FABREEKA®
VIBRATION & SHOCK CONTROL

Fabcel® Pads

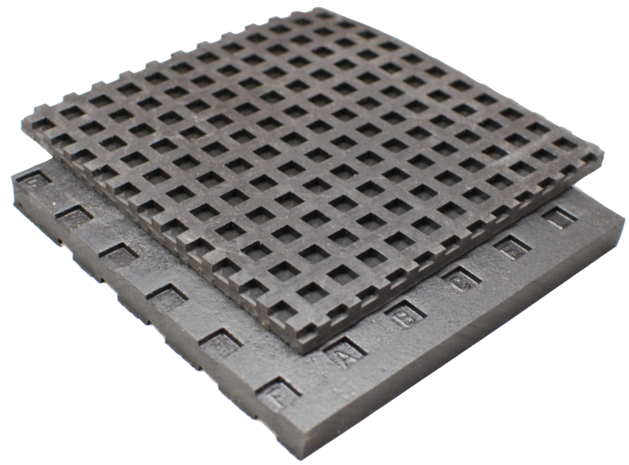
For Reduction of Low Frequency Vibration

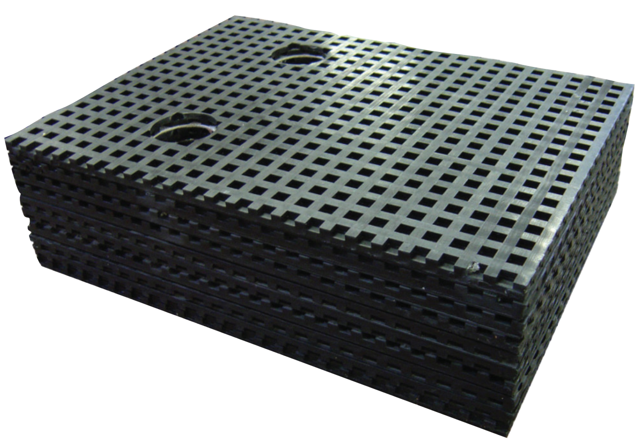
Fabcel® pad material is specifically designed to provide vibration isolation/reduction in industrial applications where structure-borne noise and vibration occur.

Fabcel pads have been used in industry since 1962 to reduce vibration and shock. They are manufactured from nitrile rubber in a range of types and thicknesses (layers) that allows for optimal loading/isolator performance. The featured cell geometry on the surface of the pads minimizes the shape factor[1,2] usually associated with unreinforced, elastomeric (rubber) pad materials.

Shape factor has an influence on the deflection and load limit properties of a material. Essentially rubber is an incompressible substance that deflects by changing shape rather than volume. As a result, the load-deflection curve is greatly influenced by the shape factor (SF) of the pad used; i.e., whether the pad is relatively tall with a small cross section, or relatively short with a large cross section.

Fabcel pads are manufactured in sheets of 18" x 18". However, they are commonly cut to size and bonded to achieve the proper thickness based on the application and isolation requirement.





[1]Shape factor is a geometric measure (ratio) of surface area to the perimeter area allowed to expand laterally.

[2]Under practical conditions, the shape factor effect of Fabcel 25, 50 or 100 is minimal and can be disregarded. Under certain conditions, Fabcel 200 and 300 exhibit a shape factor effect, although not as pronounced as would be the case in typically used elastomeric materials.

Fabcel Pad Features

- Accommodates loads up to 300 psi.
- Vertical natural frequency as low as 5.0 Hz and a horizontal natural frequency as low as 3.0 Hz.
- High energy storage rate per unit volume which makes it ideal for certain shock isolation applications.
- May be bonded together (layered) to achieve the desired isolation efficiency.
- Can be supplied as sheets, cut pads, washers and OEM parts.

Fabcel isolation washers and Fabreeka® bushings are used to eliminate metal-to-metal contact and break the vibration or shock transmission path.

Physical Properties

	Fabcel 25	Fabcel 50 | 200	Fabcel 100 | 300
Hardness Durometer	25±5	48±5	68±5
Tensile Strength	500 psi	2,000 psi	2,000 psi
Elongation	700%	350%	250%
Damping (C/Cc) (Nom)	7%	7%	7%
Thickness	5/16"	5/16" | 1/2"	5/16" | 1/2"
Maximum Load	25 psi	50 psi | 200 psi	100 psi | 300 psi

Fabcel pads are resistant to most oils, water, steam and chemicals. Temperature limits for continuous exposure are -40°F to 200°F.

Spring Rate

The spring rate formula for all thicknesses of Fabcel pads is as follows:

K = SRF x Pad Area

Imperial	Metric
K = lbs/in	K = N/m

The following spring rate factor (SRF) formulas and example will allow you to determine Fabcel's spring rate for various loadings, pad size and thickness.

Note: Elastomers respond differently under dynamic conditions. The stiffness can increase more under dynamic conditions than under static conditions.

Static: The static spring rate factor is determined from the slope of the load deflection curve (shown in Figures 2, 5, 8 and 11) or estimated from the dynamic spring rate factor. The average static spring rate is approximately 40% of the dynamic rate.

Dynamic: The dynamic spring rate factor is calculated using the frequency value shown in Figures 1, 4, 7 and 10.

DSRF = 0.10 x (Dynamic Natural Frequency)^2 x stress

A typical spring rate example using Fabcel 50 is as follows:

Imperial		Metric
50 psi	Stress	0.35 MPa
10" x 10"	Area	0.254 m x 0.254 m
9 layers	Thickness	9 layers
7.5 Hz	Dynamic Nat Freq	7.5 Hz

Static Spring Rate Factor (SSRF)

SSRF = Slope of Load-Deflection Curve
Stress 50-40 psi = 10 psi
Deflection 0.56 - 0.47 in = 0.095 in
therefore: SSRF = 10/0.095 = 105 psi/in

Imperial		Metric
105 psi/in	SSRF	29 MPa/m

Ks = Static Spring Rate
Ks = (SSRF) x Pad Area

$Ks = 105 \frac{lbs/in^2}{in} \times 100\ in^2$ $\quad Ks = 29 \times 10^6 \frac{N/m^2}{m} \times 0.645\ m^2$

Ks = 10,500 lbs/in **Ks = 1,871,000 N/m**

Dynamic Spring Rate Factor (DSRF)

DSRF = 0.10 x (Dynamic Natural Frequency)^2 x stress
DSRF = 0.10 x (7.5)^2 x 50 psi
DSRF = 280 psi/in

280 psi/in	DSRF	79 MPa/m

Kd = Dynamic Spring Rate
Kd = (DSRF) x Pad Area

$Kd = 280 \frac{lbs/in^2}{in} \times 100\ in^2$ $\quad Kd = 79 \times 10^6 \frac{N/m^2}{m} \times 0.645\ m^2$

Kd = 28,000 lbs/in **Kd = 5,100,000 N/m**

Fabcel 25

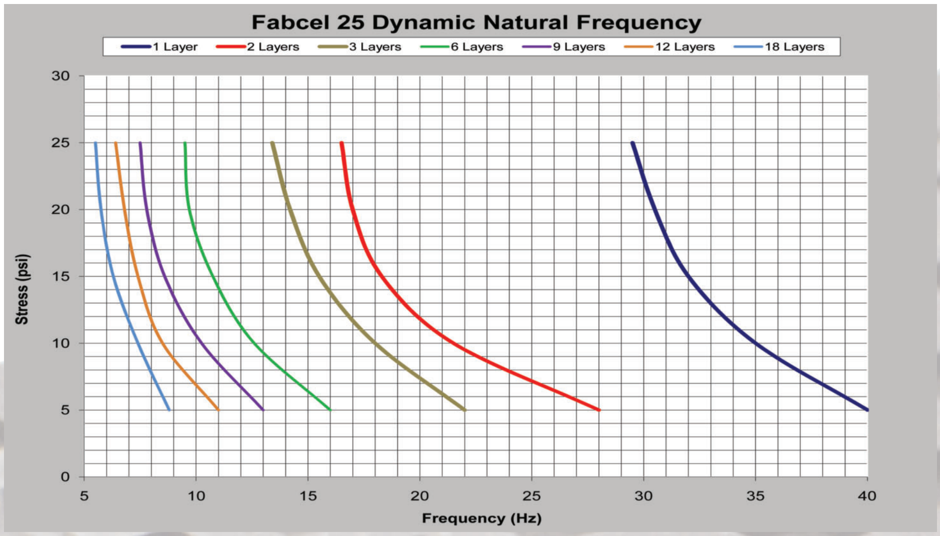


Figure 1 Dynamic Natural Frequency

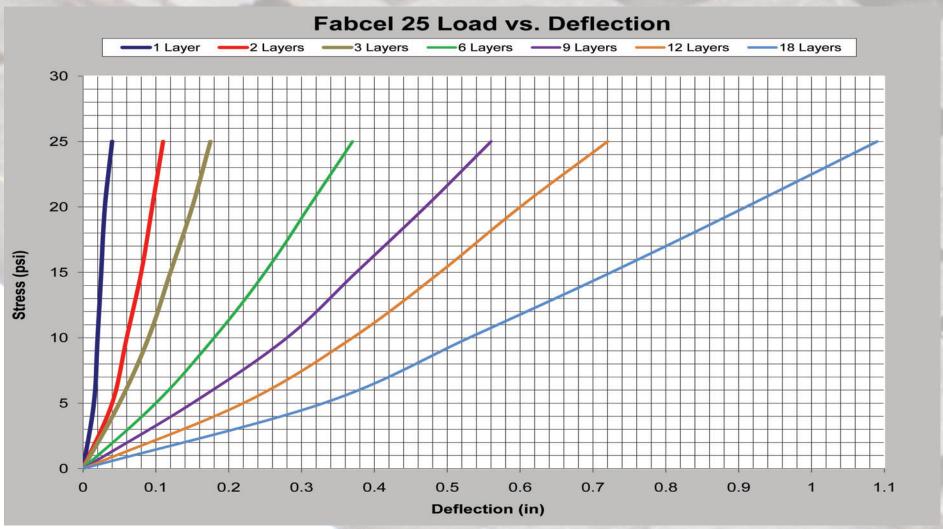


Figure 2 Load Deflection

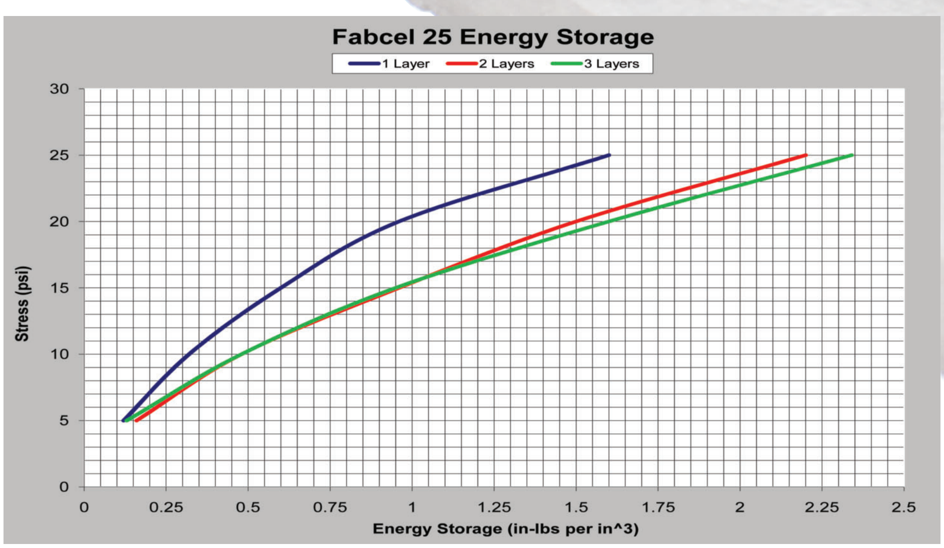


Figure 3 Energy Storage

Fabcel 50

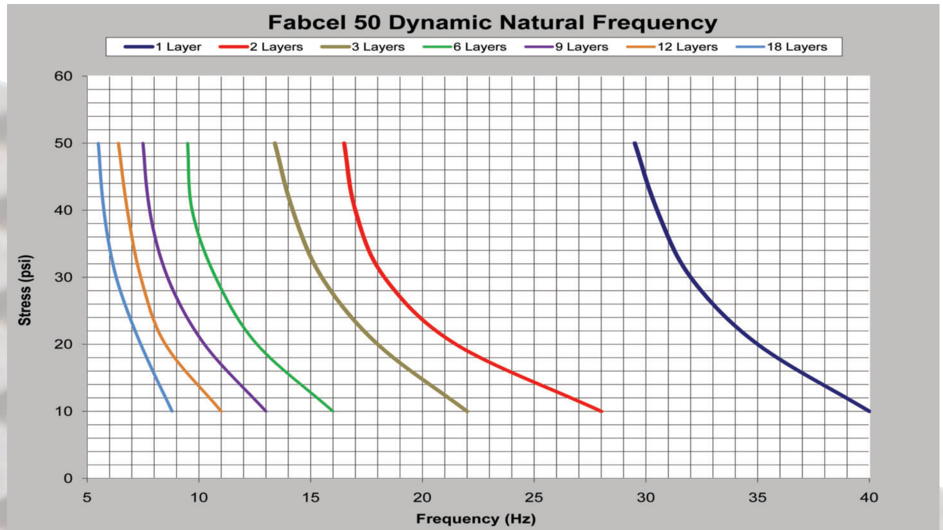


Figure 4 Dynamic Natural Frequency

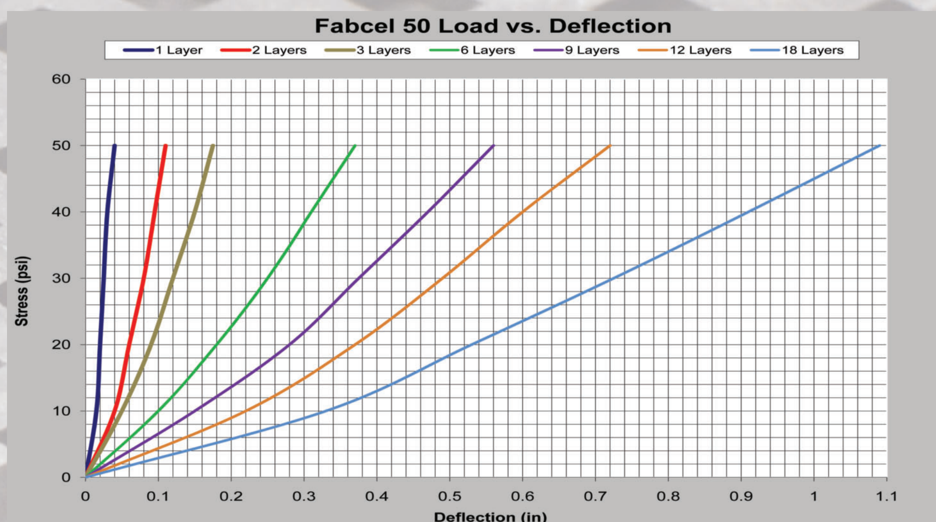


Figure 5 Load Deflection

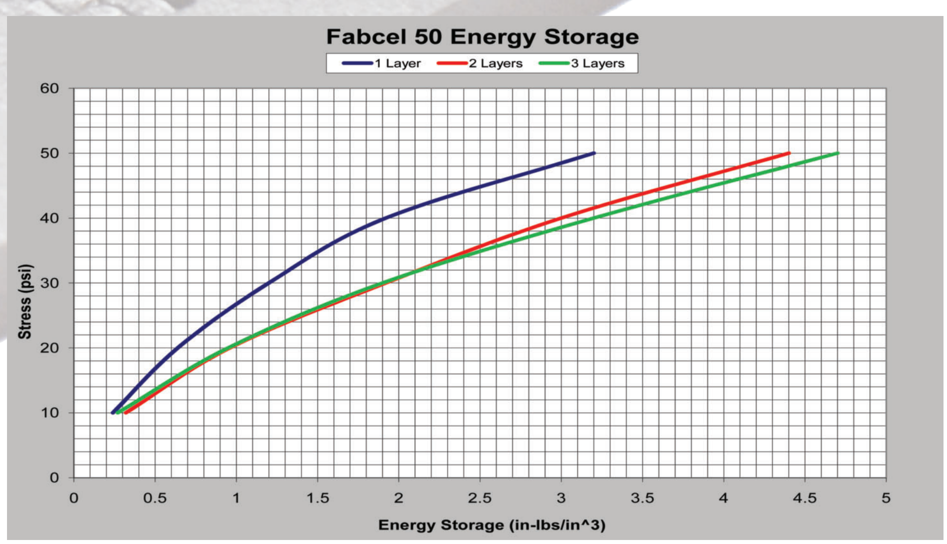


Figure 6 Energy Storage

Fabcel 100

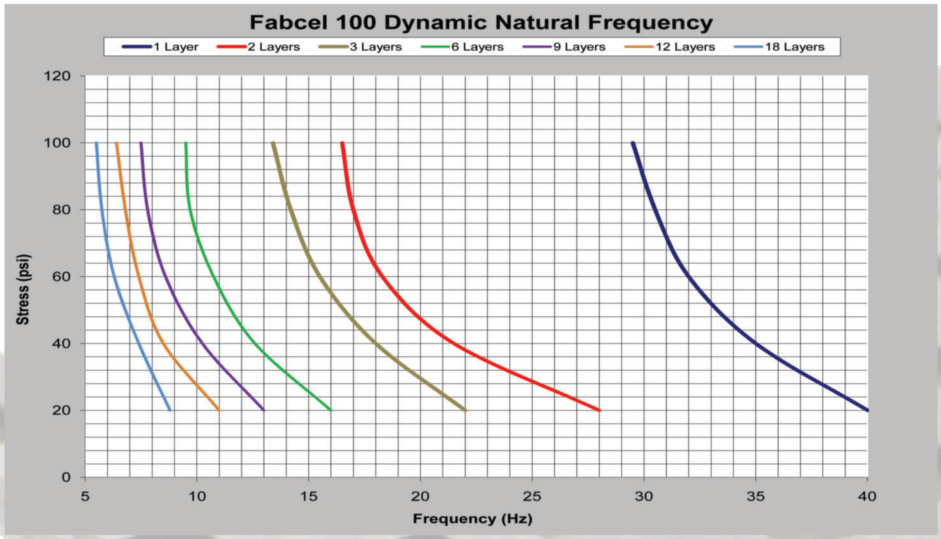


Figure 7 Dynamic Natural Frequency

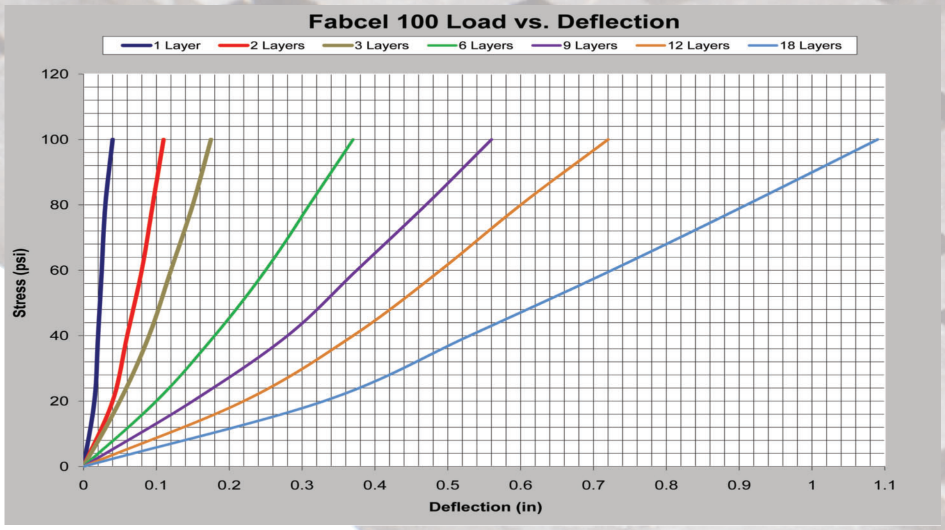


Figure 8 Load Deflection

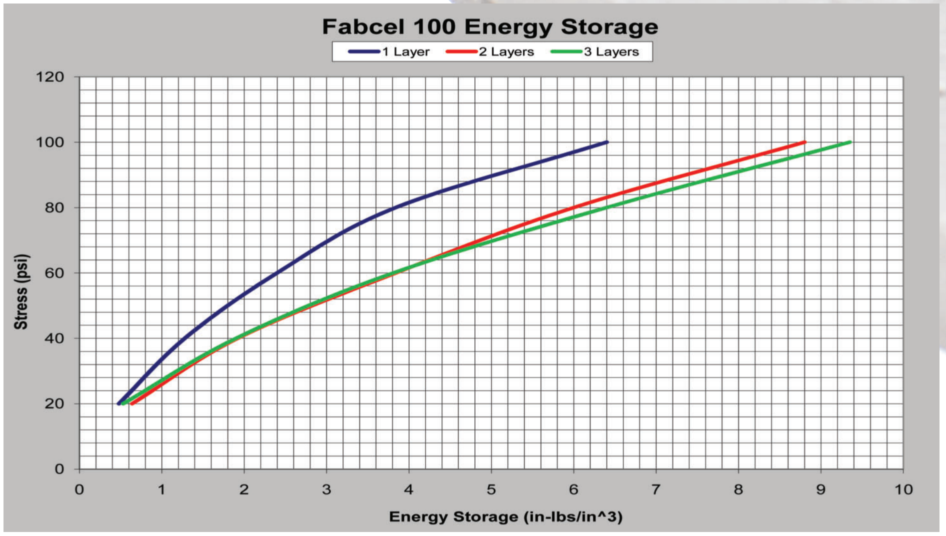


Figure 9 Energy Storage

Fabcel 200 & 300

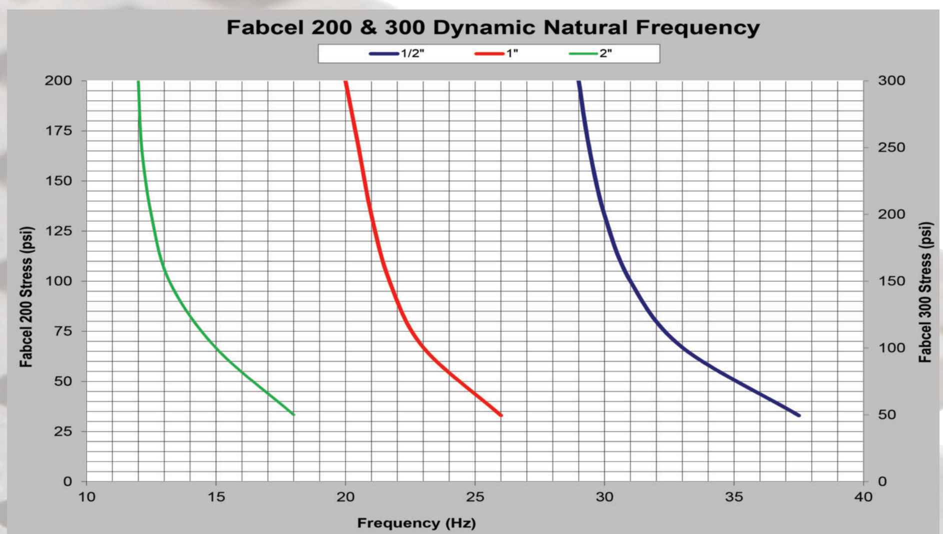


Figure 10 Dynamic Natural Frequency

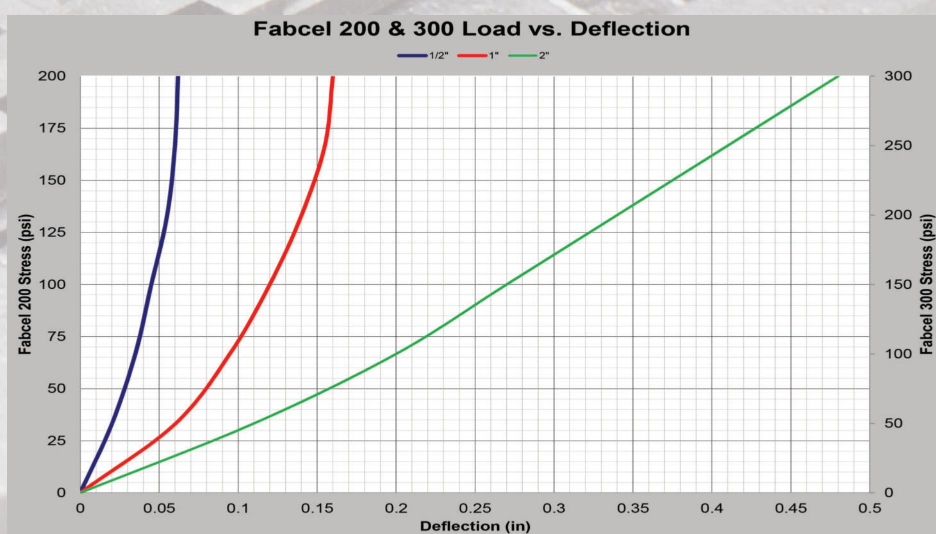


Figure 11 Load Deflection

Multiple Layers

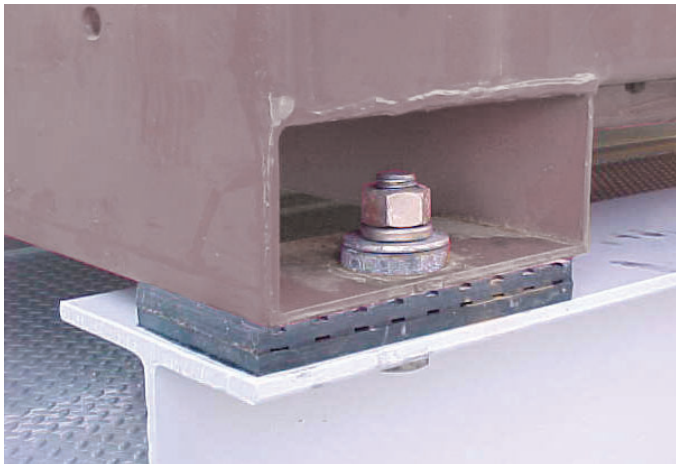
When the disturbing or forcing frequency is very low and the isolation requirements are critical, multiple layers of Fabcel® pads are necessary to lower the natural frequency and provide an acceptable frequency ratio to meet the isolation requirements.

Multiple layer isolators are designed using shims to maintain proper shape factor under load. The layers are integrally bonded together.

Fabcel's cellular design permits a larger deflection under load than a solid rubber material of the same thickness. This results in a lower natural frequency and greater isolation.

Fabcel multiple layer isolators can be placed directly under a machine or its support. If a narrow structural steel member is used as a machine support or base, it may be necessary to increase the isolator area by including a steel load distributing plate at each isolator location or one large plate for all isolators.

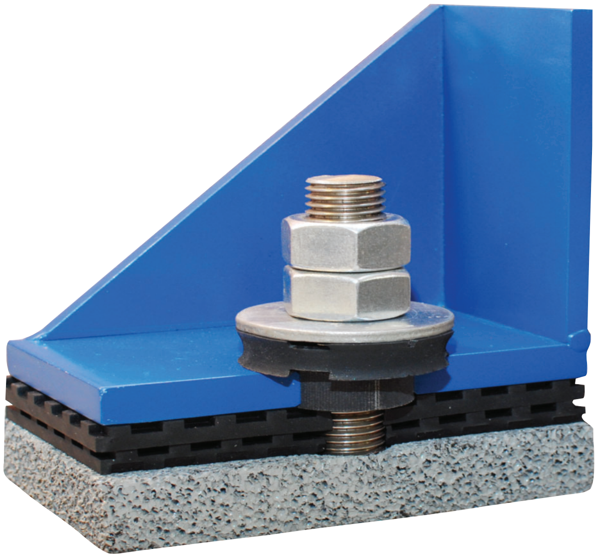
Note: For stability, design of multiple layer isolators requires that the width/length should not be narrower than twice the thickness.



Fabcel Isolation Washers and Fabreeka Bushings

Fabcel isolation washers and Fabreeka bushings are typically used in conjunction with Fabreeka pads or Fabcel pads where the reduction of impact shock or isolation of transmitted vibration is required. Bushings are manufactured with the same properties as Fabreeka pad, and therefore offer years of service under the most severe operating conditions.

Fabreeka bushings are made to specified dimensions (OD, ID, length). A minimum wall thickness of 3/32″ is recommended.



Equipment isolated by Fabcel pads should not be bolted directly to structure, but should have isolation washers and bushings to prevent metal to metal contact. This effectively isolates the entire vibration transmission path.

Fabcel for Vibration Isolation

Fabcel pads are commonly used to reduce low frequency vibration and structure-borne noise. To determine the proper type and thickness of Fabcel for an application, the stress on the material must be calculated and the desired level of vibration isolation known.

When calculating the stress, the maximum load conditions should be considered for each support location (unbalanced dynamic forces, non-uniform machine/equipment weight, etc.)

A compressor weighs 11,520 lbs. It is supported on four feet, which are 6” x 6”. Assuming even load distribution, the stress on each foot is 11,520/4 = 2,880 lbs, 2,880 lbs/36 in^2 = 80 psi. 80 psi exceeds the stress limit for Fabcel 50 (See page 5), so Fabcel 100 should be used.

The compressor operates at a frequency of 1,800 rpm or 30 Hz. A transmissibility at this frequency of 40% (60% reduction) or better is required. Refer to the “percent reduction” chart on page 11 to determine the proper thickness of Fabcel 100 under a stress of 80 psi to achieve the desired transmissibility.

Using the forcing frequency of 30 Hz, Fabcel 100 at 80 psi, 1” thick (3 layers) will provide a 68% reduction in vibration, which is equivalent to a transmissibility of 32%.

Note: Reducing the area of Fabcel material under a given load will increase the stress, but will also lower the spring rate, resulting in a lower natural frequency and greater vibration reduction. Adding layers to the thickness will also produce the same result.

Fabcel for Shock Isolation

Fabcel pads can also be used to reduce impact shock and limit transmitted force. The effectiveness of a shock isolator is measured not by transmissibility (as with vibration) but by the isolator deflection and corresponding energy storage.

Due to the storage and release of energy, the output force is much less than the input force, resulting in limited force transmission.

To determine the proper type and thickness of Fabcel, the following information is required:

Static stress on Fabcel (from equipment weight)
Dynamic stress on Fabcel (from dynamic load applied)
Kinetic energy applied to Fabcel from shock input

KE = FxD (force x distance of dynamic input) or
KE = 1/2 MV^2 (mass and velocity of dynamic input)

The static and dynamic stress are used to determine the static and dynamic deflection on the Fabcel. The total stress should not exceed the maximum allowable stress of the pad type. The maximum amount of kinetic energy the Fabcel pad can absorb without failure can be calculated by using the dynamic deflection and choosing a pad thickness.

Strain = dynamic deflection / thickness
$KE_{\text{to absorb}}$ = vol of Fabcel (1/2 x total stress x strain)

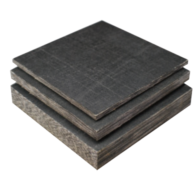
Using the energy storage charts on pages 4 through 7, the kinetic energy to be absorbed must be compared to the kinetic energy storable at the dynamic stress of the Fabcel. The energy storage capacity must be greater than the kinetic energy applied.

Please consult Fabreeka engineering regarding frequency of dynamic input and corresponding stress

Additional Products


FAB-EPM


Fabreeka Bushings


Fabreeka Pads

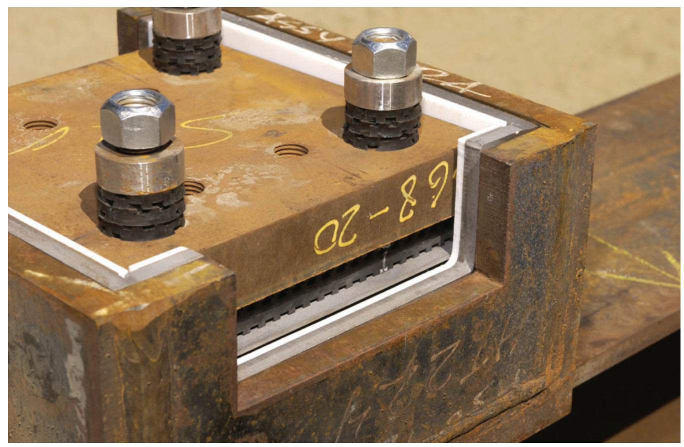

DIMFAB


Fabcel Mounts

Fabcel for Building & Construction

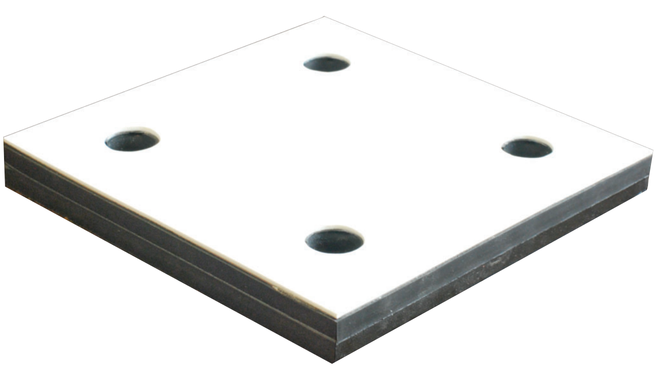
Fabcel is commonly used to provide vibration isolation and reduce structure-borne noise in buildings. Applications include footings, columns and support structures.

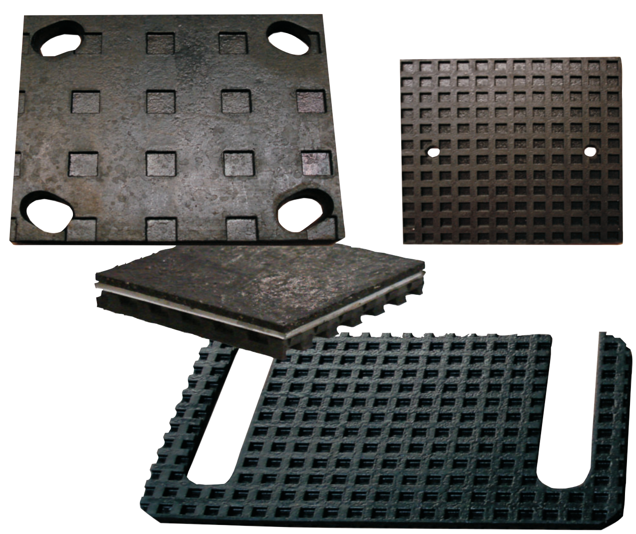
For example, Fabcel isolation washers are used in combination with layers of Fabcel material to provide complete isolation of the vibration transmission path at each structural connection in a heliport design.



OEM Parts

Fabcel can be supplied in the form of sheets, cut pads, washers and assemblies for OEM applications. The dimensions and thickness are specifically designed for the reduction of impact shock, vibration isolation and structure-borne noise reduction. Fabcel can also be manufactured with a PTFE (Teflon®) surface or a thermal insulation material to provide either a low coefficient of friction or thermal protection when required.





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Percent Reduction in Transmitted Vibration for Fabcel Pads

Percent Reduction in Transmitted Vibration for Fabcel *25, 50 and 100*

		1 Layer 5/16" (8mm) thk					2 Layers 5/8" (16mm) thk					3 Layers 1" (24mm) thk					6 Layers 2" (50mm) thk				
		Load - psi					Load - psi					Load - psi					Load - psi				
Forcing Frequency CPS (Hz)	Fabcel 25 50 100	5 10 20	10 20 40	15 30 60	20 40 80	25 50 100	5 10 20	10 20 40	15 30 60	20 40 80	25 50 100	5 10 20	10 20 40	15 30 60	20 40 80	25 50 100	5 10 20	10 20 40	15 30 60	20 40 80	25 50 100
20		--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	--	35	55	65	69
30		--	--	--	--	--	--	12	37	47	55	--	47	62	68	73	59	77	83	86	87
40		--	--	--	--	--	3	63	71	75	78	55	75	81	83	86	79	88	90	92	93
50		--	--	13	30	43	53	78	83	85	86	74	85	88	89	91	87	92	94	94	95
60		20	40	50	60	66	71	85	88	89	90	83	89	91	92	93	91	94	95	96	96
70		50	61	68	72	76	79	89	91	92	93	88	92	93	94	95	93	95	96	97	97
80		65	72	76	79	82	85	92	93	94	94	90	94	95	95	96	94	96	97	97	97
90		74	79	82	84	86	88	93	94	95	95	92	95	96	96	96	95	97	97	98	98
100		79	83	85	87	89	90	94	95	96	96	94	96	96	97	97	96	97	98	98	98
120		86	88	90	91	92	93	96	96	97	97	95	97	97	97	98	97	98	98	98	98
		9 Layers 3-1/16" (78mm) thk					12 Layers 4-1/8" (105mm) thk					15 Layers 5-3/16" (132mm) thk					18 Layers 6-1/4" (160mm) thk				
		Load - psi					Load - psi					Load - psi					Load - psi				
Forcing Frequency CPS (Hz)	Fabcel 25 50 100	5 10 20	10 20 40	15 30 60	20 40 80	25 50 100	5 10 20	10 20 40	15 30 60	20 40 80	25 50 100	5 10 20	10 20 40	15 30 60	20 40 80	25 50 100	5 10 20	10 20 40	15 30 60	20 40 80	25 50 100
10		--	--	--	--	--	--	--	--	3	26	--	--	4	26	42	--	3	26	42	55
20		26	65	76	79	82	55	76	82	85	87	66	80	85	87	89	73	85	87	89	90
30		75	86	90	91	92	83	90	92	93	94	87	91	93	94	95	89	93	94	94	95
40		87	92	94	94	95	90	94	95	96	96	92	95	96	96	97	93	96	96	96	97
50		91	94	96	96	96	94	96	96	97	97	95	96	97	97	98	95	97	97	97	98
60		94	96	97	97	97	95	97	97	97	98	96	97	98	98	98	96	97	98	98	98
70		95	97	97	97	98	96	97	98	98	98	97	98	98	98	98	97	98	98	98	98
80		96	97	98	98	98	97	98	98	98	98	98	98	98	98	98	98	98	98	98	98
90		98	97	98	98	98	97	98	98	98	98	98	98	98	98	99	98	98	98	99	99
100		97	98	98	98	98	98	98	98	98	99	98	98	99	99	99	98	98	99	99	99
120		98	98	98	99	99	98	98	99	99	99	98	99	99	99	99	98	99	99	99	99

Percent Reduction in Transmitted Vibration for Fabcel *200 and 300*

		1 Layer 1/2" (13mm) thk				2 Layers 1" (25mm) thk				4 Layers 2" (50mm) thk			
		Load - psi				Load - psi				Load - psi			
Forcing Frequency CPS (Hz)	Fabcel 200 300	50 50	100 100	200 200	-- 300	50 50	100 100	200 200	-- 300	50 50	100 100	200 200	-- 300
20		--	--	--	--	--	--	--	--	--	--	26	43
30		--	--	--	--	--	--	4	19	32	59	76	80
40		--	--	--	--	16	43	61	66	70	80	87	89
50		--	13	42	48	58	69	78	80	82	88	92	93
60		32	51	65	68	74	80	85	86	88	91	94	95
70		57	68	76	78	81	85	89	90	91	94	96	96
80		70	76	82	84	86	89	91	92	93	95	96	97
90		77	82	86	87	89	91	93	94	94	96	97	97
100		82	85	89	90	91	93	94	95	95	96	97	98
110		85	88	91	92	93	94	95	96	96	97	98	98
120		87	90	92	93	94	95	96	96	97	97	98	98

Transmissibility can be calculated by using the following formula:

$$\text{Percent Reduction} = 100 \times \left[1 - \frac{1}{\left(\frac{\text{Forcing Frequency}}{\text{Resonant Frequency}}\right)^2 - 1} \right]$$

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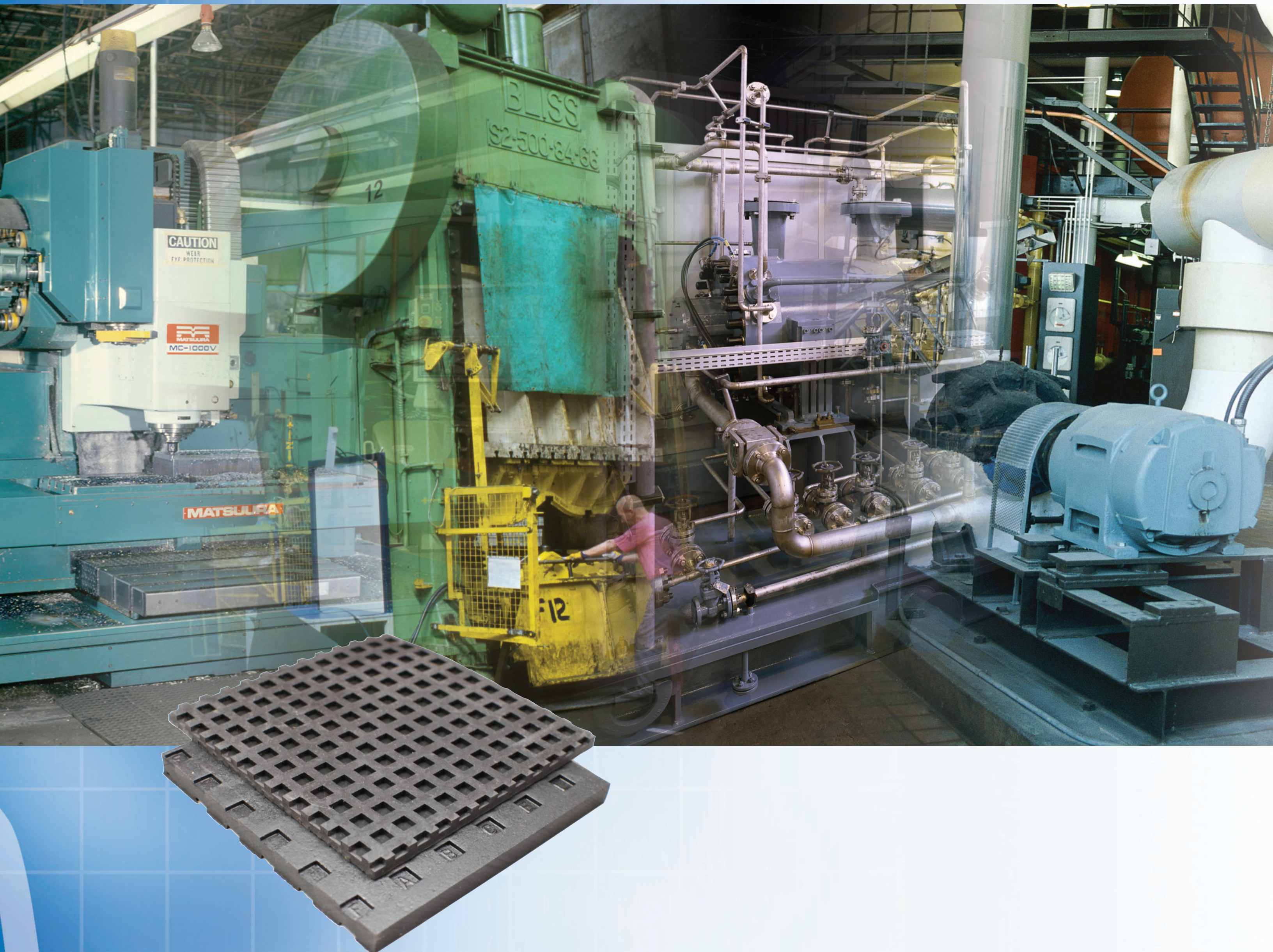

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