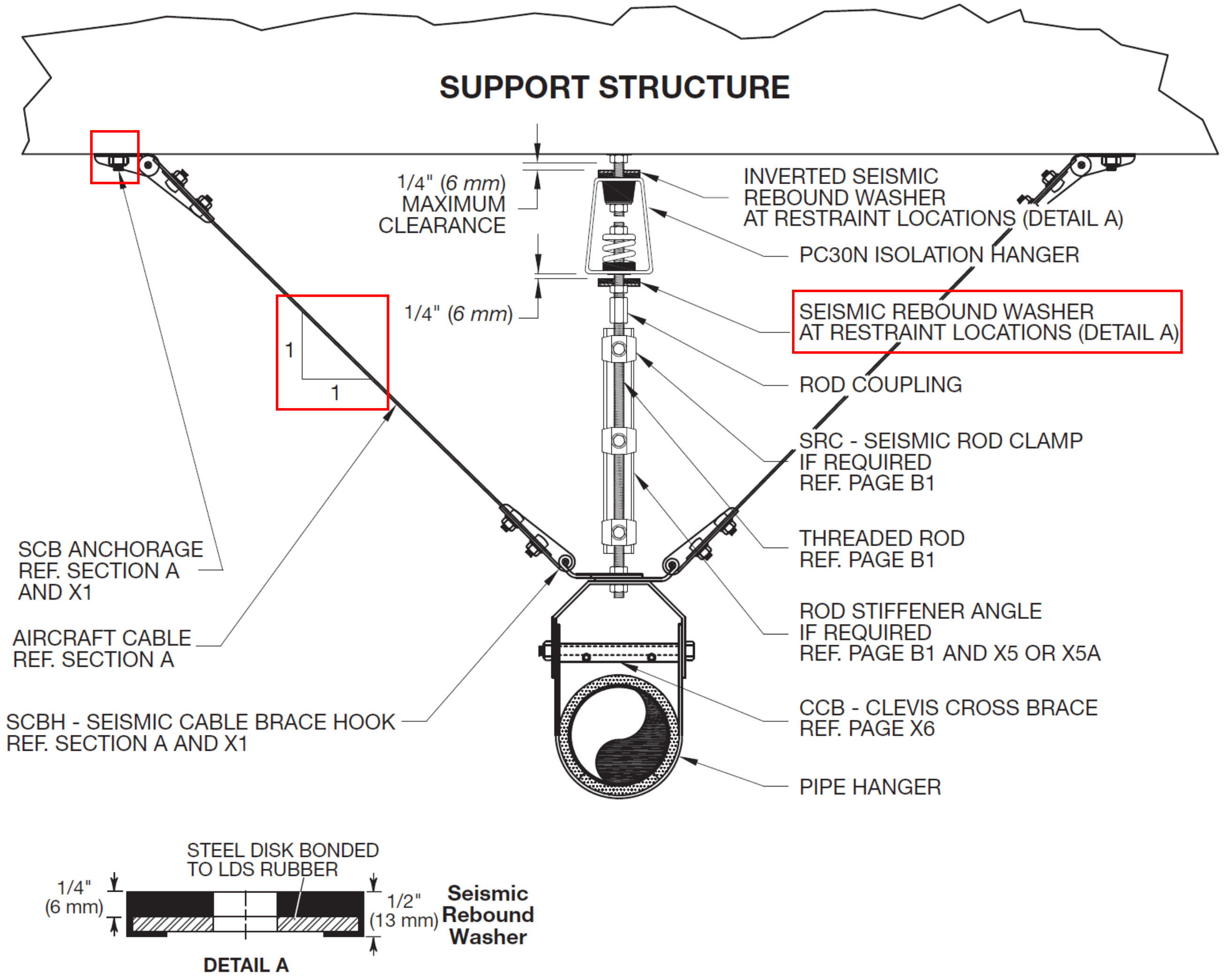
The same forces are imposed on hanging equipment, piping and ducts.
Sway bracing is used to limit motion.
Below is an example of solid strut bracing.





Solid struts must not be used with isolated pipe work (vibration path)

- Cable restraints solve the problem
- Only work in tension



Mason Mercer

There are exceptions from these design values in certain situations

Only applies to “supports for ducts and piping distribution systems”

As per AS1170.4-2007, Section 8.1.4

Exceptions - supports for ducts & piping distribution systems

(A) In structures classified as being in EDC I.

Exceptions - supports for ducts & piping distribution systems

(A) In structures classified as being in EDC I.

(B) For gas piping less than 25mm inside diameter.

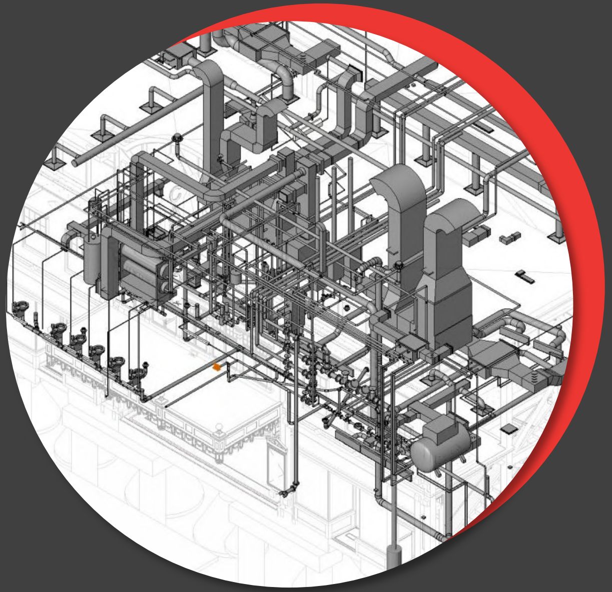
Exceptions - supports for ducts & piping distribution systems

(A) In structures classified as being in EDC I.
(B) For gas piping less than 25mm inside diameter.
(C) For piping in boiler and mechanical rooms less than 32mm inside diameter.

Exceptions - supports for ducts & piping distribution systems

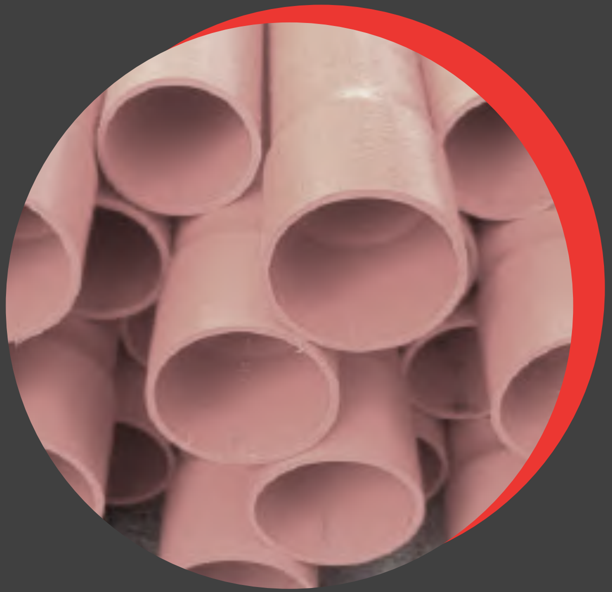
(A) In structures classified as being in EDC I.
(B) For gas piping less than 25mm inside diameter.
(C) For piping in boiler and mechanical rooms less than 32mm inside diameter.

(D) For all other piping less than 64mm inside diameter.



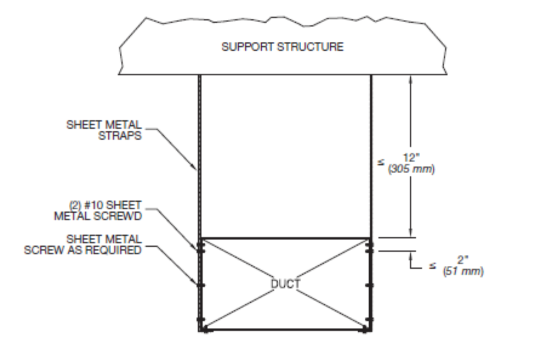
Exceptions - supports for ducts & piping distribution systems

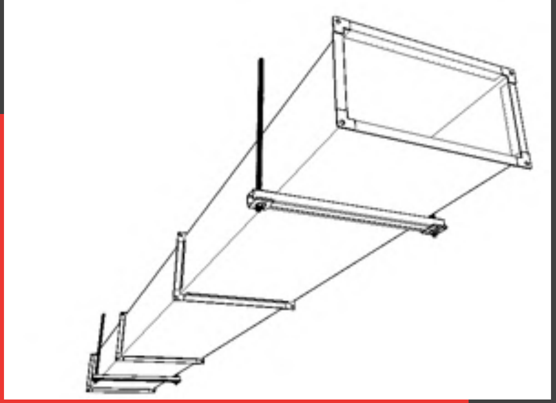
(A) In structures classified as being in EDC I.
(B) For gas piping less than 25mm inside diameter.
(C) For piping in boiler and mechanical rooms less than 32mm inside diameter.
(D) For all other piping less than 64mm inside diameter.
(E) For all electrical conduit less than 64mm inside diameter.



Exceptions - supports for ducts & piping distribution systems

(A) In structures classified as being in EDC I.
(B) For gas piping less than 25mm inside diameter.
(C) For piping in boiler and mechanical rooms less than 32mm inside diameter.
(D) For all other piping less than 64mm inside diameter.
(E) For all electrical conduit less than 64mm inside diameter.
(F) For all rectangular air-handling ducts less than 0.4m2 in cross sectional area.

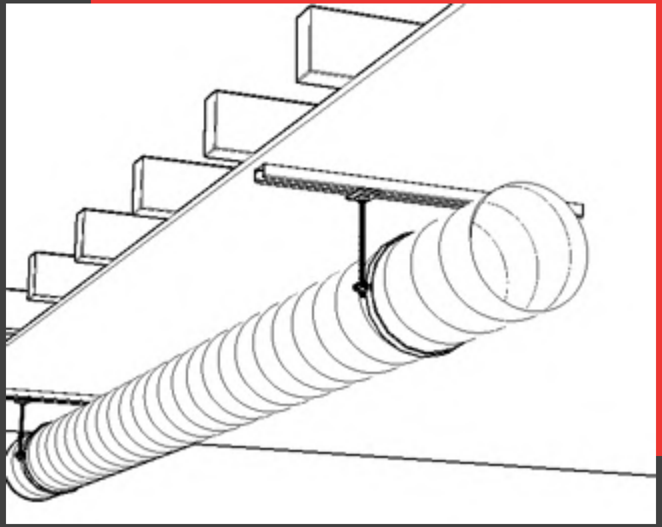




Exceptions - supports for ducts & piping distribution systems

(A) In structures classified as being in EDC I.
(B) For gas piping less than 25mm inside diameter.
(C) For piping in boiler and mechanical rooms less than 32mm inside diameter.
(D) For all other piping less than 64mm inside diameter.
(E) For all electrical conduit less than 64mm inside diameter.
(F) For all rectangular air-handling ducts less than 0.4m2 in cross sectional area.

(G) For all round air-handling ducts less than 700mm in diameter.

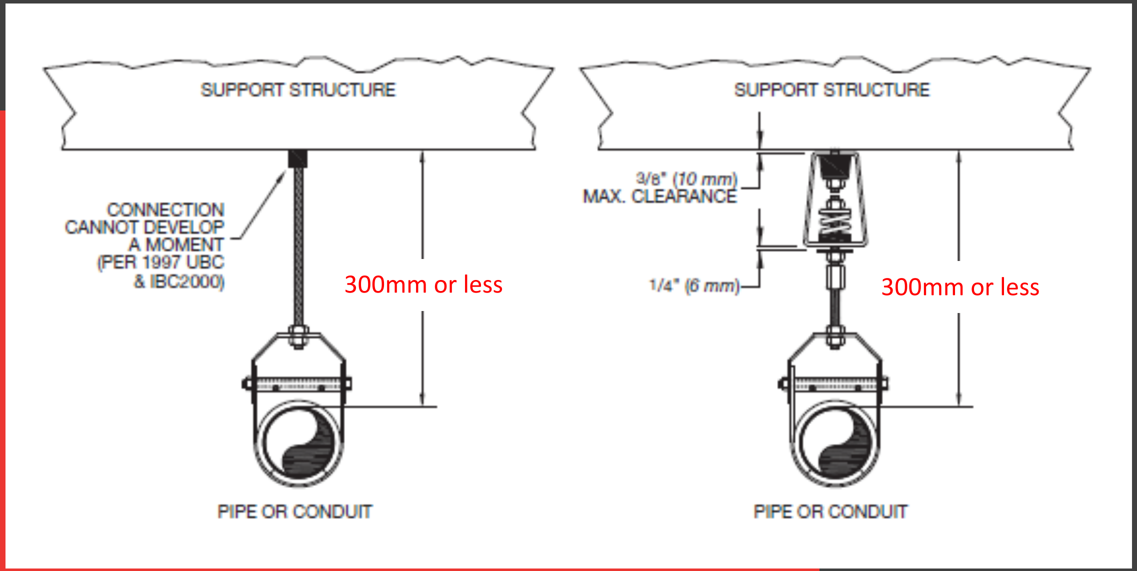


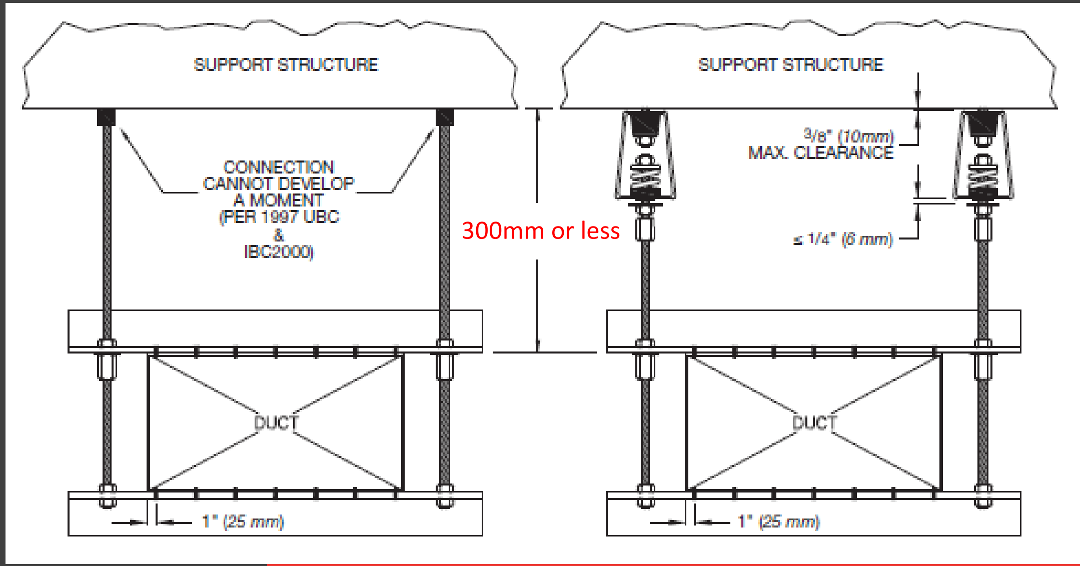
Exceptions - supports for ducts & piping distribution systems

(A) In structures classified as being in EDC I.
(B) For gas piping less than 25mm inside diameter.
(C) For piping in boiler and mechanical rooms less than 32mm inside diameter.
(D) For all other piping less than 64mm inside diameter.
(E) For all electrical conduit less than 64mm inside diameter.
(F) For all rectangular air-handling ducts less than 0.4m2 in cross sectional area.
(G) For all round air-handling ducts less than 700mm in diameter.

(H) For all ducts and piping suspended by individual hangers 300mm or less in length from the top of the pipe to the bottom of the support for the hanger.

These conditions must be met alone the entire pipe run





In the event that **sway bracing is required**

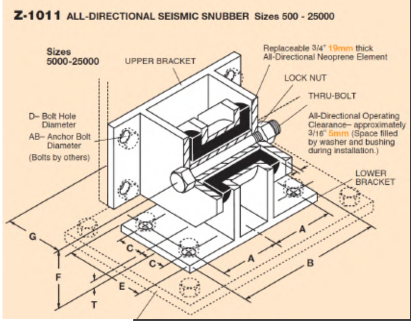
- Restraint system must resist horizontal and vertical design accelerations (Fc & Fcv that we looked at earlier)
- Simplified rules of thumb and tables available in “Seismic Restraint Guidelines” – Mason Industries (Available in either soft or hard copy)
- Although based on the IBC, tables and sway bracing techniques are still relevant.

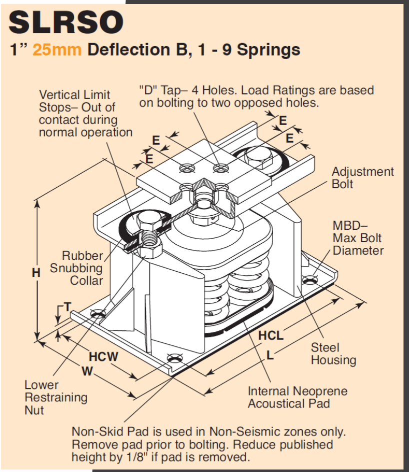
We are here **to help.**

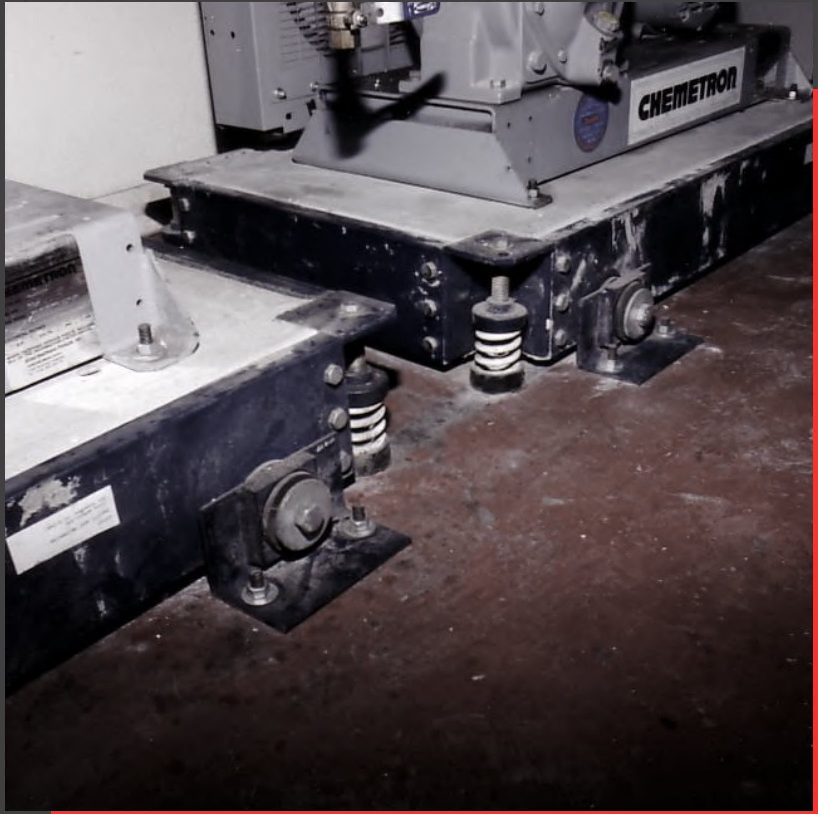
- Contact us to arrange a meeting to discuss individual projects.
- Submittal packages available on request.

Restraint of Equipment

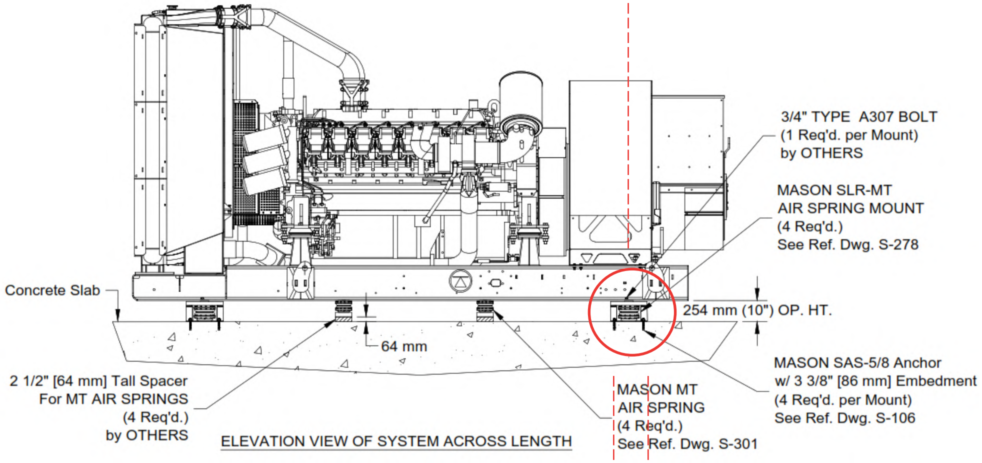
- If machinery is solid mounted (no isolation), anchor methods must be sufficient to resist the horizontal and vertical forces discussed earlier.
- If machinery is isolated (neoprene, springs, air springs), a direct connection to structure would create a path for vibration.
- Seismic snubbers are the answer. They can be either stand alone or built into the isolation mounts.

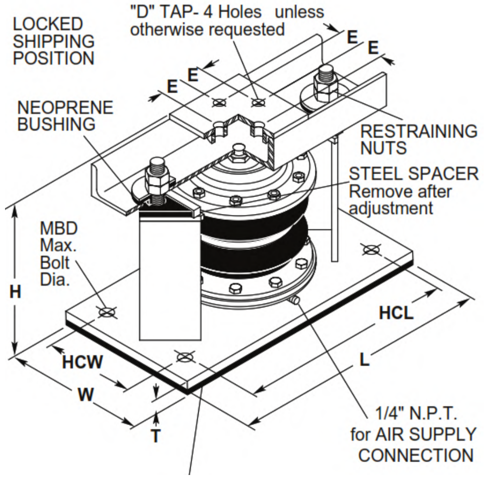


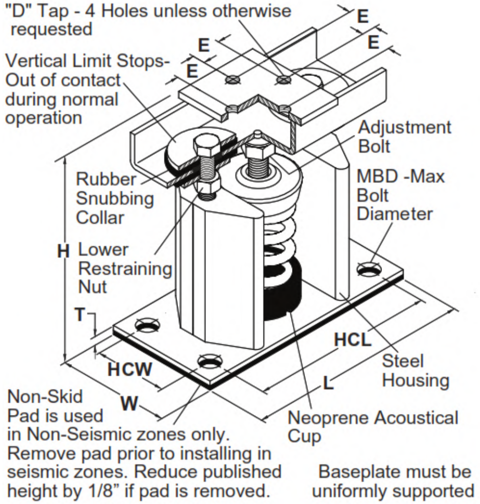


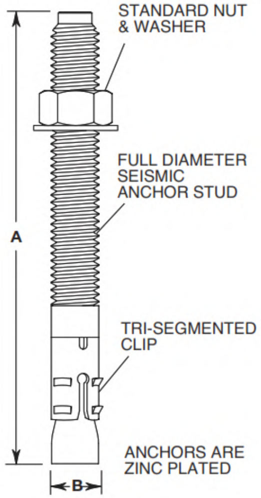


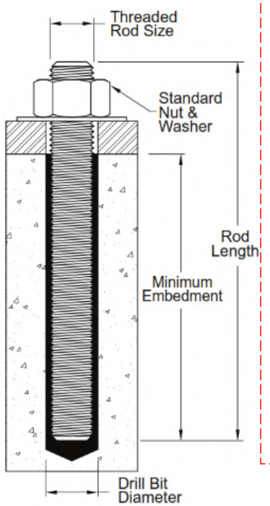
Restraint of Equipment

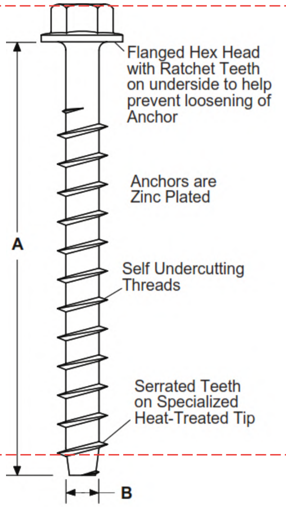


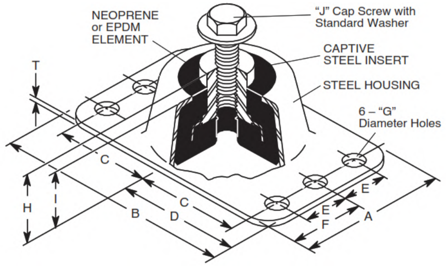












Mason Mercer

What is a seismic snubber?

- Seismic snubbers provide physical restraint of machinery.
- During normal operation, there is no direct contact between the isolated machine and the structure. (no path for vibration)
- Seismic activity can produce a wide range of frequencies, if aligned with the natural frequency of an isolated system resonance occurs.
- Resonance can amplify forces applied to anchors.
- Neoprene pads and washers are integrated into Mason snubbers to reduce the forces that components are exposed to.
- Anchors bolts are defined in submittal packages.
- Extended base plates can be used to increase anchor strength.

Anchor bolts

- A chain is only as strong as its weakest link.
- Defined in submittal packages
- Housekeeping pads (plinths) must also be anchored (tied to structure) – starter bars – if overlooked, plinth anchors are an option.
- This is why we offer submittal packages which define appropriate anchors for the application.

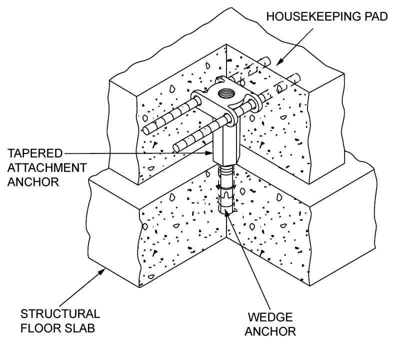


FIGURE 6-3

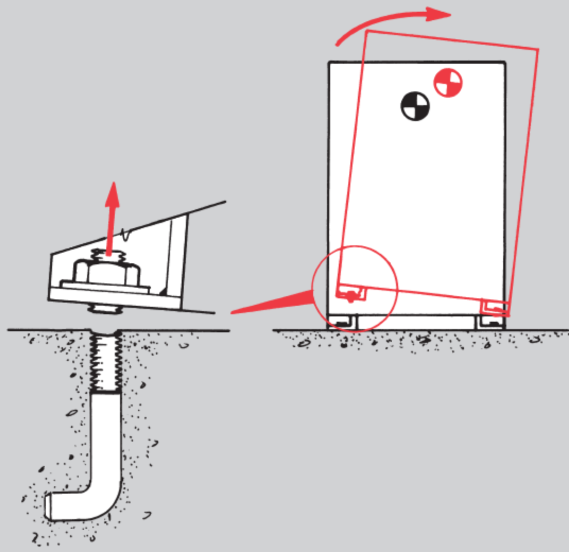


Figure 9. ROTATIONAL TENSILE FAILURE

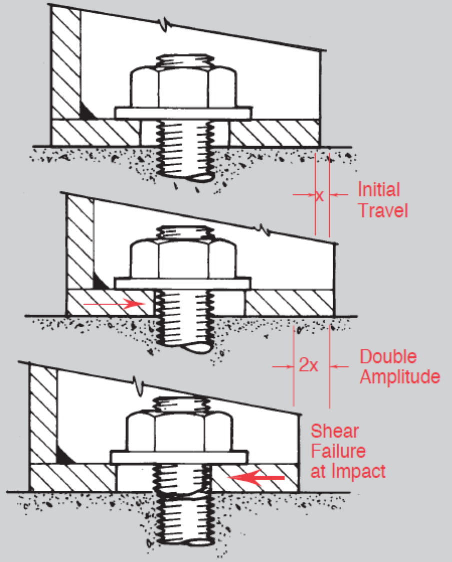
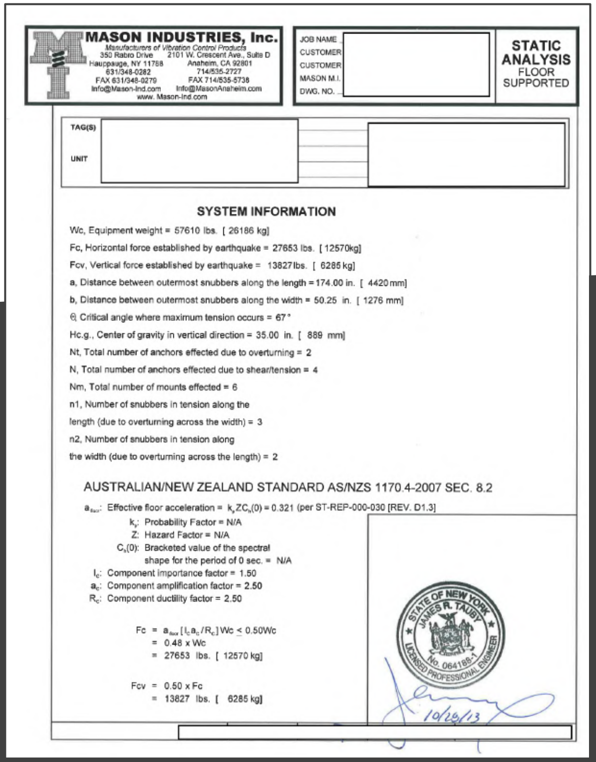


Figure 8. IMPACT SHEAR FAILURE

Extracts from a **Mason Submittal Package**



MASON INDUSTRIES, Inc.
Manufacturers of Vibration Control Products
350 Rabro Drive, Hauppauge, NY 11788, 631/348-0282, FAX 631/348-0279, Info@Mason-Ind.com
2101 W. Crescent Ave., Suite D, Anaheim, CA 92801, 714/535-2727, FAX 714/535-5738, Info@MasonAnaheim.com
www. Mason-Ind.com

JOB NAME
CUSTOMER
CUSTOMER
MASON M.I.
DWG. NO.

STATIC ANALYSIS FLOOR SUPPORTED

TAG(S)
UNIT

SYSTEM INFORMATION

Wc, Equipment weight = 57610 lbs. [26186 kg]
Fc, Horizontal force established by earthquake = 27653 lbs. [12570kg]
Fcv, Vertical force established by earthquake = 13827lbs. [6285 kg]
a, Distance between outermost snubbers along the length = 174.00 in. [4420 mm]
b, Distance between outermost snubbers along the width = 50.25 in. [1276 mm]
Θ, Critical angle where maximum tension occurs = 67°
Hc.g., Center of gravity in vertical direction = 35.00 in. [889 mm]
Nt, Total number of anchors effected due to overturning = 2
N, Total number of anchors effected due to shear/tension = 4
Nm, Total number of mounts effected = 6
n1, Number of snubbers in tension along the length (due to overturning across the width) = 3
n2, Number of snubbers in tension along the width (due to overturning across the length) = 2

AUSTRALIAN/NEW ZEALAND STANDARD AS/NZS 1170.4-2007 SEC. 8.2

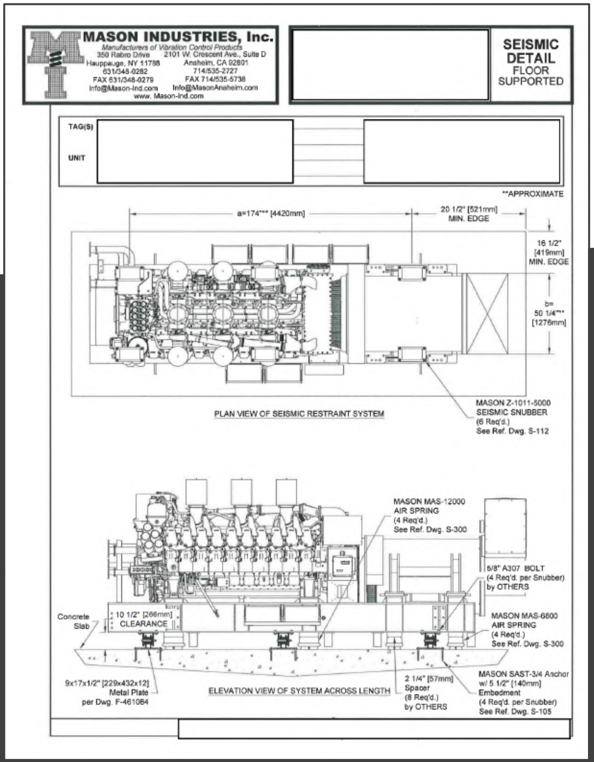
a_{floor}: Effective floor acceleration = $k_p Z C_h(0)$ = 0.321 (per ST-REP-000-030 [REV. D1.3]
k_p: Probability Factor = N/A
Z: Hazard Factor = N/A
$C_h(0)$: Bracketed value of the spectral shape for the period of 0 sec. = N/A
I_c: Component importance factor = 1.50
a_c: Component amplification factor = 2.50
R_c: Component ductility factor = 2.50

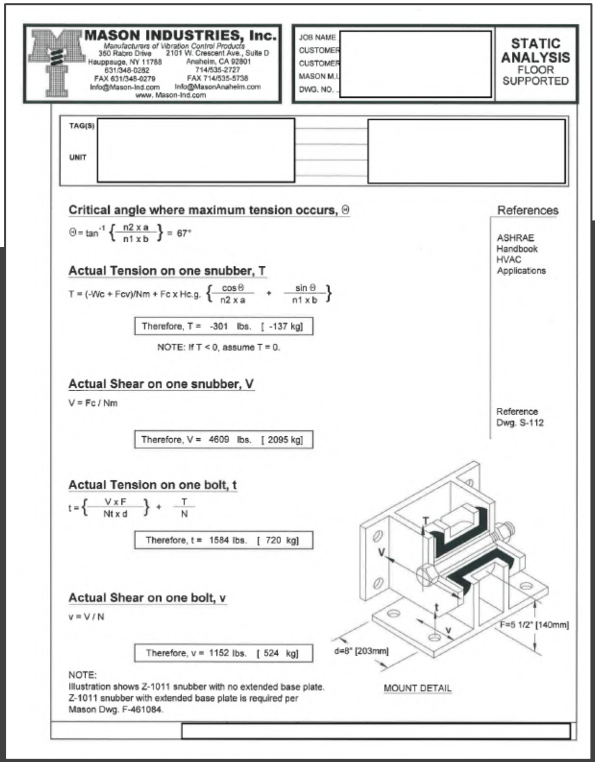
$Fc = a_{floor} [I_c a_c / R_c] Wc \leq 0.50Wc$
= 0.48 x Wc
= 27653 lbs. [12570 kg]

Fcv = 0.50 x Fc
= 13827 lbs. [6285 kg]

STATE OF NEW YORK · JAMES R. TAUBY · LICENSED PROFESSIONAL ENGINEER · No. 064188-1

10/29/13





MASON INDUSTRIES, Inc.
Manufacturers of Vibration Control Products
350 Rabro Drive, Hauppauge, NY 11788, 631/348-0282, FAX 631/348-0279, Info@Mason-Ind.com
2101 W. Crescent Ave., Suite D, Anaheim, CA 92801, 714/535-2727, FAX 714/535-5738, Info@MasonAnaheim.com
www. Mason-Ind.com

JOB NAME
CUSTOMER
CUSTOMER
MASON M.I.
DWG. NO.

STATIC ANALYSIS FLOOR SUPPORTED

TAG(S)
UNIT

Critical angle where maximum tension occurs, Θ

$\Theta = \tan^{-1}\left\{\frac{n2 \times a}{n1 \times b}\right\} = 67°$

Actual Tension on one snubber, T

$T = (-Wc + Fcv)/Nm + Fc \times Hc.g. \left\{\frac{\cos\Theta}{n2 \times a} + \frac{\sin\Theta}{n1 \times b}\right\}$

Therefore, T = -301 lbs. [-137 kg]

NOTE: If T < 0, assume T = 0.

Actual Shear on one snubber, V

V = Fc / Nm

Therefore, V = 4609 lbs. [2095 kg]

Actual Tension on one bolt, t

$t = \left\{\frac{V \times F}{Nt \times d}\right\} + \frac{T}{N}$

Therefore, t = 1584 lbs. [720 kg]

Actual Shear on one bolt, v

v = V / N

Therefore, v = 1152 lbs. [524 kg]

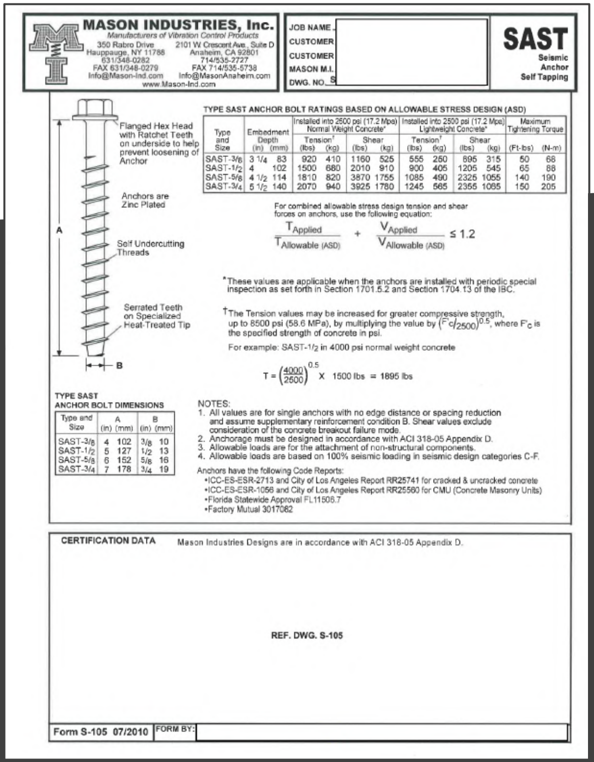
NOTE:
Illustration shows Z-1011 snubber with no extended base plate.
Z-1011 snubber with extended base plate is required per Mason Dwg. F-461084.

References

ASHRAE Handbook HVAC Applications

Reference Dwg. S-112

F=5 1/2" [140mm]
d=8" [203mm]
MOUNT DETAIL



MASON INDUSTRIES, Inc.
Manufacturers of Vibration Control Products
350 Rabro Drive, Hauppauge, NY 11788, 631/348-0282, FAX 631/348-0279, Info@Mason-Ind.com
2101 W Crescent Ave., Suite D, Anaheim, CA 92801, 714/535-2727, FAX 714/535-5738, Info@MasonAnaheim.com
www.Mason-Ind.com

JOB NAME
CUSTOMER
CUSTOMER
MASON M.I.
DWG. NO. S

SAST Seismic Anchor Self Tapping

Flanged Hex Head with Ratchet Teeth on underside to help prevent loosening of Anchor
Anchors are Zinc Plated
Self Undercutting Threads
Serrated Teeth on Specialized Heat-Treated Tip
A
B

TYPE SAST ANCHOR BOLT RATINGS BASED ON ALLOWABLE STRESS DESIGN (ASD)

Type and Size	Embedment Depth		Installed into 2500 psi (17.2 Mpa) Normal Weight Concrete*				Installed into 2500 psi (17.2 Mpa) Lightweight Concrete*				Maximum Tightening Torque	
			Tension†		Shear		Tension†		Shear			
	(in)	(mm)	(lbs)	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)	(kg)	(Ft-lbs)	(N-m)
SAST-3/8	3 1/4	83	920	410	1160	525	555	250	695	315	50	68
SAST-1/2	4	102	1500	680	2010	910	900	405	1205	545	65	88
SAST-5/8	4 1/2	114	1810	820	3870	1755	1085	490	2325	1055	140	190
SAST-3/4	5 1/2	140	2070	940	3925	1780	1245	565	2355	1065	150	205

For combined allowable stress design tension and shear forces on anchors, use the following equation:

$$\frac{T_{Applied}}{T_{Allowable\ (ASD)}} + \frac{V_{Applied}}{V_{Allowable\ (ASD)}} \leq 1.2$$

*These values are applicable when the anchors are installed with periodic special inspection as set forth in Section 1701.5.2 and Section 1704.13 of the IBC.

†The Tension values may be increased for greater compressive strength, up to 8500 psi (58.6 MPa), by multiplying the value by $(F'c/2500)^{0.5}$, where F'_c is the specified strength of concrete in psi.

For example: SAST-1/2 in 4000 psi normal weight concrete

$$T = \left(\frac{4000}{2500}\right)^{0.5} \times 1500\text{ lbs} = 1895\text{ lbs}$$

TYPE SAST ANCHOR BOLT DIMENSIONS

Type and Size	A (in)	A (mm)	B (in)	B (mm)
SAST-3/8	4	102	3/8	10
SAST-1/2	5	127	1/2	13
SAST-5/8	6	152	5/8	16
SAST-3/4	7	178	3/4	19

NOTES:
1. All values are for single anchors with no edge distance or spacing reduction and assume supplementary reinforcement condition B. Shear values exclude consideration of the concrete breakout failure mode.
2. Anchorage must be designed in accordance with ACI 318-05 Appendix D.
3. Allowable loads are for the attachment of non-structural components.
4. Allowable loads are based on 100% seismic loading in seismic design categories C-F.

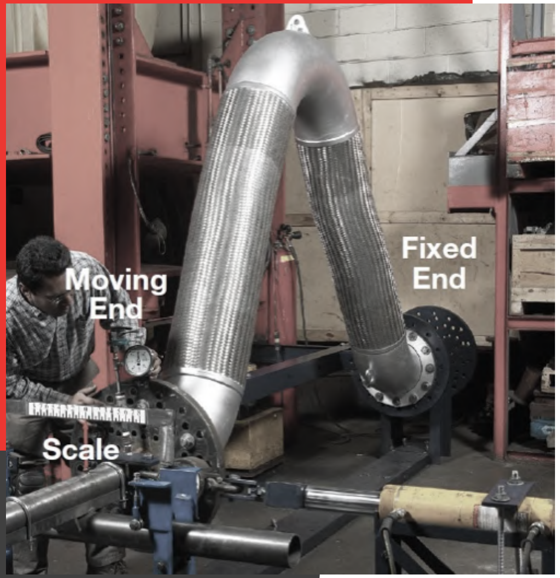
Anchors have the following Code Reports:
- ICC-ES-ESR-2713 and City of Los Angeles Report RR25741 for cracked & uncracked concrete
- ICC-ES-ESR-1056 and City of Los Angeles Report RR25560 for CMU (Concrete Masonry Units)
- Florida Statewide Approval FL11506.7
- Factory Mutual 3017082

CERTIFICATION DATA Mason Industries Designs are in accordance with ACI 318-05 Appendix D.

REF. DWG. S-105

Form S-105 07/2010 FORM BY:

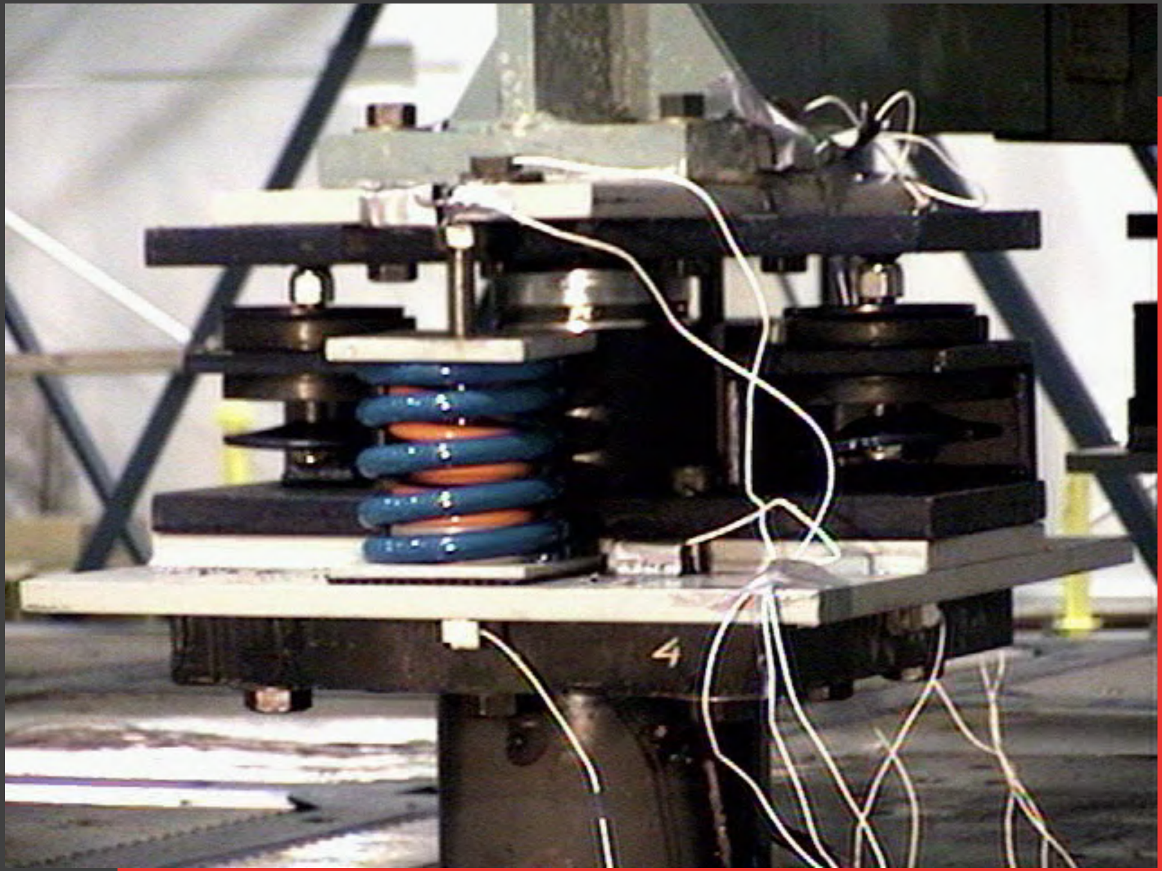
Mason Mercer



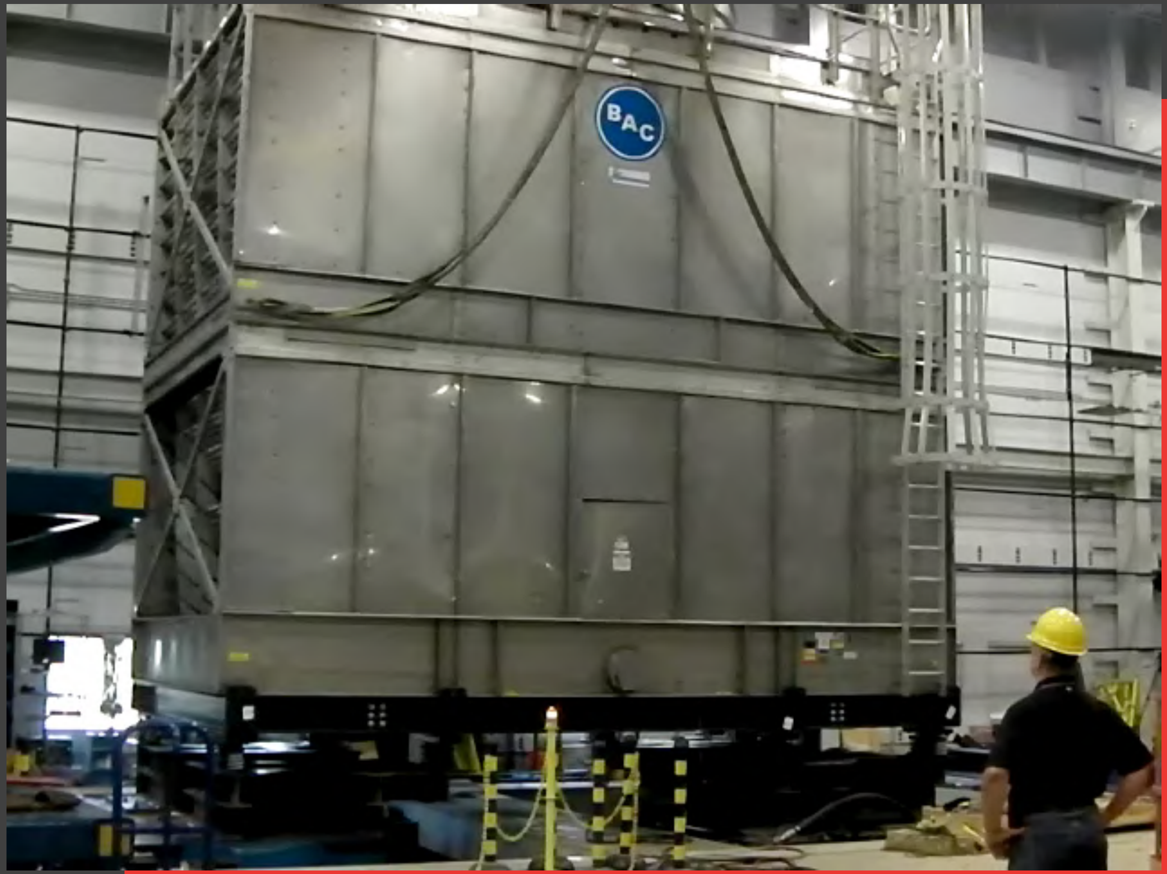
Seismic Certification

- All Mason products certified for use in seismic applications have been tested both in-house during development as well as by a third party.
- All published rated values are results from physical testing.
- Conservative safety factors are built into all published ratings.
- Latest certification methods in the US include shaker table testing.
- OPA Numbers - OSPD

Seismic Testing of Spring Mounts & Snubbers



Seismic Testing of Cooling Tower



Summary

- What is an Earthquake
- Potential Effects
- What needs to be done
- AS1170.4 (Earthquake actions in Australia)
- EDC’s & Design Accelerations
- Exceptions from these requirements
- How we resist the imposed forces
- Types of seismic restraint and anchors
- How hardware is tested and certified

You made it!

Mason Mercer

Contact

Jonathan Watson

jw@masonmercer.com.au
www.masonmercer.com.au
0450 336 245