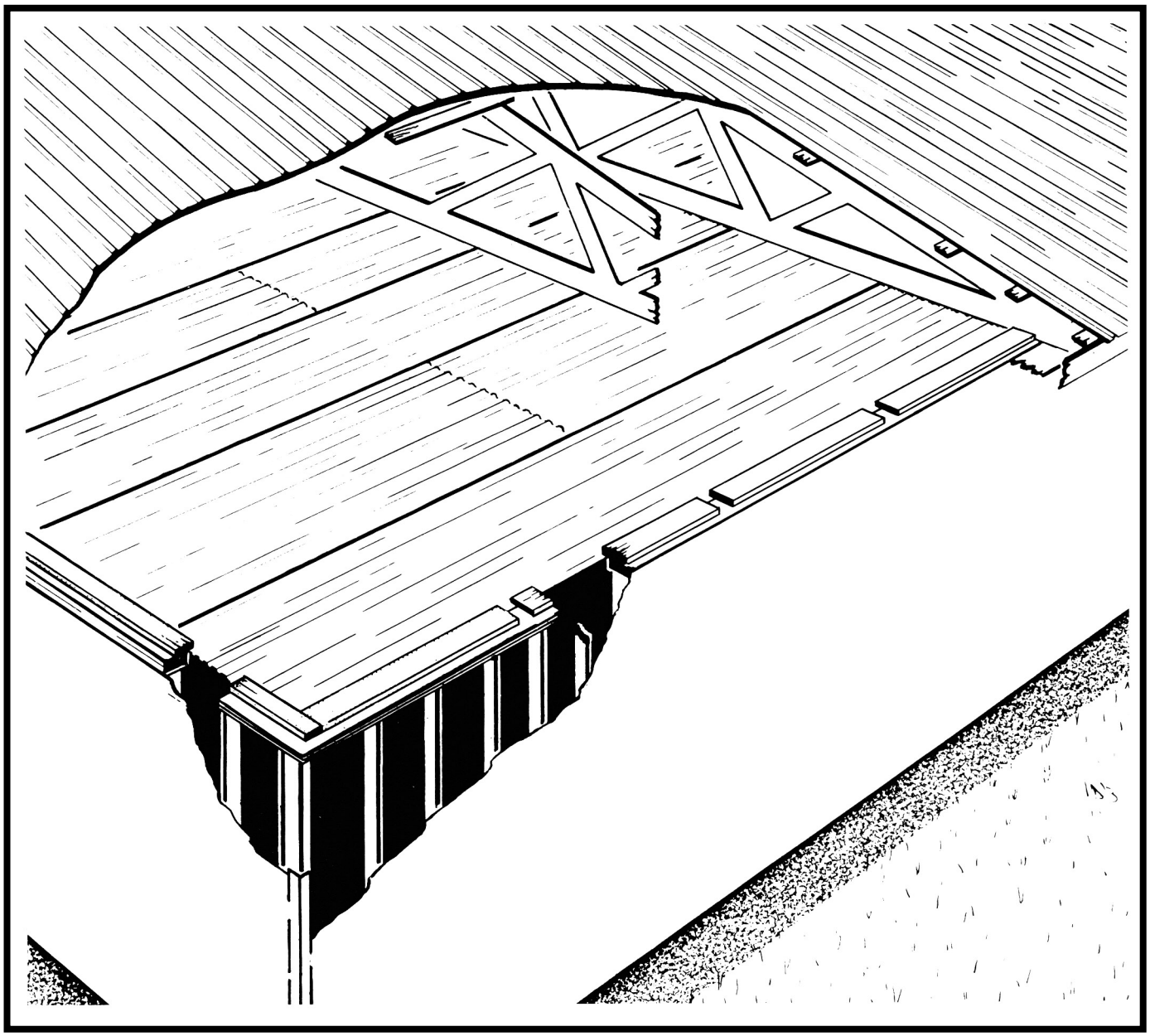
STEEL CEILING DIAPHRAGM



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305 – 10

STEEL CEILING DIAPHRAGM

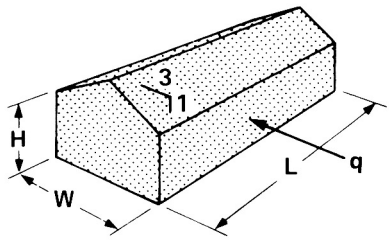
CPS
PLAN M-9371 REVISED: 82:06

Wind blowing across a typical rectangular, gable-roof farm building produces forces that tend to overturn the walls and lift the roof. The uplift forces on roofs are best resisted by secure attachment of roofing to trusses, trusses to walls, and walls to foundations; the overturning forces acting on the walls must be handled in other ways.

Where buildings are clad inside with wide panel materials such as plywood or galvanized steel, horizontal wind effects can be most economically handled by the "diaphragm" action of the ceiling working together with the four walls. This leaflet and corresponding Plan 305-10 give details of how to use a ceiling of galvanized steel to wind-brace a stud wall farm building.

For effective diaphragm action, each panel of ceiling and wall cladding must be connected on all four edges to adjacent framing and cladding. The plan gives details for all the cladding and connections necessary to make an effective diaphragm wind bracing system.

DESIGN Wind pressures for locations in Canada, and the rules for determining design wind forces applicable to various typical building shapes, are found in the Supplement to the National Building Code of Canada, 1980. For "low human occupancy" farm buildings as defined in the Canadian Farm Building Code, use the 1/10 hourly wind pressures as tabled in the Supplement.



For rectangular farm buildings with stud walls and gable truss roofs as above, the maximum hourly wind pressure is:

$$q = 2.22 \frac{SW}{HL}$$

where

- q = 1/10 hourly wind pressure, kN/m^2
- S = ceiling shear, kN/m of span
- W = ceiling span, m
- L = ceiling (or room) length, m
- H = stud wall height, m

The ceiling shear strength S may be limited by either the shear strength of the ribbed galvanized steel, or by the spacing of the fasteners around the perimeter and across each sheet. The customary steel thickness and profile for ceilings is 0.30 mm (30 gauge, before galvanizing) diamond rib, with ribs spaced at approximately 150 mm. This profile gives good longitudinal stiffness for a ceiling screwed to the underside of trusses spaced at up to 1200 mm. Joints between adjacent panels should be lapped one full rib at the sides and at least 75 mm at the ends, so order the sheets 4875 mm long to span four truss spaces of 1200 mm plus 75 mm. Using special self-drilling roofing screws 4.2 x 19 mm (No. 8 x 1"), the ceiling shear strength is:

screw spacing to trusses (beside each rib) mm	stitch-screw spacing at lapped ribs mm	ceiling shear strength S kN/m
150	150	2.71
150	200	2.25
150	300	1.50

EXAMPLE PROBLEM For a gable-roofed farm building 10.8 x 30 m with stud walls 3.6 m high, find the diaphragm ceiling screw spacings for a location near Swift Current, Saskatchewan (1/10 hourly wind pressure q = 0.46 kN/m^2).

Try stitch-screws spaced at 200 mm. The allowable ceiling shear strength S = 2.25 kN/m (table above), and the maximum allowable wind force is:

$$q = 2.22 \frac{SW}{HL} = \frac{2.22(2.25)(10.8)}{(3.6)(30)} = 0.49 \text{ kN/m}^2$$

Since q = 0.49 is slightly greater than 0.46 (the 1/10 hourly wind pressure for Swift Current) a stitch-screw spacing of 200 mm is safe.

A table in the plan sheet gives maximum hourly wind pressure for a wide range of building dimensions. Use the above calculation for cases not covered in the table.

Note also that shear and bending forces developed in the diaphragm ceiling must be carried by the four building walls, down to the foundation. This requires ceiling-to-wall shear connections that are at least as strong as the ceiling. The plan shows a row of blocking nailed to the top of the wall plates, providing an inverted shelf for screwing the ceiling steel to the wall plates. At side walls, the spacing of these screws should be the same as the lap-joint stitch-screws. The stitch-screws connecting the lapped sheet edges will clearly show at the finished ceiling, so use a chalk-line to keep the stitch-screws in straight lines across the ceiling.

The stitch-screws should be slightly shorter than the depth of the ribs in the steel, otherwise the screws will penetrate the polyethylene vapor barrier that is sandwiched between the trusses and the steel.