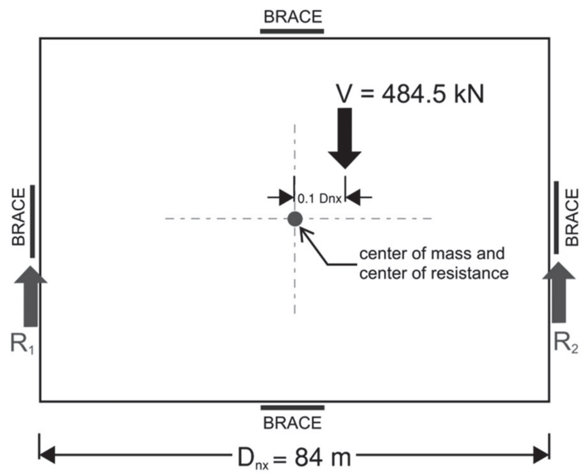
SINGLE-STOREY BUILDING DESIGN

1st Edition, 1st Printing, November 2019

REVISION LIST - 4 FEBRUARY 2022

The following revisions to the first printing of the CISC publication, *Single-Storey Building Design,* 1st Edition, will be incorporated in future printings. Minor editorial revisions are not shown.

Page(s)	Revisions
84-86	*Replace pages 84-86 with the following pages. Revisions are highlighted in red.*
	The section on "Shear transfer" has been moved to page 87.



Accidental Torsion

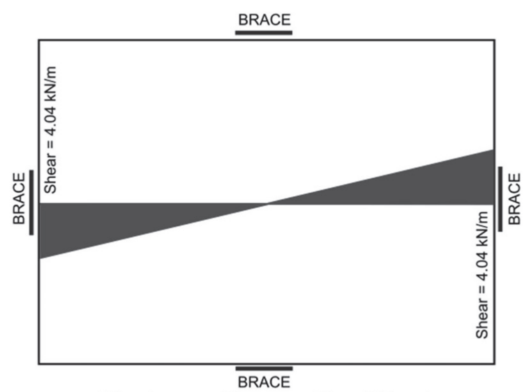
V = 484.5 kN acting at $0.1D_{nx}$ from the centre of mass

$0.1D_{nx}$ = 0.1 x 84 m = 8.4 m

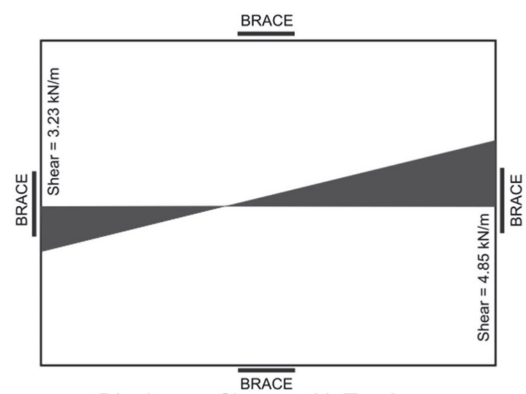
Solving for R_1 and R_2:

R_1 = (484.5 x (84/2-8.4))/84 = 193.8 kN
R_2 = 484.5 - 193.8 = 290.7 kN

Note: e_x = 0 as the center of resistance provided by the bracing system coincides with the center of mass.



Diaphragm Shears without Torsion



Diaphragm Shears with Torsion

The maximum diaphragm shear from seismic loads is =290.7 kN/60m = 4.85 kN/m. This will occur on the opposing side of the diaphragm as well when the torque is applied in the other direction.

This maximum diaphragm shear was calculated using R_dR_o = 1.5 x 1.3. However, according to the CISC commentary on CSA S16-14 (Clause 27.11) “diaphragms with connections that have not been shown to be ductile should be designed using forces calculated using R_dR_o = 1.3. Button-punched side lap connections or arc-spot welded connections commonly used for steel decks have not shown adequate ductile behavior under cyclic loading.”

In this example, because we have chosen welds and button punching for the diaphragm connections, the design shear force must be adjusted.

For the diaphragm design: V = 290.7 kN (R_dR_o = 1.5x1.3/R_dR_o = 1.3) = **436.1** kN
Uniformly distributed shear: V = 436.1kN /60m = **7.27** kN/m

Wind Shear

The load factor for wind load is 1.4.

Wind w_f = 2.87 x 1.4 = 4.01 kN/m < 7.27 kNm, therefore the seismic loads govern.

The design will use the seismic load. Note that even though the seismic loads govern the strength design, wind loads may govern drift.

Information from Vendor Publications

Steel deck vendors publish the data required for the design of steel deck diaphragms. This example will use the 2007 Steel Deck Diaphragm manual published by Canam. The vendors publication provide the strength and stiffness parameters for choosing the type and spacing of connectors. Deflection will not be calculated in this example.

Steps for choosing the type and spacing of connectors

1. Find the page for the deck profile being used.
2. Find the joist spacing in the span across the top of the table.
3. Find the shear value Q that exceeds the required shear value.
4. Record the connection pattern for the supports and side laps.

P-3615 DIAPHRAGM

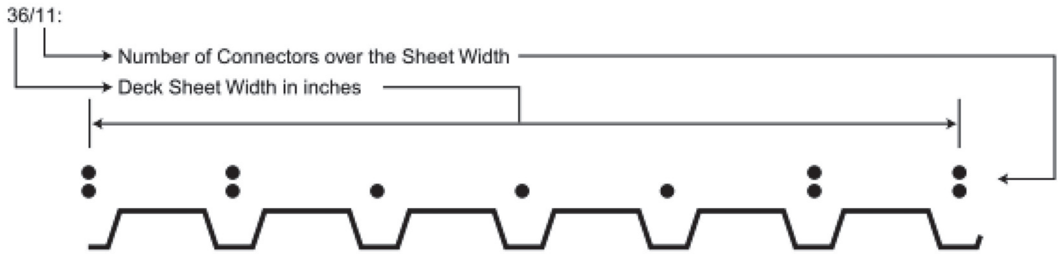
FACTORED SHEAR RESISTANCE Q (N/mm)
AND STIFFNESS COEFFICIENT G' (10^3 N/mm)

METRIC

Thickness = 0.76 mm
ϕ = 0.50

SUPPORT FASTENING: 19 mm puddle weld
SIDE-LAP FASTENING: Button punch

SUPPORT PATTERN	SIDE-LAP SPACING		SPAN (mm)								
			900	1 050	1 200	1 350	1 500	1 650	1 800	1 950	2 100
36/7	900 mm o/c	Q	10.3	9.1	8.0	7.1	6.4	5.8	5.4	5.0	4.6
		G'	8.8	9.1	9.3	9.4	9.3	9.3	9.1	8.9	8.8
	600 mm o/c	Q	10.6	9.3	8.2	7.4	6.7	6.1	5.6	5.2	4.9
		G'	8.8	9.1	9.3	9.4	9.4	9.3	9.2	9.0	8.8
	300 mm o/c	Q	11.2	10.0	9.0	8.2	7.5	6.9	6.4	6.0	5.7
		G'	8.8	9.2	9.4	9.5	9.5	9.4	9.3	9.1	9.0
	230 mm o/c	Q	11.6	10.4	9.5	8.7	8.0	7.4	6.9	6.5	6.2
		G'	8.8	9.2	9.4	9.5	9.5	9.5	9.4	9.2	9.1
	150 mm o/c	Q	12.5	11.3	10.4	9.7	9.1	8.5	8.1	7.7	7.3
		G'	8.9	9.3	9.5	9.6	9.7	9.6	9.5	9.4	9.3
36/4	900 mm o/c	Q	7.0	6.2	5.6	5.0	4.5	4.1	3.8	3.5	3.3
		G'	1.7	1.9	2.1	2.3	2.4	2.5	2.7	2.8	2.9
	600 mm o/c	Q	7.2	6.4	5.8	5.3	4.8	4.4	4.1	3.8	3.6
		G'	1.7	1.9	2.1	2.3	2.4	2.6	2.7	2.8	2.9
	300 mm o/c	Q	7.7	7.0	6.4	6.0	5.6	5.2	4.9	4.6	4.4
		G'	1.7	1.9	2.1	2.3	2.4	2.6	2.7	2.8	2.9
	230 mm o/c	Q	8.0	7.4	6.8	6.4	6.0	5.7	5.4	5.1	4.9
		G'	1.7	1.9	2.1	2.3	2.4	2.6	2.7	2.8	2.9
	150 mm o/c	Q	8.7	8.1	7.6	7.2	6.8	6.5	6.3	6.1	5.9
		G'	1.7	1.9	2.1	2.3	2.5	2.6	2.7	2.9	3.0



<u>Connector Pattern</u>

At the perimeter of the diaphragm, $Q_{req'd}$ = 7.27 kN/m.

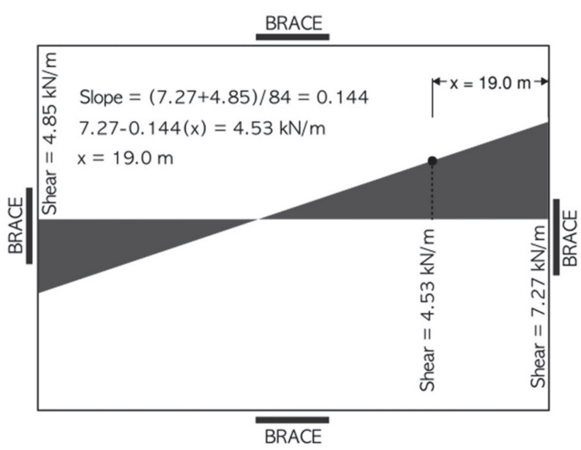
Interpolate factored shear resistance Q for a spacing of 2000mm.

> Q_{prov} = 7.57 kN/m > 7.27 kN/m for 36/7 fastening (7 welds per sheet to the supports), and button punched at 150 mm o/c.

Near the center of the building where the shear is lower, the connector pattern can be reduced. For a single weld in every other flute (pattern 36/4) and button punching at 300 mm o/c, Q_{prov} = 4.53 kN/m.

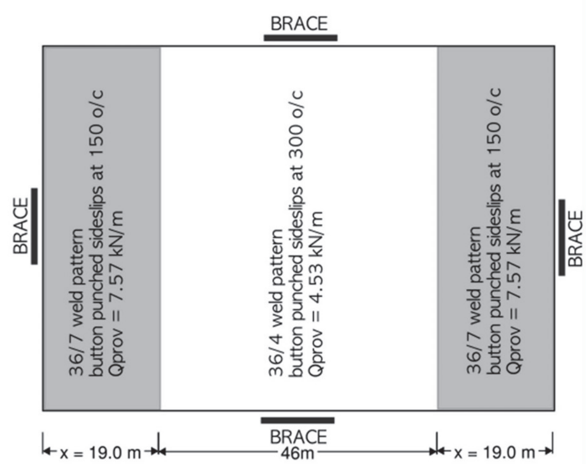
Weld Pattern Layout

Next, you can determine the extent of each connector pattern. This is the connector pattern for 19 mm puddle welds, button punched side laps @150 o/c as per the Canam publication.



<u>Diaphragm Shears For Connection Design</u>

R_dR_o=1.3



<u>Extent of Connector Pattern</u>