DIAPHRAGM SHEAR STRENGTH AND STIFFNESS

The following information is based upon the Steel Deck Institute's Second Edition of the Diaphragm Design Manual prepared by Larry D. Luttrell, Ph. D., P.E., Dr. Luttrell has been involved in testing of diaphragms at West Virginia University since 1965.

The following limiting conditions are taken from this book. "The quality of a diaphragm can be limited by inattention to detail particularly at end and edge terminations."

End Laps

"At interior positions, panels must be sufficiently overlapped to provide adequate distances fro the connector used. A minimum end distance for fasteners used should be one inch requiring an end lap not less than two inches. Within the system, end laps may be staggered or on a continuous line without particular effect on the diaphragm strength. However, greater care must be exercised in making connections through multiple layered of deck at the panel corners on the end lap. If panels are butted at their ends rather than end lapped, as is common with floor decks, then each panel must be individually connected at its ends with the specified pattern."

Side Laps

"The overlapping edges of panels should be in close contact to allow minimum eccentricity of fasteners in the lap. When stitch fasteners connect adjacent panels between supports, equivalent or superior fasteners should be use on the edgemost panel at the diaphragm perimeter. Otherwise shear strength along the first interior sidelap may exceed that along the perimeter member and thus diminish the contribution of the stitich fasteners."

Welds

"Welds should be made by qualified operators following AWS D1.3 specifications. Approximate checks on weld quantity can be made by placing one end of a long panel over support and attaching it only to that support with tow welds six inches apart. The far end of the panel can be moved in the diaphragm plane by the workman until shear distress is noted in the weld. The welds should be sufficient to cause local distortions in the panel around both welds and should show good perimeter contact between welds and the panel. For 22, 20, and 18 gauge panels, the weld should not shear across its contact plane on structural supports else the welding temperature may have been too low for adequate penetration."

Screws

"Screws must be installed using properly calibrated tools to avoid overdriving which can strip the threads at sidelaps or sever the screw when it is placed into heavier substrata."

Longitudinal Edges

"In applications where joist terminate on a shear, wall the edge-most diaphragm panel may not contact the wall. If intermediate stitch fasteners have been required on sidelaps, similar intermediate stitch fasteners must exist at the edge. These can be accompanied by installing a block-like spacer on the wall, to match the joist elevation, and then making connections to the block."

Mixed Panel Lengths

"When decks are installed with multiple spans, occasional shorter panels may be required. In a large diaphragm area, the shear strength can be determined satisfactorily by using the typical three span panel length."

Load Tables

The following load tables are based upon Marlyn's various types of steel deck.

There is a comprehensive section on example problems in DDM02. For this reason we have elected to take our simple design problem out of this catalog. DDM02 gives you a new more straightforward means of computing shear stiffness that is reflected by this catalog.

In some of the light-gage shallow decks, you will notice that as the spans get long the shear strength reaches some maximum value. This is caused from "platelike shear buckling". As the thickness of the deck gets smaller and the spans get longer for shallow decks, buckling can result as the shear strength increases. See Section 2.4 Stability Checks of DDM02.

This catalog is not presented as an alternative to the use of the Second Edition of the Diaphragm Design Manual (DDM02), but as an extension to it for our decks. We have given you the shear strength and stiffness of our various decks, but not the backup data behind these calculations. DDM02 does a good job of supplying you that information. We hope that you will contact the SDI about ordering your own copy of DDM02. Steel Deck Institute, P.O. Box 825, Fox River Groves, IL 60021.

These tables were derived making the following assumptions:

1. The number of fasteners are the same at both end members and interior supports. Example: 30/6 means 30 inch wide deck with 6 fasteners per support. One in each flute.
2. The number of intermediate sidelap stitch connectors is assumed to be the same number of exteme edge fasteners.
3. The values printed have the factor of safety applied. 3.25 for filled diaphragms, 2.75 when any of a bare diaphragm is welded.
4. All values are for a three span condition. Greater values are available for a 1 or 2 span condition since you will have more fasteners to count in the calculation of the strength.
5. Where welds are shown at the support, the Steel Deck Institute recommends using welding washers only on deck thicknesses less than 0.028". These should be 16 gauge with 3/8" hole in them.
6. Lightweight fill should be placed on slot vented deck.
7. For roof deck and composite floor deck the steel yield point is taken at 33ksi. For form deck it is taken as 80ksi.
8. The tables already have considered a stress increase of 1.33 for short-term or wind loading. The values are not to be increased again.
9. The values printed using Marlyn Steel Decks and Type II Fill were derived using Cellular Concrete Fill with 200 psi minimum compressive strength, a layer of Cellular Concrete placed to a level slightly above the corrugation crests. Rigid polystyrene insulation boards up to 4" thick embedded into the concrete and a topping coat of two or more inches of Cellular Concrete to finish the diaphragm.