Conklin Company Inc.
TECHNICAL BULLETIN
B-11-18-02
Wind Uplift Design for Commercial Roofing

Purpose

This technical bulletin is provided by Conklin Company Inc. for the purpose of giving information regarding wind uplift and commercial roofing systems. This document has references from (FM) Factory Mutual Insurance, (ASCE) American Society of Civil Engineers, (SPRI) Single Ply Roofing Institute and (AIA) American Institute of Architects. This information can be helpful in designing fastening patterns for insulation and board stock used in a mechanically fastened or fully adhered single ply systems and Conklin roofing systems. Conklin will at no time design, specify or otherwise advise on the proper securement of any such system. Please refer to FM Global, RoofNav, (ICC) International Code Council, and (NRCA) National Roof Contractors Association, local code officials or an engineer for proper attachment designs for your region.

Wind Uplift

The force (pressure) caused by wind velocity which creates an upwards lift. Basically it is the density of air, times the velocity squared that creates the force from wind on a building. (See figure #1)

Wind Patterns and High Rise Buildings

The altered path causes an acceleration of velocity at the roof top as it meets the unencumbered wind forces and a slight rotation will occur. A similar experience is walking around a corner of a building in a downtown area on a windy day.
(See figure #2) The rotation causes a mini vortex pattern on the roof top from wind approaching over the wall or roof edge. The pattern causes a "negative pressure" to occur which in effect will cause suction against the roof membrane. (See figure #3)

Wind Exposure Definitions (2009 IBC)

1609.4 For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. For a site located in the transition zone between categories, the category resulting in the largest wind forces shall apply. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as constructed features. For any given wind direction, the exposure in which a specific building or other structure is sited shall be assessed as being one of the following categories. When applying the simplified wind load method of Section 1609.6, a single exposure category shall be used based upon the most restrictive for any given wind direction.

1. **Exposure A**. This exposure category is no longer used on ASCE.
2. **Exposure B**. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single – family dwellings or larger. Exposure B shall be assumed unless the site meets the definition of another type of exposure.
3. **Exposure C**. Open terrain with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 feet (9144 mm) extending more than 1,500 feet (457.2) from the building site in any quadrant for a distance of more than 600 feet (182.9). This category includes flat open country, grasslands and shorelines in hurricane-prone regions.
4. **Exposure D**. Flat, unobstructed areas exposed to wind flowing over open water (excluding shorelines in hurricane-prone regions) for a distance of at least 1 mile (1.61 km). Shorelines in exposure D include inland waterways, the Great Lakes and coastal areas of California, Oregon, Washington and Alaska. This exposure shall apply only to those buildings and other structures exposed to the wind coming from over the water. Exposure D extends inland from shoreline a distance of 1,500 feet (460 m) or 10 times the height of the building or structure, whichever is greater. (See table #1609.3.1)

Figure #1609.3.1

TABLE 1609.3.1
EQUIVALENT BASIC WIND SPEEDSa,b,c

V3S	85	90	100	105	110	120	125	130	140	145	150	160	170
Vfm	71	76	85	90	95	104	109	114	123	128	133	142	152

For SI: 1 mile per hour=0.44 m/s.

1. Linear interpolation is permitted.
2. V3S is the 3-second gust wind speed (mph).
3. Vfm is the fastest mile wind speed (mph).

Fastening Patterns

The fastening pattern needed for a certain roof assembly is based on four different wind zones for the U.S. The “Wind Zones in the United States” map should be referenced when designing fastening patterns for a particular roof system (See figure #4). Several fastening patterns may be required on a single roof, due to an uneven building design, the topography surrounding the building and the zone the building falls in. Conklin Company, Inc. has minimum recommendations that utilize patterns that fall into the Zone III category for all Conklin roof systems. (See figure #5 - 10)

END OF SECTION

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Figure #1

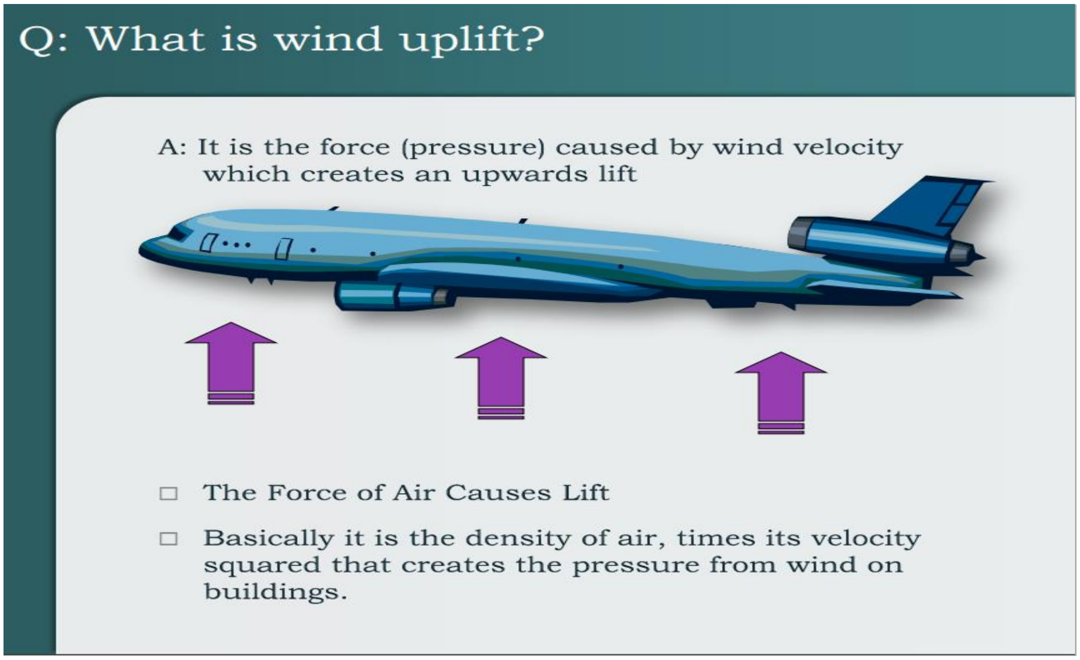

Figure #2

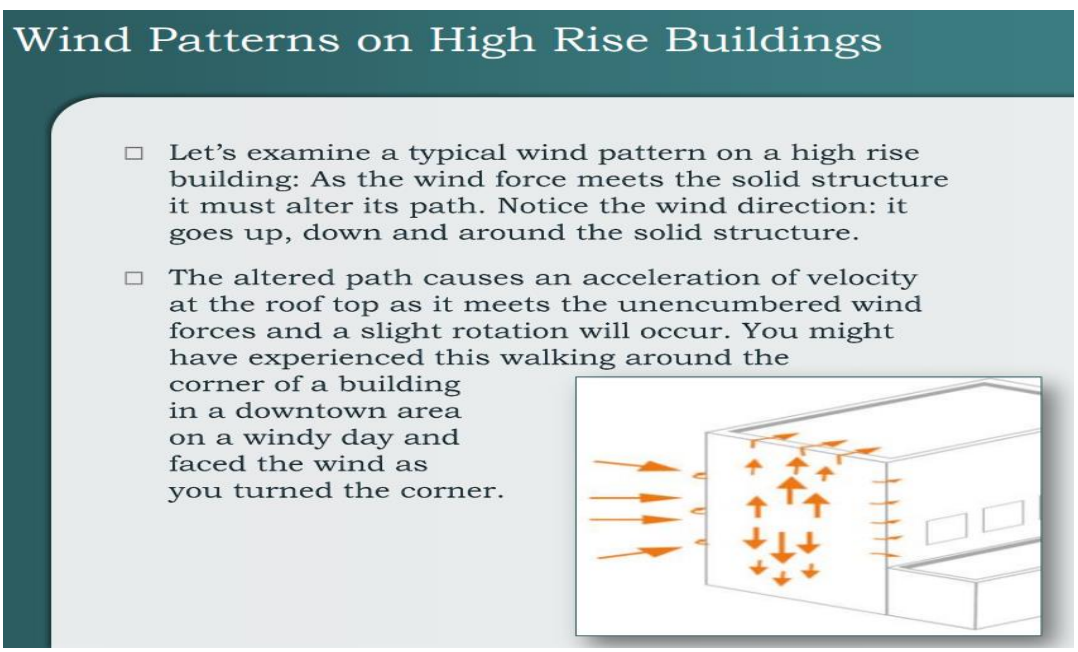

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Figure #3

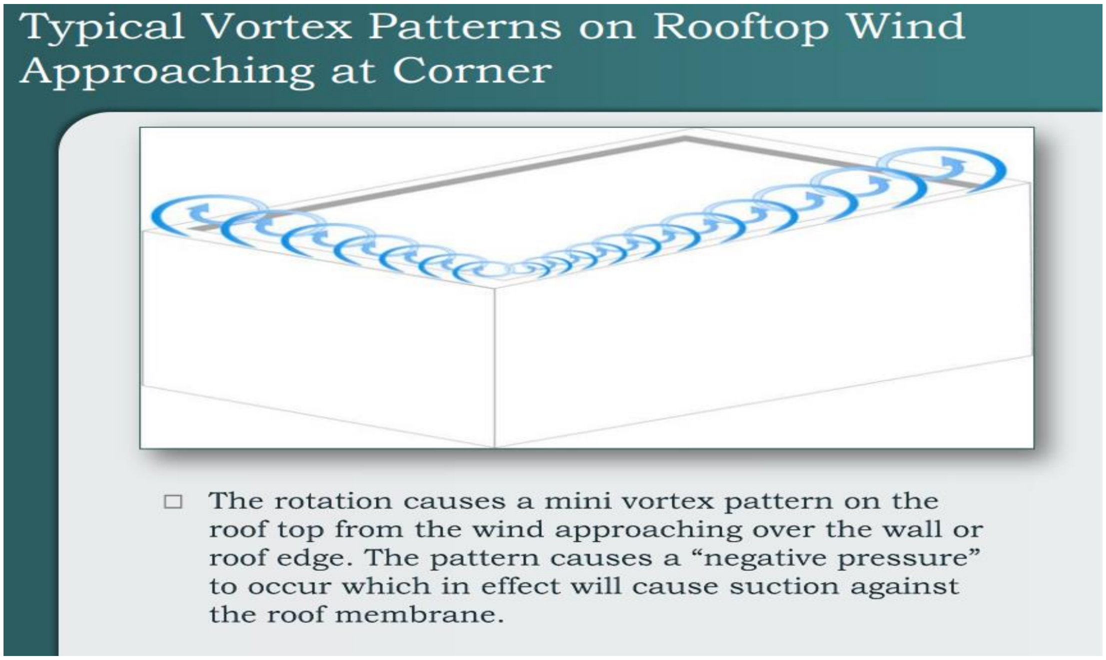

Figure #4

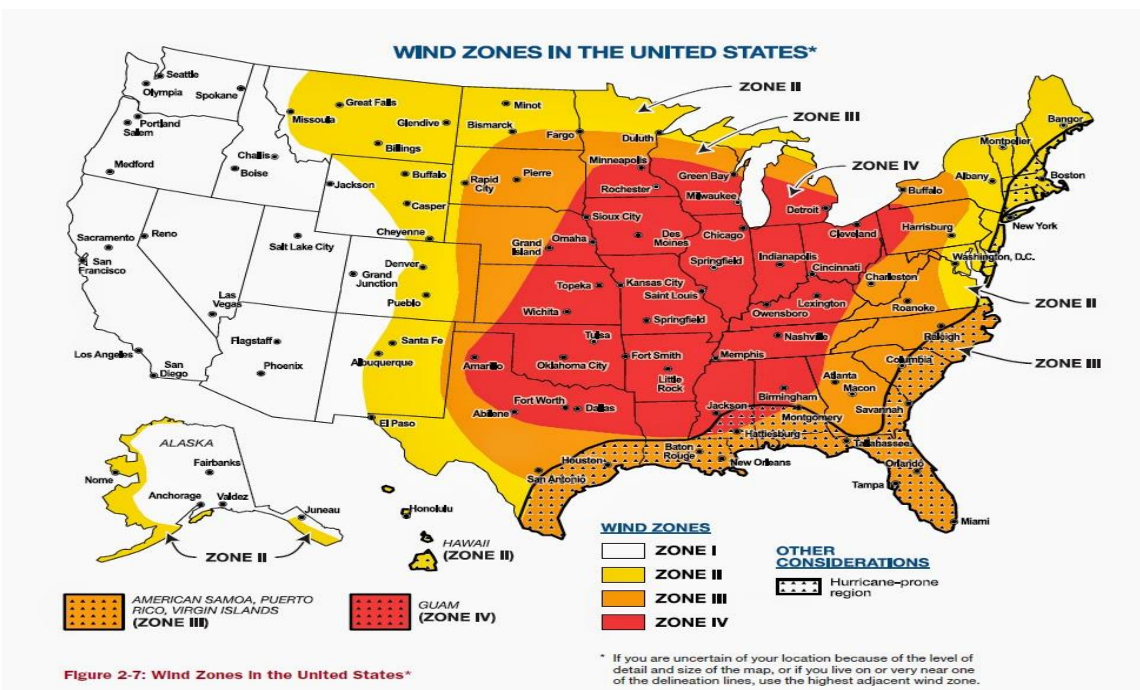

Figure 2-7: Wind Zones in the United States*

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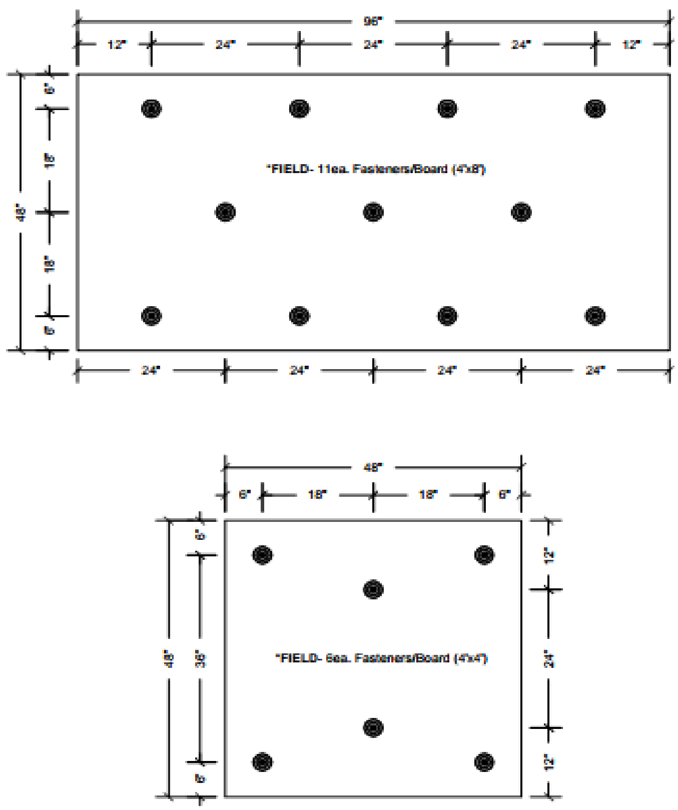
Figure #5

ACFoam®
Polyiso Roof Insulation
CONNECTING FUNCTION WITH FACILITY™



NOTES:

1. Minimum single layer thickness of insulation shall be 1.5" to 1.9".
2. Refer to Factory Mutual Approval Guide for approved fasteners and plates.
3. Factory Mutual 1-90 Fastening Pattern.
4. Refer to Factory Mutual Global Property Loss Prevention Data Sheets (1-29) or consult roof system manufacturer for perimeter and corner design enhancement recommendations.

ATLAS

ACFoam®-II | ACFoam®-III [FULLY ADHERED SINGLE PLY SYSTEMS]

DWG #: FA-11
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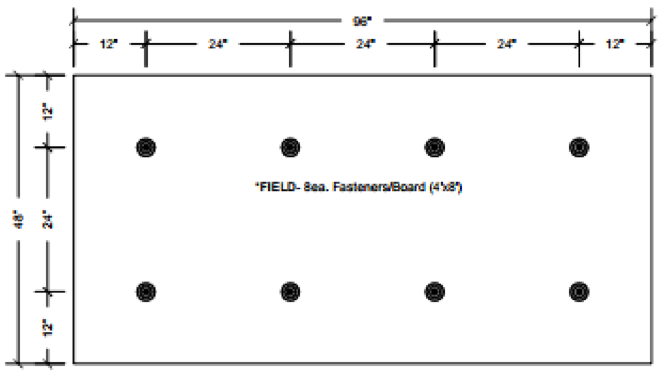
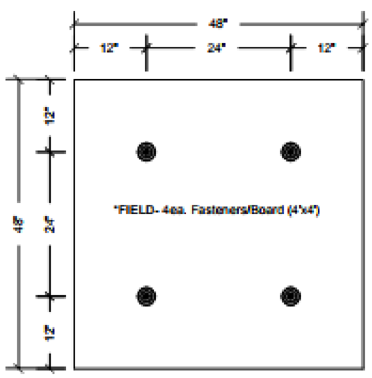
Figure #6

ACFoam®
Polyiso Roof Insulation
CONNECTING FUNCTION WITH FACILITY™





NOTES:

1. Minimum single layer thickness of insulation shall be 2.0".
2. Refer to Factory Mutual Approval Guide for approved fasteners and plates.
3. Factory Mutual 1-90 Fastening Pattern.
4. Refer to Factory Mutual Global Property Loss Prevention Data Sheets (1-29) or consult roof system manufacturer for perimeter and corner design enhancement recommendations.

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ACFoam®-II | *ACFoam®-III* [FULLY ADHERED SINGLE PLY SYSTEMS]

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CONKLIN 40 YEARS ROOFING SYSTEMS

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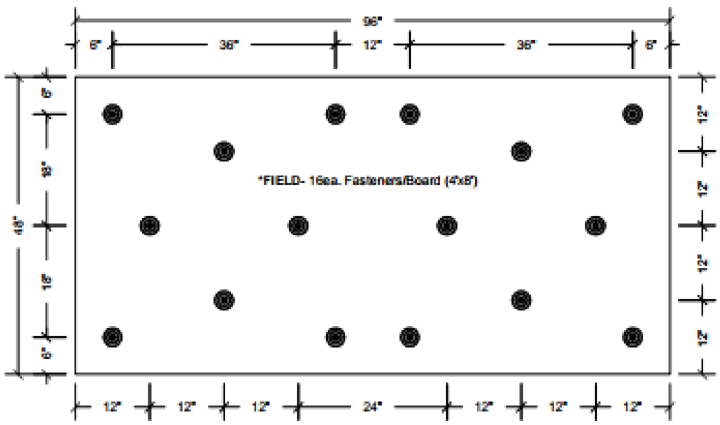
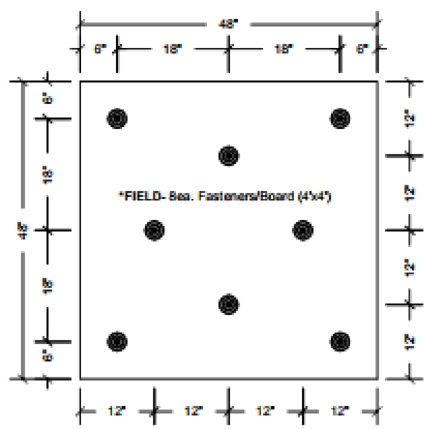
Figure #7

ACFoam®
Polyiso Roof Insulation
CONNECTING FUNCTION WITH FACILITY™





NOTES:

1. Minimum single layer thickness of insulation shall be 1.3" to 1.4".
2. Refer to Factory Mutual Approval Guide for approved fasteners and plates.
3. Factory Mutual 1-90 Fastening Pattern.
4. Refer to Factory Mutual Global Property Loss Prevention Data Sheets (1-29) or consult roof system manufacturer for perimeter and corner design enhancement recommendations.

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ACFoam®-II | ACFoam®-III [FULLY ADHERED SINGLE PLY SYSTEMS]

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CONKLIN 40 YEARS ROOFING SYSTEMS

Figure #8

Importance of Fastener Placement

FM Global research testing has shown that fastener placement on the insulation board has a significant effect on the ultimate strength of the assembly. For example, research conducted with 4 × 4 ft × 1.5 in. (1.2 × 1.2 m × 38 mm) polyisocyanurate insulation covered with a BUR showed a dramatic change in performance simply by rearranging the fasteners on the boards. For both tests, the fastening density was 1 fastener per 1.78 ft^2 (0.17 m^2). Figures 12a and 12b show the fastener placement for each test.

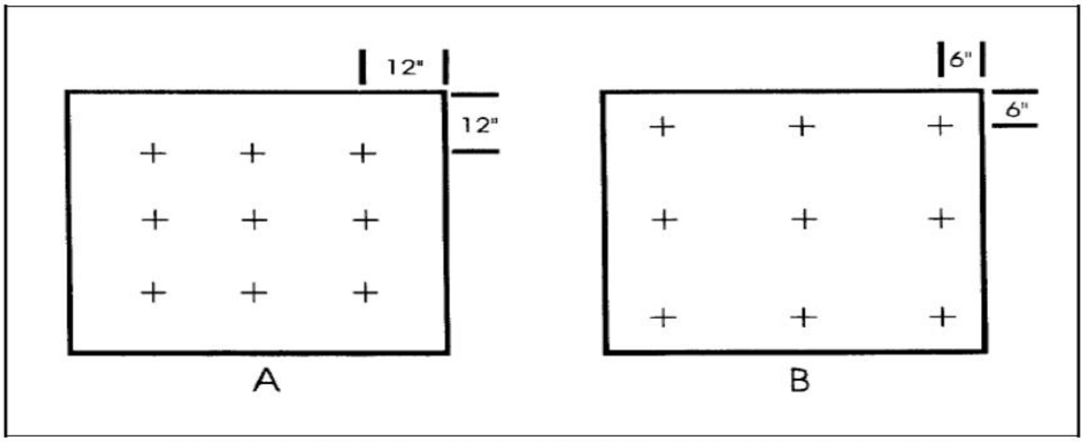

Fig. 12a/12b. 4 × 4 ft (1.2 × 1.2 m) insulation boards secured with nine fasteners per board.

The test of pattern 12a failed at 105 psf (5.0 kPa) by fracture of the insulation board. The test of pattern 12b failed at 160 psf (7.6 kPa) by screws pulling out of the deck.

Figure #9

Addressing FM 1-60 and FM 1-75

RATING	FIELD	PERIMETER	CORNER
1-60 & 1-75, with fastened insulation	Varies per Mfg. (Typ) Max density 1 per 4 SF or denser.	50% increase, min. 1 per 2 SF	100% increase, min. 1 per 1 SF
1-60 & 1-75, MA-Single Ply	See max spacing of mfg	Distance between rows is reduced by .60%	Distance between rows is reduced by .40%
1-60 & 1-75, MA-Base Sheet	See max spacing of mfg	Distance between rows is reduced by .60%	Distance between rows is reduced by .40%

Figure #10

2.2.4 Topographic Factor (K_{ZT})

Topographic effects can increase wind speed locally due to significant hills, ridges, and escarpments of specified dimensions and proximity to the building or proposed building in question. Guidelines for determining design pressures under these conditions are provided in ASCE Standard 7, and use K_{ZT} values greater than 1. The topographic factor greater than 1 is generally the exception (for extreme cases) rather than the rule. However, when applicable, the design pressure adjustments can be significant. Due to the additional complexity when using a K_{ZT} greater than 1, and the fact that this is for the minority of cases, the procedure for this is excluded from this data sheet. Refer to ASCE Standard 7 for further information on the topographic factor.

2.2.5 Wind Tunnel Testing to Determine Wind Design Pressures

Wind tunnel testing for determination of design wind loads is sometimes done for various reasons (irregular building shapes, channeling effects or buffeting in the wake of upwind obstructions, etc.). Wind loads determined from tunnel testing are acceptable to use, provided that ASCE 7, Section 6.6 "Method 3 – Wind Tunnel Procedure" is followed, and that recommended wind speeds from this document are modeled and an Importance Factor of 1.15 is applied to resulting pressures.

Where multi-level roofs meet at a common wall, the edge of the upper roof is treated as roof perimeter and corner areas (Zones 2 and 3) if the difference in height is ≥ 3 ft (0.9 m). The lower roof strip where it meets a higher wall is treated as a field area, except for the square areas at each end, which are treated as perimeters. (See Figures 1 and 2.)

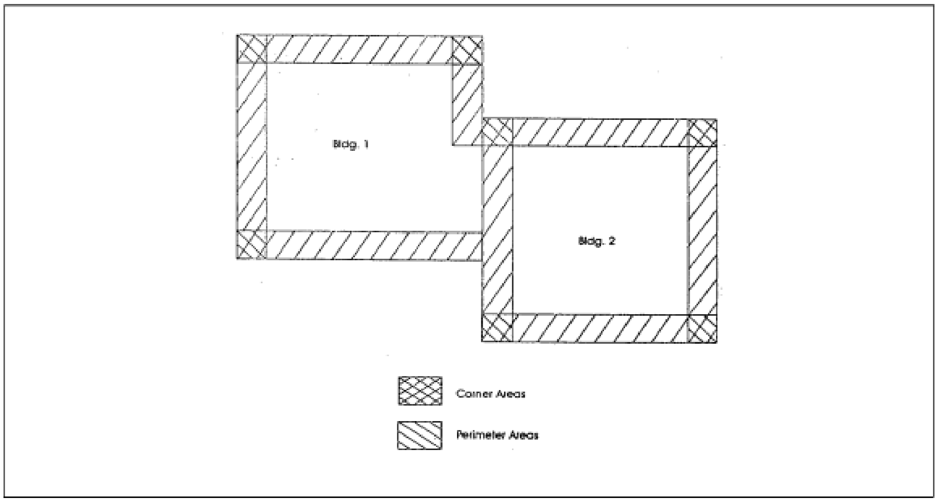

Fig. 1. Building 2 is more than 3 ft (0.9 m) higher than Building 1.

2.2.6 Roof Overhangs

For roof areas extending beyond exterior walls (overhangs), adjust design pressures in accordance with Table 7.

For the specific conditions in Table 7, apply the factors in Table 7 to the design pressures previously determined for that particular roof area.

Please refer to FM for insulation fastening patterns. Conklin's minimum recommendations are to increase field fasteners by 50% for parameters and increase parameters by 50% for corners.