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THE REDUCTION OF STRUCTURAL BUILDING VIBRATION INDUCED BY HELICOPTERS THROUGH A HELIPORT

Problem: St. Agnes Medical Center's needs were to attenuate the disturbing frequency produced by a helicopter landing on a "to be" newly constructed heliport incorporating some type of isolation system. Many types of solutions were pondered such as springs and various types of pad systems. When Fabreeka was contacted, we jumped at the challenge to partner with Gayle Mfg. Co. to provide the solution as part of their structure.

Solution: Fabreeka decided to use Fabcel due to the low resonant frequency the isolator had to offer along with average damping properties of 6%. Thirty one isolators were chosen for the structure. Fabreeka partnered with Colin Gordon Associates (architects), the Stichler Group (structural engineers) and Gayle Manufacturing, the manufacturer of the heliport system.

The following calculations will show how we selected the proper isolation.

HELIPORT
ISOLATION
FROM BUILDING STRUCTURE

Stichler Group
Structural Engineers

Application:

- Heliport / helicopter weight
- Disturbing frequency is 20 Hz.
- Customer would like isolation natural frequency of 8 Hz. or less.
- Total isolator area available is 8,287in² (31 isolators).
- Total static weight 500,000 lbs., total isolator area 8,287in² equals 60.34 PSI.
- Use Fabcel 100 due to variations in weight of helicopters, people and equipment.
- Using Fabcel 100 at 60 PSI, the dynamic natural frequency is 7.3 Hz. using 12 layers of pad with three shims to control the stability and expansion on deflection.
- Transmissibility can be calculated using the following formula:

Heliport Isolation

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

Reduction in this case = 85%

$$100 \times \left[1 - \frac{1}{\left(\frac{20\ \text{Hz}}{7.3\ \text{Hz}} \right)^2 - 1} \right]$$

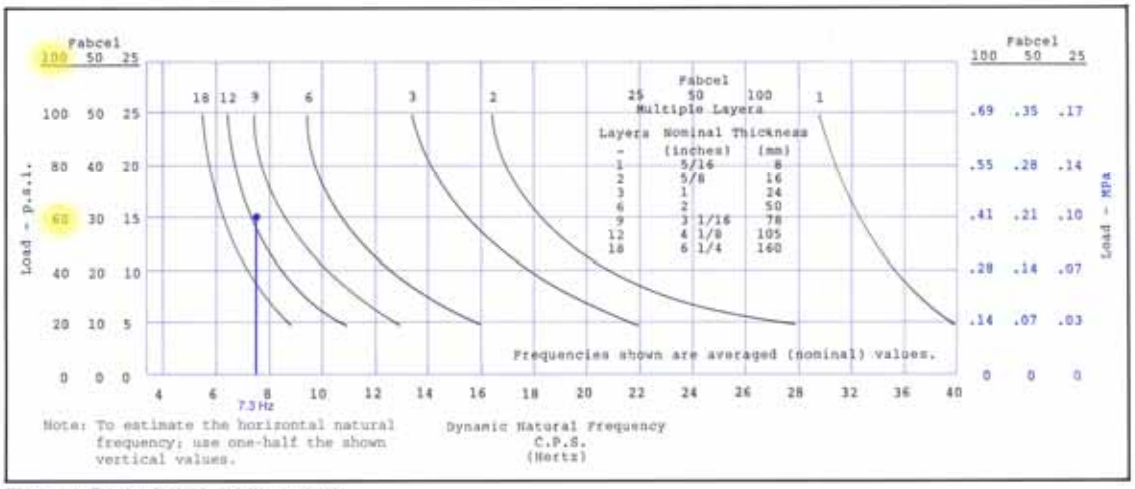

Figure 1. Dynamic Natural Frequency

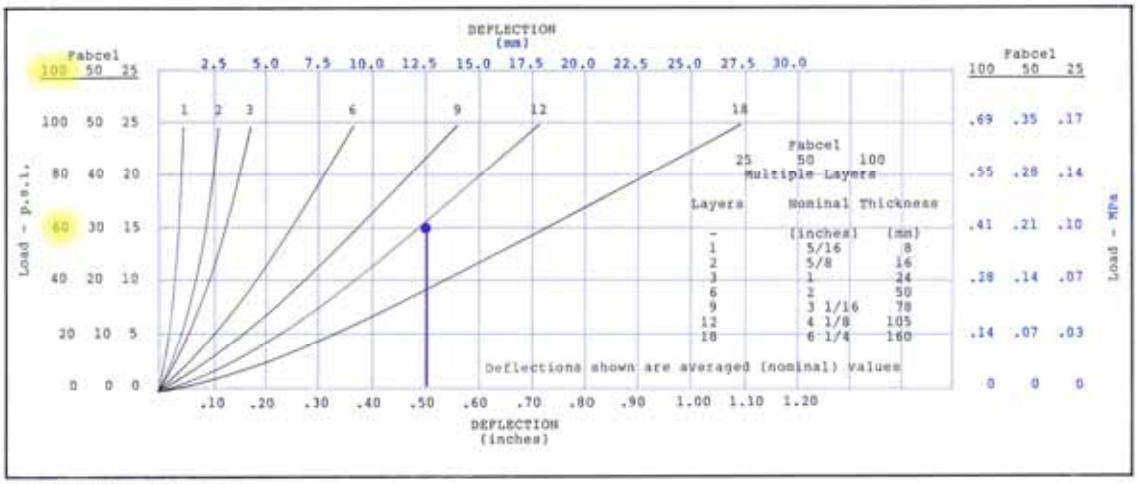

Figure 2. Load Deflection

PERCENT REDUCTION IN TRANSMITTED VIBRATION FOR FABCEL 25, 50, 100, 200 and 300

FABCEL 25, 50 and 100

Forcing Frequency C.P.S. (Hertz)	Fabcel 25 / 50 / 100	1 Layer 5/16" (8mm) Thick LOAD-P.S.I.					2 Layers 5/8" (16mm) Thick LOAD-P.S.I.					3 Layers 1" (24mm) Thick LOAD-P.S.I.					6 Layers 2" (50mm) Thick LOAD-P.S.I.				
		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

Forcing Frequency C.P.S. (Hertz)	Fabcel 25 / 50 / 100	9 Layers 3 1/16" (78mm) Thick LOAD-P.S.I.					12 Layers 4 1/8" (105mm) Thick LOAD-P.S.I.					15 Layers 5 $^{3}/_{16}$" (132mm) Thick LOAD-P.S.I.					18 Layers 6 1/4" (160mm) Thick LOAD-P.S.I.				
		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

FABCEL 200 and 300

Forcing Frequency C.P.S. (Hertz)	Fabcel 200 / 300	1 Layer ½" (13mm) Thick LOAD-P.S.I.				2 Layers 1" (25mm) Thick LOAD-P.S.I.				4 Layers 2" (50mm) Thick LOAD-P.S.I.			
		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

Early stages of building/heliport construction.

Isolators made of twelve layers of Fabcel pad with three shims are used to control stability and expansion on deflection. PTFE covers the inside of the “box”, to insure no binding when the pad deflects and returns to its original position.

Fabcel washers are used to isolate the fastener so there is no transmission of vibration.

Above and below, portions of support structure before erection.

View of heliport on isolators “boxes” on the building support structure.

The following shows typical examples of isolators for heliport installations.