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Plasti-Fab DuroFloat® Flotation Billets - Design and Application

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Plasti-Fab DuroFloat® flotation billets consist of expanded polystyrene (EPS) coated with an eco-friendly material that provides additional resistance against abrasion and intermittent exposure to hydrocarbons. Standard billet sizes are shown below providing flotation force as noted.

Table 1 - DuroFloat® Flotation Billet Material Properties

DuroFloat® Flotation Billets

Note: If DuroFloat flotation billets are to be wrapped or covered for storage outdoors with direct exposure to sunlight, use opaque non-transparent wrap to avoid degradation of billets due to heat buildup within wrap.

DuroFloat flotation billets consist of EPS coated with a polyurea elastomer coating that is flexible yet provides a tough monolithic membrane with excellent water and chemical resistance. Special sizes are available for custom floating structures.

Billet Size - mm (in.)	Weight - kg (lb)	Volume - m^3 (ft^3)	Flotation Force - kg (lb)
254 x 508 x 2,440 (10 x 20 x 96)	5.0 (11.1)	0.315 (11.11)	277 (611)
178 x 508 x 2,440 (7 x 20 x 96)	3.5 (7.3)	0.220 (7.78)	194 (428)

CAUTION: *Plasti-Fab flotation billets are combustible and should be treated with care. Normal fire precautions and good housekeeping practices should be observed during construction. Avoid open flames, welding torches and high intensity lamps. Water fog, carbon dioxide, dry chemical or foam should be used as an extinguishing media.*

DuroFloat flotation billets offer the following advantages:

- Lightweight and easy to work with using conventional tools. However, care must be taken not to crack or damage the coatings when tightening fasteners through the billets
- Unaffected by winter temperatures and suitable for use in fresh or salt water. Additional design considerations should be employed for flotation structures exposed to winter weather to prevent or minimize mechanical damage to billets caused by ice movement. One method of addressing this issue is extension of skirt boards below the water line.
- EPS provides a flotation force of 880 kg per cubic meter (55 lbs per cubic foot) with a margin of safety, whereas wood is 20 to 40 times heavier depending on type and will support only one-third to one-half of this weight.
- Billets provide no food value for marine animals and the billet coating reduces the ability of marine animals to chew out a space within the billet for a nest and cause settling. Growth of marine life on billets may occur in stagnant water; however any topical growth will not impair the billets flotation and can be removed with a wooden scraper.
- Floating structures utilizing properly placed flotation billets exhibit excellent rebound characteristics with minimum rocking, provide less resistance to breaking waves and are quieter than other types of flotation devices (e.g. drum floats).

Flotation Calculations:

Flotation billets are installed flat with the longer side horizontal and as close to the outside edges as possible. Leave wide spaces between billets to permit waves to roll through with minimum effect on the structure. The information required to complete the flotation calculation includes the following:

1. **Live Load** – The weight of the maximum number of people plus any sporting equipment, such as outboard motors, which might be expected on the structure. An additional 25% is often added to the live load as a safety factor.
   Note: A high safety factor will cause the structure to ride high when not loaded exposing the billet to damage by ice or floating debris. When damage due to floating debris on the surface of the water or ice is possible, consider designing the depth of skirt boards around the entire floating structure so that they extend into the water when there is no live load on the structure.

2. **Dead Load** – The weight of the wood in the floating structure above the design waterline.

3. **Flotation of Structure** – The flotation of lumber below the waterline.
   The total live load with safety factor plus dead load to be supported is used to calculate flotation requirements for raft applications. For floating docks, the total live load with safety factor plus dead load allowance divided by the length of the dock can be used to provide the average load per lineal meter (foot) of dock.

4. **Flotation Required** – The flotation required is calculated using the following formula:

   Flotation Required = Live Load including Safety Factor + Dead Load – Flotation of Structure.

   Choose an even number of billets to permit symmetrical placement along the sides for maximum stability. The flotation force provided by a pair of billets must be greater than the flotation required per 2.44 meter (8 foot) section of dock. Dock length may be up to several hundred meters (feet) and can be secured at intervals either by piles to the bottom or anchors to the shore or the bottom. Figure 1 illustrates typical construction details for a section of dock.

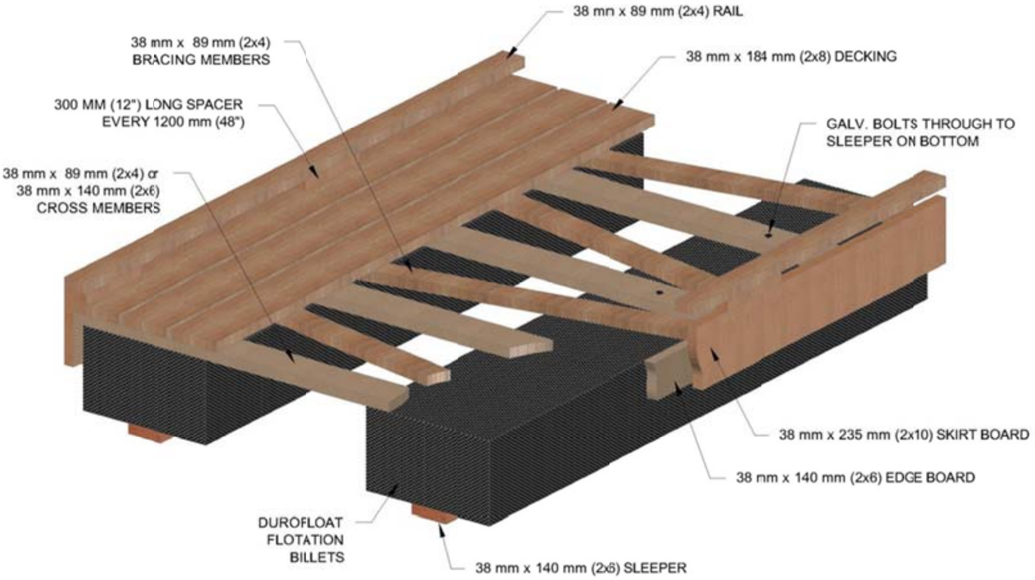

Figure 1 - Floating Dock or Marina

Dock construction can be completed on shore, with sections then towed into position in the water and the skirt boards nailed into place with the joints staggered to the section joints. The tie rail is the last piece to be added.

Table 2 below provides weight and buoyancy force values for Western Red Cedar and Douglas fir. Cedar lumber can be used without preservative treatment. All other types of lumber should be treated with preservative. Use commercially treated wood or apply treatment at the jobsite after all cutting but before assembly.

Table 2 - Weight and Buoyancy Force of Lumber

Lumber Size mm (in.)	Western Red Cedar				Douglas Fir			
	Weight		Buoyancy		Weight		Buoyancy	
	kg/m	lb/ft	kg/m	lb/ft	kg/m	lb/ft	kg/m	lb/ft
38x89 (2x4)	1.31	0.88	1.62	1.09	1.95	1.31	1.09	0.73
38x140 (2x6)	2.05	1.38	2.56	1.72	3.07	2.06	1.71	1.15
38x184 (2x8)	2.80	1.88	3.48	2.34	4.18	2.81	2.32	1.56
38x235 (2x10)	3.54	2.38	4.42	2.97	5.30	3.56	2.95	1.98
38x292 (2x12)	4.29	2.88	5.34	3.59	6.41	4.31	3.57	2.40
19x89 (1x4)	0.65	0.44	0.80	0.54	0.97	0.65	0.54	0.36
19x140 (1x6)	1.03	0.69	1.28	0.86	1.53	1.03	0.85	0.57
19x184 (1x8)	1.40	0.94	1.74	1.17	2.08	1.40	1.16	0.78
89x89 (4x4)	3.04	2.04	3.79	2.55	4.55	3.06	2.53	1.70

Note: The buoyancy forces provided in Table 2 above are based upon the initial weight of wood submerged below water. Over time the submerged wood will become saturated and provide less buoyancy.

Design Example:
This design example provides sample calculations for construction of a 2.44 meter (8 foot) long by 1.829 meter (6 foot) wide section of dock using the lumber weight and buoyancy force values for Western Red Cedar and Douglas Fir provided in Table 1.

1. **Live Load Calculation:**
   Live Load estimate per 2.44 m (8 ft) of dock
   = 3 people @ 80 kg (176 lb) + Sporting Equipment @ 100 kg (221 lb) + 25% safety factor
   = (3 x 80 +100) x 1.25 = 425 kg (937 lb)

2. **Dead load Calculation:**
   The lumber required to construct the dock section must be determined in advance based upon the required dock design. The lumber used in this design example is based upon construction details provided in Figure 1.

Table 3 - Lumber Calculation above Waterline

Lumber Size mm (in.)	Description of Dock Component	Number Pieces	Length mm (in.)	Total m (ft)
38x140 (2x6)	Outside lumber placed on edge at a distance apart equal to the dock finished width less 75 mm (3”).	2	2,440 (96)	4.88 (16.0)
38x140 (2x6)	Cross members at 610 mm (24”) on centres nailed to edge members make up the section of the dock	4	1,752 (69)	7.00 (23.0)
Total length 38 x 140 mm (2” x 6”) lumber = 11.88 m (39.0 ft)				
38x184 (2x8)	Wood decking	9	2,440 (96)	21.96 (72.0)
Total length 38 x 184 mm (2” x 8”) lumber = 21.96 (72.0 ft)				
38x89 (2x4)	Diagonals between cross members	4	1,829 (72)	7.32 (24.0)
38x89 (2x4)	Tie down rail	2	2,440 (96)	4.88 (16.0)
38x89 (2x4)	Tie down rail spacers at 1,220 mm (48”) on centre	4	305 (12”)	1.22 (4.0)
Total length 38 x 89 mm (2” x 4”) lumber = 13.42 m (44.0 ft)				
38x235 (2x10)	Skirt boards	2	2,440 (96)	4.88 (16.0)
Total length 38 x 235 mm (2” x 10”) lumber = 4.88 m (16.0 ft)				

Total Dead Weight for each 2.44 meter (8 foot) long by 1.829 meter (6 foot) wide section of dock is calculated using the lumber weights for each lumber size provided Table 2.

a) Western Red Cedar = 118.6 kg (261.1 lb)
b) Douglas Fir = 177.9 kg (391.6 lb)

3. Flotation of Structure:

For this design example, it is assumed that all lumber is above waterline except the sleepers below the billets. It is assumed that lumber below the waterline will become saturated; therefore, in this case, flotation force due to Western Red Cedar or Douglas Fir sleepers is assumed to be zero.

4. Flotation Required

Flotation Required = Live Load including Safety Factor + Dead Load – Flotation of Structure

a) ***Using Western Red Cedar Wood:*** Flotation Required = 425.0 + 118.0 = 543.0 kg (1,197 lb)

From Table 1 select two DuroFloat Flotation Billets = 2 @ 277 kg (610 lb)
= 554 kg (1,220 lb) > 543.6 kg (1,197 lb) OK

b) ***Using Douglas Fir Wood:*** Flotation Required = 425.0 + 177.0 = 602.0 kg (1,327 lb)

In this case the buoyancy force required is greater than the value provided by the standard billets provided in Table 1. A custom billet with dimensions 305 mm x 508 mm x 2,440 mm (12” x 20” x 96”) has a volume of 0.378 m^3 (13.33 ft^3) and each billet will provide a flotation force of 333 kg (733 lb).

Using two of the custom DuroFloat Flotation Billets = 2 @ 333 kg (733 lb)
= 666 kg (1,466 lb) > 602.9 kg (1,327 lb) OK