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SIPLAST LIGHTWEIGHT INSULATING CONCRETE BULLETIN:

DESIGNING SIPLAST ROOF INSULATION SYSTEMS TO CARRY UNIFORM LIVE LOADS ON STEEL DECK AND EXISTING ROOF ASSEMBLIES

Bulletin #8: SRIS-973 **December 27, 2023**

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Siplast Roof Insulation Systems are designed to be placed over galvanized metal deck in new construction and over existing roofing assemblies in reroofing constructions. In both cases, the live load capacity of the substrate must be considered. This bulletin will discuss important issues to consider in either of the aforementioned design situations.

New Metal Deck Construction:

First and foremost, metal deck designed to receive lightweight insulating concrete must be coated with a minimum G-60 galvanized coating. In many building code jurisdictions, a G-90 galvanized coating must be used**.**

Note: Lightweight insulating concrete must never be directly placed on any type of painted metal deck.

Two types of metal deck are used with lightweight insulating concrete. They are referred to by the metal deck manufacturers as "roof deck" (1.5 to 3-inch deep A, B, or N Deck profile) or "metal centering" (9/16 to 1 5/16 inch deep corrugated metal deck). Metal centering is also referred to as "form deck" by some manufacturers. Both of these basic decks are rolled in various thickness gauges to accommodate the loads and spans for which the building is designed.

Typically, "roof deck" is designed to carry the vertical loads imposed by building design without regard to any composite action that may result by screwing rigid insulation boards to the metal deck. These "roof deck" products are manufactured by rolling 18, 20, or 22-gauge steel with a fiber stress of 33 ksi and a design fiber stress of 20 ksi.

Typically, "metal centering" is manufactured using steel with a fiber stress of 80 ksi and a design fiber stress of 36 ksi. This increase in design fiber stress results in metal centering being able to hold the design loads with thinner gauges and lower metal profiles. Because of the design advantage of thinner gauges and lower profiles, "metal centering" has been the metal deck of choice for a large portion of the insulating concrete industry. Today, higher side wall wind loads as well as seismic loads must be considered in the design process, which may dictate using roof deck profiles with insulating concrete systems.

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Designing For Uniform Live Loads in New Construction:

When designing for uniform loads, the metal deck selected must meet both stress limited loads and deflection limited loads. In most cases, deflection limitations will control the metal deck selected.

A typical metal manufacturer's load and span table is shown below for metal centering with deflection loads limited to l/240. Although the stress limiting design may provide the load capacity required, it may not have the deflection limiting capacity.

The table below shows one manufacturer's maximum allowable uniform loads in psf based on stress with the $^{steel}f_b$ limited to 36 ksi and deflection limited to l/240. Please consult steel deck manufacturers' catalogs for design data for the steel deck being used on a given project.

Metal Centering Load / Span Table
Maximum Allowable Uniform Load psf - Three Span Condition

Type	Design Condition	3'-0"	3'-6"	4'-0"	4'-6"	5'-0"	5'-6"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"
26-Gauge 15/16" Nominal Depth	Stress 36 ksi	244	179	138	108	88	73	61	52			
	Deflection 1/240	168	106	71	50	36	27	21	17			
22-Gauge 1-5/16" Nominal Depth	Stress 36 ksi			343	271	220	182	153	130	112	98	86
	Deflection 1/240			226	159	116	87	67	53	42	34	28

As stated earlier, the roof deck must be chosen on the basis of both the stress and deflection limitation of the metal deck profile and span. In the case of lightweight insulating concrete, the bond created between the metal centering and the lightweight insulating concrete results in higher composite loads based on stress and lower deflection than that provided by the metal deck itself. The composite that is created is due to the chemical bond developed between the galvanized metal and the cement matrix of the lightweight insulating concrete. The magnitude of this chemical bond ranges from 5 to 10 psi (720 to 1440 psf). The following example will illustrate this phenomenon.

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Example:

Problem: Design the metal deck required to withstand a total load of 55 psf at a 6-foot span with deflection limited to l/240.

Solution: The metal deck properties table above indicates that a 26-gauge, 15/16-inch deep profile would support the load at a 6-foot span based on stress limitation. This profile will carry 61 psf based on stress. However, the deflection limitation indicates that the same profile would only carry a load of 21 psf based on a deflection limitation of l/240. At this point two choices are available. One option is to increase the metal deck to a 22-gauge with a 1 5/16-inch profile since it can carry 67 psf with a deflection limitation of l/240. However, if cost is of concern another alternative is available.

The second alternative is to review the Vertical Load Data section of the Siplast Engineering Design Manual and the Vertical Load Data sheet for ZIC Lightweight Insulating Concrete. The table from this data sheet is reprinted below. It shows the load capacity of the lightweight insulating concrete installed over various metal deck profiles. The table shows both the total load capacity of the composite and the load based on a deflection limitation of l/240.

ZIC Downward Load Table

	ZIC Insulating Concrete Over Corrugated Metal			ZIC Insulating Concrete & Insulperm Over Corrugated Metal			ZIC Insulating Concrete Insulperm Over Slotted Corrugated Metal		
Metal Deck Gauge & Span	Live Load for >= L/240 (psf)	Ultimate Load (psf)	Safety Factor	Live Load for >= L/240 (psf)	Ultimate Load (psf)	Safety Factor	Live Load for >= L/240 (psf)	Ultimate Load (psf)	Safety Factor
26-ga. Metal 15/16" Profile On 6'0" O.C. Span	148	417	13.9	78	240	8.0	**110**	**256**	8.5
24-ga. Metal 1-5/16" Profile On 8'0" O.C. Span	92	290	9.7	54	198	6.6	60	180	6.0

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Notes:

1. *Details of construction for the three roof decks are:*

   a. *ZIC Lightweight Insulating Concrete over corrugated metal - two inches of ZIC Lightweight Insulating Concrete is placed over the top of the corrugations of the galvanized metal decking.*
   b. *ZIC Lightweight Insulating Concrete and Insulperm over corrugated metal – ZIC Lightweight Insulating Concrete slurry coat is used to fill the flutes of the galvanized metal decking and is placed to a depth of 1/8" over the top of the metal deck. Insulperm is embedded in this slurry coat while it is still wet, and a final layer of two inches of ZIC Lightweight Insulating Concrete is placed over the Insulperm.*
   c. *ZIC Lightweight Insulating Concrete and Insulperm over corrugated metal - the details of construction are the same as in 1b, except that the galvanized corrugated metal deck is slotted to provide approximately 1.5% open area.*

2. *Safety factor is based on a design live load of 30 psf.*

3. *Test results shown are for a two span-condition.*

4. *Welding patterns were conventional with washers.*

A review of the 26-gauge, 15/16-inch profile metal deck shows that for ZIC Lightweight Insulating Concrete with Insulperm placed over slotted corrugated metal the deflection limited load is 110 psf and the ultimate load is 256 psf. Clearly the deflection limitation load of 110 psf provides sufficient protection for the design condition of 55 psf required in this example. To use this alternative design approach, it must determine if the building code will allow the use of this composite design information. If it does not, the decision will be to increase the metal gauge and depth of the profile as discussed above.

In all cases of metal deck design, all load conditions must be considered. For example, wind uplift loads or seismic design loads will dictate using stronger metal decks than required to handle downward load conditions.

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Reroofing Design:

Siplast offers two lightweight insulating concrete systems for use on existing roof assemblies. Siplast NVS and Insulcel systems are acceptable for use in reroofing applications to increase the building's insulation value and to correct and improve rooftop drainage. Lightweight insulating concrete is the most economically efficient means of retrofitting for these characteristics. NVS is preferred due to the superior characteristics of its aggregate base and its lower incremental load on the existing structure. Lightweight insulating concrete systems will vary in wet and dry density criteria by system design. An example of these differences is as follows:

	Siplast NVS System *(Aggregate Based)*	Cellular-based
Minimum thickness:	1 inch	2 inches
Densities		
Wet density	60-68 pcf	38-48 pcf
Dry density	35 pcf	30 pcf
Weight		
Wet	5-5.67 lb./board foot	3.17-4 lb./board foot
Dry	2.92 lb./board foot	2.5 lb./board foot
Loading (minimum thickness)		
Wet	5-5.67 lb./ft^2	6.34 - 8 lb./ft^2
Dry	2.92 lb./ft^2	5 lbs./ft^2

All existing buildings being considered for reroofing incorporating Siplast lightweight insulating concrete should be evaluated by a structural engineer for their ability to withstand the incremental load that will be applied.

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