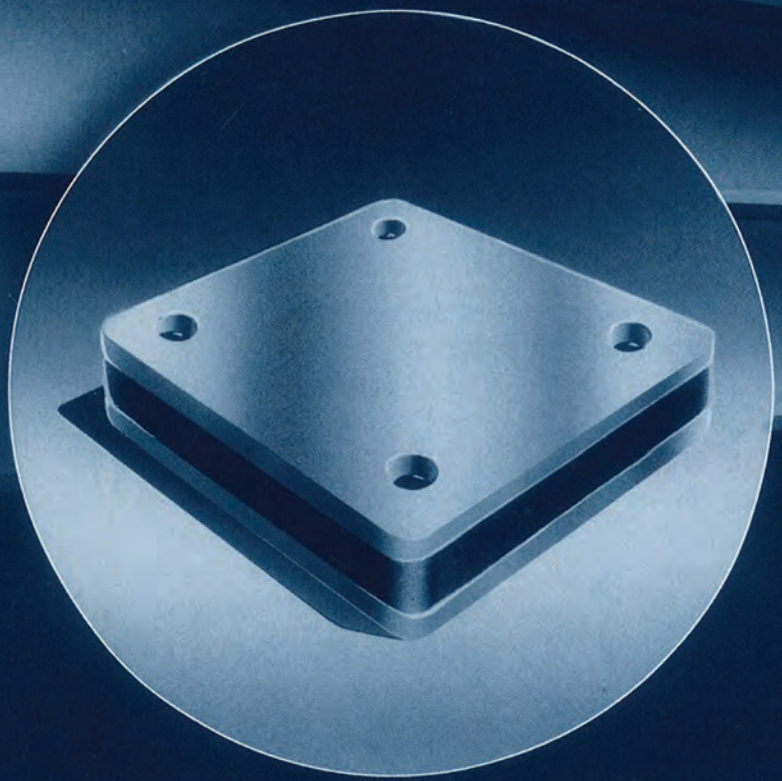
REDWOOD PLASTICS CORPORATION

INNOVATIVE SOLUTIONS IN PLASTIC



REDCO® S.V.I. IMPACT & VIBRATION ISOLATION PADS

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In the last 10 years Redwood Plastics Corp. has increasingly become more involved in solving shock, vibration and impact problems through the use of Redco polymers.

Our knowledge of elastomeric products and applications has enabled us to develop **new concepts** for engineered Redco S.V.I (shock, vibration, impact) pads.

We have designed and engineered composite materials to help reduce and control **NOISE** generated in the work place.

One proven method of controlling sound energy is to modify your existing equipment through the use of **Redco Sound Dampening and Absorption Composites**. Our products can also be designed and custom made with added features for abrasion, wear, impact, sliding (slippery) and extensive rebound. Fastening methods include floating, mechanical and binds to steel that can be welded.

This engineering data has been developed for use in structural and related areas for easy and accurate analysis of the required size, shape and grade of Redco S.V.I pads for your application.

At Redwood Plastics our experience is demonstrated by the quality of our parts.

FEATURES

- Engineered sizes and formula charts
- High quality, elastomeric, polymers/composites
- Chemical resistant to most oils, greases & solvents
- Excellent memory, toughness and cut resistance
- Variable operating temperature - 80^{O}F to 210 ^{O}F

BENEFITS

- Quick and easy method of size & shape evaluation
- Proven in a wide variety of applications
- Cost effective

A FEW APPLICATIONS

- Structural Isolation
- Equipment Isolation
- Bearing Mount Pads
- Impact Cushions
- Shock Absorbers

PARTIAL USERS LIST

- Weldwood of Canada
- MacMillan Bloedel
- Slocan Forest Products
- West Fraser Timber
- Linden Fabricating
- Dunkley Lumber Co.

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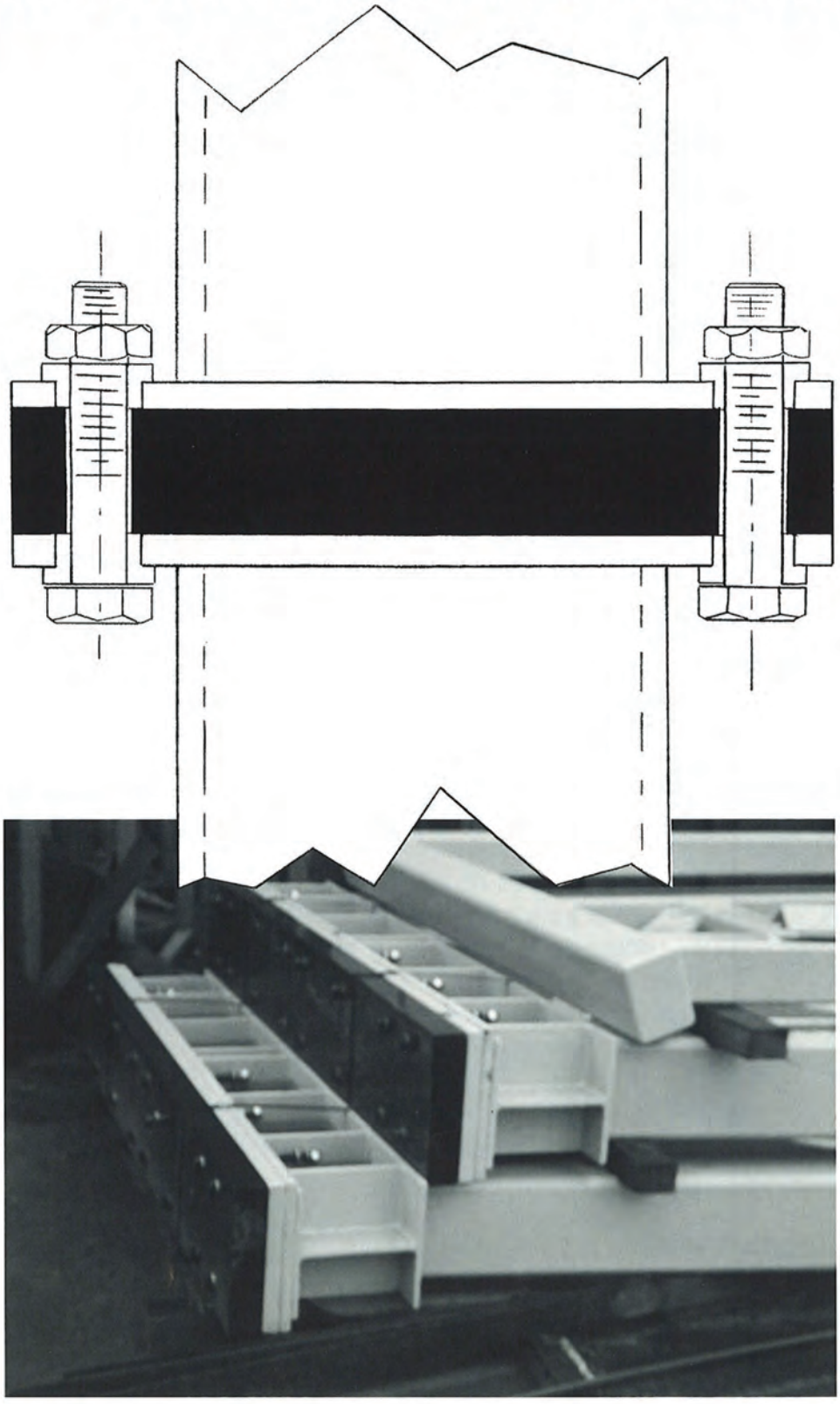
SHOCK & VIBRATION ISOLATION PADS.



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(a) Redco Pre-Engineered Shock Isolation Pads

Redco pre-engineered impact shock isolation pads are designed to absorb impact energy and lessen the peak forces or "shock" transmitted into the supporting structure. A knowledgeable designer wil be able to use these pre-engineered pads to reduce the transmission of **noise vibration** and **shock**.

(b) Basics for Impact Energy Isolation

Impact energy is absorbed through the deflection of the impact absorbing material. This is shown by the formula $E = Fd$, (where E is the energy, F= the resisting force, and d = the distance thru which the force acts).

For example: Using a force (F) of 10 lbs. acting over a distance (d) of 2 feet we get E = 10 lbs. * 2 feet = 20 ft - lbs., or = 240 inch - lbs.

However, if the resisting force (F) is a spring with a constant (K), then this force depends on how much the spring is compressed. The spring force (F) keeps increasing the more the spring is compressed. This is represented by the formula $F = Kx$. (Where x = distance the spring is compressed). The energy (E) absorbed by a linear spring is calculated using the formula $E = {}^1/_2\, Kx^2$ (Integral of $F = Kx$.)

(c) Redco Shock Isolation Pads

The Redco pre-engineered shock isolation pads respond as springs up to the maximum deflections specified, generally 25% of the uncompressed height ($x_{max} = 0.25h$).

Redco shock pads do not have coils like a spring to compress. When Redco shock pads are compressed they need to bulge. If the shock pads are confined they become incompressible. The freedom to bulge determines the spring effect of the material. Laboratory experiments have found the compression properties of SVI materials are controlled by the amount of area they are free to bulge.

The pre-engineered shock pads performance for the specific size, shape and grade are tabulated. The force (F) is that amount required to compress the pad the maximum deflection distance (x) tabulated. The energy (E) is that amount used when the force compresses the pad this same distance. The tabulated distance (x) is the maximum allowable for each shape and size.

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The spring constant (K) for each size, shape and grade can be calculated by dividing the force (F) by the deflection (K = F/x). K is then used in the spring energy formula ($E = {}^1/_2\ Kx^2$) to determine the energy absorbed by the pad.

Most applications for shock pads will require values of energy, force, or deflection less than those tabulated. For such applications the tables can be interpolated using the linear spring formula above.

(d) Rebound and Set

As does a spring, the Redco shock pads will rebound or spring back. The shock pad rebound is not linear, but a percentage of the impact or compression energy is absorbed. The absorbed energy is dissipated in the form of heat.

If bounce back is of concern, using a higher grade will reduce it.

The shock pads will also exhibit "compression set" (or tendency to remain in compressed position after the force is removed). The "set" is reduced by minimizing permanent loading and avoiding higher temperatures. Compression set occurs over time and is a percentage of the deflection from original height as listed below:

Redco S.V.I. Grade	**#1**	**#2**	**#3**	**#4**	**#5**
Rebound %	72	65	60	45	39
Absorbed %	28	35	40	55	61
Set %	9	20	45	45	45

(e) Installation Notes

1) Pads must be free to bulge.
2) The pads are electrical insulators. Any equipment isolated by the pads **must be grounded** according to the **CEC to avoid shock**, damage due to welding, etc.
3) Pads can "float" or be held in place with keepers or bolts.
4) Pads can be supplied bonded to backing plates which are bolted in place.
5) Bonded backing plates are recommended for the doughnut shape shock pads.
6) Minimum bonded backing plate thickness for all shapes: 1" & 2", 10 gauge; 3" & 4", $^1/_4$" plate; 5" - 7", $^3/_8$" plate; 8"- 10", $^1/_2$" plate.

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(f) Selection Procedure and Notes

1) Interpolating: The values listed are for maximum deflection (x), with corresponding force (F), and impact energy (E), they can be used for any deflection using the formulas in part **C above**.

2) Accuracy: The values listed are accurate only within 10% due to transferring laboratory data to the real world, and manufacturing variances.

3) Deflection values greater than those listed should generally not be used because:

i) the Redco Shock Pad compression pressure is non linear for higher deflections,

ii)excessive deflection may over-stress the pads causing them to fail.

4) Selection call-up: specify - shape, height ratio, size and shock pad Grade #. **eg. Square HR4 - 4" Grade 2.**

(g) Calculation Example of Pad Values at 1/2 Allowable Deflection

From tables: **Doughnut HR1 - 8" Grade 3,** at maximum deflection (x) = 1.0", Force = 14,000 lbs., Energy = 7,000 inch lbs. What are its values at new (x) = 1/2" deflection?

Step 1) Calculate the spring constant (K), using formula $F = Kx$

$K = 14{,}000 \text{ lbs.} / 1 \text{ inch} = 14{,}000 \text{ lbs./inch}$

Step 2) Using New (x) = 1/2"
New Energy = $\frac{1}{2} K x^2 = \frac{1}{2} * 14{,}000 \text{ lbs./inch} * (0.5 \text{ inch})^2 =$ 1,750 inch lbs. for 1/2" deflection
New Force = 14,000 lbs./inch * 0.5 inch = 7,000 lbs.

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(h) Redco S.V.I. Shock Pad Selection Examples

Example (1) A 2,000 lb. rock drops 2.8 feet and lands on a steel plate supported by 4 shock pads. (Assume the weight of the plate is negligible.)

i) Calculate Total Energy
Energy = weight * height
E = w*h = 2,000 lb.* 2.8 feet * 12 inches/ft.
E = 67,200 inch lbs.

ii) The energy is absorbed by 4 shock pads so the energy per shock pad is 16,800 inch lbs./shock pad, or approximately 17,000 in lbs.

iii) Using Pre-Engineered Shock Pad Table look under the columns labelled "energy" for 17,000 inch lbs.

1) **Square HR4 - 6" Grade 4**
Energy = 17,000 in lbs.
Force (F) = Transmitted Force = 90,000 lbs.,
Deflection = 0.375"

2) **Square HR4 - 7" Grade 3**
Energy = 17,000 in lbs.
Force (F) = Transmitted Force- 78,000 lbs.,
Deflection = 0.438"

iv) The **Square HR4 - 6" Grade 4** shockpad has a lower deflection, but the supporting structure must be designed for peak transmitted shock force of 90,000 lbs. for each shock pad. The **Square HR4 - 7" Grade 3** shock pad has a lower peak force of 78,000 lbs., but a higher deflection of 0.438" must be accommodated.

Example 2) A 1000 lb. log is travelling horizontal at 5 feet per second and hits a shock pad.

i) Calculate total energy.

$E = {}^1/_2\ mv^2 = {}^1/_2$ 1000 lbs./32.2 ft/sec^2 * (5 ft/sec)^2
E = 388.2 lbs. ft. convert to inch lbs., 388.2 ft. lbs. * 12 = 4,658 inch lbs.
Energy to be absorbed by the shock pad is approximately 4,700 inch lbs.

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ii) Select Redco shock pad using the energy column.

Doughnut HR1 - 7" Grade 3, E = 4,700 in lbs., Force 11,000 lbs., deflection = 0.875

or **Doughnut HR2 - 7" Grade 3,** E = 4,700 in lbs., Force = 22,000 lbs., deflection = 0.438

The **HR 1 Doughnut** has a lower peak transmitted force of 11,000 lbs., but a deflection of 0.875 inches. Whereas the HR 2 Doughnut has half the deflection at 0.438 inches but twice the peak transmitted force of 22,000 lbs.

Example 3) 400 lb. carriage is being pushed into a bumper at 3 feet per second by a cylinder with a static force capacity of 2,000 lbs.

i) Calculate the energy of the carriage,
$E = {}^1/_2 mv^2 = {}^1/_2$ 400 lbs./32.2 ft/sec^2 * (3 ft/sec)^2
= 56 lbs. ft * 12 in/ft = 672 inch lbs.

ii) Select a shock pad that will absorb 672 inch lbs. plus have reserve to restrain the 2,000 lb cylinder force.

A square **HR4 - 3" Grade 2** shockpad will absorb 840 inch lbs., with peak force of 9,000 lbs., and deflection = 0.188".

The spring constant K = 9,000 lbs. /0.188 inch = 47,900 lbs/inch.

iii) Energy of the carriage = Energy to be absorbed by the shock pad. Spring energy = $E = {}^1/_2 Kx^2$ = 672 in lbs. = ${}^1/_2$ 47,900 lbs/in*x^2 then X^2 = 2 * 672 in lbs. /47,900 lbs/in = 0.28 in^2 or x = 0.167 inches.

iv) Peak force to be with stood by the shock pad.
F = Kx = cylinder force = 47,900 lbs/in * 0.167 inch + 2,000 lbs.
F = 8,000 lbs. + 2,000 = 10,000 lbs.

This selection is 1,000 lbs. over the capacity of the selected shock pad, so try a **Square HR4 - 3" Grade 3,** or a **Square HR4 - 4" Grade 2.**

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STRESS TABLE (psi) for max deflection = 25% of unloaded height

REDCO SHOCK PAD	1.00	2.00	4.00	8.00 = HR= Height Ratio
Grade				
#1	100	250	630	1600
#2	140	400	1000	2600
#3	370	750	1600	4000
#4	670	1300	2500	4000 @ 15% deflection max.
#5	1160	2100	3800	3200 @ 10% deflection max.

NOTES: Tabulated values are for the maximum allowable deflection for each pad or material.

Lower working numbers are normal.

Interopolate tables as necessary up to the maxImum from 0 deflection = O force.

Energy = inch-lbs., E = $^1/_2$ Kx2

Force = lbs., F = kx

Accuracy = + -10%

HR - 1

Doughnut HR = 1 size = o.d., i.d. = o.d./2, h = I.d./HR

size	h	defl.	Grade #1		Grade #2		Grade #3		Grade #4		Grade #5	
inch	inch	inch	force	energy	force	energy	force	energy	force	energy	force	energy
1	0.5	0.125	60	3.7	80	5.2	220	14	400	25	700	43
2	1.0	0.250	240	29	330	41	870	110	1600	200	2700	340
3	1.5	0.375	530	100	740	140	2000	370	3600	670	6200	1200
4	2.0	0.500	940	240	1320	330	3500	870	6300	1600	11000	2700
5	2.5	0.625	1500	460	2100	640	5500	1700	9900	3100	17000	5300
6	3.0	0.750	2100	800	3000	1100	7800	2900	14000	5300	25000	9200
7	3.5	0.875	2900	1300	4000	1800	11000	4700	19000	8500	33000	15000
8	4.0	1.000	3800	1900	5300	2600	14000	7000	25000	13000	44000	22000
9	4.5	1.125	4800	2700	6700	3800	18000	10000	32000	18000	55000	31000
10	5.0	1.250	5900	3700	8300	5200	22000	14000	39000	25000	68000	43000

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Doughnut HR = 2 — size = o.d., i.d. = o.d./2, h = i.d./HR

HR - 2

size inch	h inch	defl. inch	Grade #1 force	Grade #1 energy	Grade #2 force	Grade #2 energy	Grade #3 force	Grade #3 energy	Grade #4 force	Grade #4 energy	Grade #5 force	Grade #5 energy
1	0.25	0.063	150	4.6	240	7.4	440	14	770	24	1200	39
2	0.50	0.125	600	37	940	59	1800	110	3000	190	5000	310
3	0.75	0.188	1300	120	2100	200	4000	370	6900	650	11000	1000
4	1.00	0.250	2400	300	3800	470	7100	880	12000	1500	18000	2500
5	1.25	0.313	3700	580	5900	920	11000	1700	19000	3000	31000	4800
6	1.50	0.375	5300	1000	8500	1600	16000	3000	28000	5200	45000	8400
7	1.75	0.438	7200	1600	12000	2500	22000	4700	38000	8200	61000	13000
8	2.00	0.500	9400	2400	15000	3800	28000	7100	49000	12000	79000	20000
9	2.25	0.563	12000	3400	19000	5400	36000	10000	62000	17000	100000	28000
10	2.50	0.625	15000	4600	24000	7400	44000	14000	77000	24000	124000	39000

Square HR = 4 — size = Length, width = L, height = L / HR

HR - 4

size inch	h inch	defl. inch	Grade #1 force	Grade #1 energy	Grade#2 force	Grade#2 energy	Grade #3 force	Grade #3 energy	Grade #4 force	Grade #4 energy	Grade #5 force	Grade #5 energy
1	0.25	0.063	630	20	1000	31	1600	50	2500	78	3800	120
2	0.50	0.125	2500	160	4000	250	6400	400	10000	630	15000	950
3	0.75	0.188	5700	530	9000	840	14000	1400	23000	2100	34000	3200
4	1.00	0.250	10000	1300	16000	2000	26000	3200	40000	5000	61000	7600
5	1.25	0.313	16000	2500	25000	3900	40000	6300	63000	98000	95000	15000
6	1.50	0.375	23000	4300	36000	6800	58000	11000	90000	17000	140000	26000
7	1.75	0.438	31000	6800	49000	11000	78000	17000	120000	27000	190000	41000
8	2.00	0.500	40000	10000	64000	16000	100000	26000	160000	40000	240000	61000
9	2.25	0.563	51000	14000	81000	23000	130000	36000	200000	57000	310000	87000
10	2.50	0.625	63000	20000	100000	31000	160000	50000	250000	78000	380000	120000

Square HR = 8 — size = Length, width = L, height = L / HR

HR - 8

size inch	h inch	defl. inch	Grade #1 force	Grade #1 energy	Grade #2 force	Grade #2 energy	Grade #3 force	Grade #3 energy	15% mx defl. Grade #4 force	15% mx defl. Grade #4 energy	10% max defl. Grade #5 force	10% max defl. Grade #5 energy
1	0.13	0.031	1600	25	2600	41	4000	63	4000	38	3200	20
2	0.25	0.063	6400	200	10000	330	16000	500	16000	300	13000	160
3	0.38	0.094	14000	680	23000	1100	36000	1700	36000	1000	29000	540
4	0.50	0.125	26000	1600	42000	2600	64000	4000	64000	2400	51000	1300
5	0.63	0.156	40000	3100	65000	5100	100000	7800	100000	4700	80000	2500
6	0.75	0.188	58000	5400	94000	8800	14000	13500	140000	8100	120000	4300
7	0.88	0.219	78000	8600	130000	14000	200000	21000	200000	13000	160000	6900
8	1.00	0.250	100000	13000	170000	21000	260000	32000	260000	19000	200000	10000
9	1.13	0.281	130000	18000	210000	30000	320000	46000	320000	27000	260000	15000
10	1.25	0.313	160000	25000	260000	41000	400000	63000	400000	38000	320000	20000

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Rectangle HR=4 size=length, width=L/2, height=L/1.5*HR

size	W	h	defl.	Grade #1		Grade #2		Grade #3		Grade #4		Grade #5	
inch	inch	inch	inch	force	energy	force	energy	force	energy	force	energy	force	energy
2.0	1.00	0.33	0.083	1300	53	2000	83	3200	130	5000	210	7600	320
3.0	1.50	0.50	0.125	2800	180	4500	280	7200	450	11000	700	17000	1100
4.0	2.00	0.67	0.167	5000	420	8000	670	13000	1100	20000	1700	30000	2500
5.0	2.50	0.83	0.208	7900	820	13000	1300	20000	2100	31000	3300	48000	5000
6.0	3.00	1.00	0.250	11000	1400	18000	2300	29000	3600	45000	5600	68000	8600
8.0	4.00	1.33	0.333	20000	3400	32000	5300	51000	8500	80000	13000	120000	20000
10.0	5.00	1.67	0.417	32000	6600	50000	10500	80000	17000	130000	26000	190000	40000
12.0	6.00	2.00	0.500	45000	11000	72000	18000	120000	29000	180000	45000	270000	68000
14.0	7.00	2.33	0.583	62000	18000	98000	29000	160000	46000	250000	71000	370000	110000
16.0	8.00	2.67	0.667	81000	27000	130000	43000	200000	68000	320000	110000	490000	160000

Rectangle HR=8 size=length, width=L/2, height=L/1.5* HR

size	W	h	defl.	Grade #1		Grade#2		Grade #3		Grade #4		Grade #5	
inch	inch	inch	inch	force	energy	force	energy	force	energy	force	energy	force	energy
2.0	1.00	0.17	0.042	3200	67	5200	110	8000	170	8000	100	6400	53
3.0	1.50	0.25	0.063	7200	230	12000	370	18000	560	18000	340	14000	180
4.0	2.00	0.33	0.083	13000	530	21000	870	32000	1300	32000	800	26000	430
5.0	2.50	0.42	0.104	20000	1000	33000	1700	50000	2600	50000	1600	40000	830
6.0	3.00	0.50	0.125	29000	1800	47000	3000	72000	4500	72000	2700	58000	1400
8.0	4.00	0.67	0.167	51000	4300	83000	6900	130000	11000	130000	6400	100000	3400
10.0	5.00	0.83	0.208	80000	8300	130000	13500	200000	21000	200000	12500	160000	6700
12.0	6.00	1.00	0.250	120000	14000	190000	23000	290000	36000	290000	22000	310000	18000
16.0	8.00	1.33	0.333	200000	34000	330000	55000	510000	85000	510000	52000	410000	27000

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Redwood warrants that the products will be manufactured in a good and workmanlike manner, in accordance with the specifications of Redwood or the customer, as the case may be. This warranty is in lieu of all other warranties, written, oral, statutory, express or implied, including, without limitation, warranties of merchantability and of fitness for a particular purpose. Redwood's liability shall be limited to the replacement of the goods and customer shall not have any claim for damages arising out of the use or the operation of the goods, whether in tort or in contract; and without limiting the foregoing, Redwood shall not be liable for any indirect, special or consequential damages of any nature or kind whatsoever, including business, economic or other loss.

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