Department of Defense

REPORT TO CONGRESS
ON
RECYCLED PLASTIC LUMBER

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RECYCLED PLASTIC LUMBER

House Report 115-188, page 23, accompanying H.R. 2998, the Military Construction, Veterans Affairs, and Related Agencies Appropriations Bill, 2018, requests the Secretary of Defense further explore and report on applications for the use of recycled plastic lumber:

> *Recycled plastic lumber.*—The Committee understands that the Department of Defense has been utilizing recycled plastic lumber in various manners on its military installations. Applications include, but are not limited to, bridge infrastructure, dunnage boards, landscape timbers, rub rails, construction sleepers, fence posts, and nailer boards. Manufactured from post-consumer and industrial waste, recycled plastic lumber is insect resistant, will not rot, splinter, crack or fail in the manner of traditional wood. Recycled plastic lumber carries positive environmental impacts by reducing deforestation, diverting waste materials from landfills and lowering greenhouse gas emissions. The Committee directs the Secretary of Defense to further explore applications for use of recycled plastic lumber, particularly recycled plastic lumber that uses no virgin plastic, in military installations, and provide a report to the Committee not later than 120 days after enactment of this Act on its findings.

The Department of Defense recognizes recycled plastic lumber to fill a unique niche in the spectrum of building materials available to designers and construction contractors for specific applications where its superior durability and corrosion resistance are more important than structural strength. In this regard, one of the most prevalent DoD applications is for waterfront structures, particularly those components which do not carry large loads such as fenders and small craft berthing structures.

Because of the unique characteristics of recycled plastic lumber, DoD—and specifically the Construction Engineering Research Laboratory of the U.S. Army Corps of Engineers—has been involved since the early 1990's with developing and testing innovative structural applications that would accommodate its lower strength while exploiting its excellent durability. This effort resulted in construction of the first plastic lumber bridge capable of crossing a light vehicle (at Fort Leonard Wood, Missouri in 1998), construction of three heavy-load bridges capable of supporting an M-1 main battle tank (at Camp Mackall / Fort Bragg, North Carolina since 2009), and even construction of two railroad bridges (at Ft. Eustis, Virginia in 2010). The Army assessed these heavy-load bridges to be competitive to conventional wood construction on a first-cost basis, and significantly lower cost over the expected service life. (The technical report on these bridges is available on the Army Corps of Engineers web site at http://dx.doi.org/10.21079/11681/26030.)

Figure 1: First known plastic bridge in the United States constructed in 1998 at Fort Leonard Wood, Missouri.

Figure 2: Load test of plastic railroad bridge at Fort Eustis, Virginia, April 2010.

In spite of the success of recycled plastic lumber in such demonstration projects, its widespread adoption in heavy-load structural applications has been hindered by a lack of industry consensus standards and design guidance. To mitigate this difficulty, the Department is working to revise Unified Facilities Criteria (UFC) 3-301-01, Structural Engineering, to include information and design guidance for the use of polymer composites and plastic lumber materials for bridging applications, short of having accepted industry standards. DoD has also revised Unified Facilities Guide Specification (UFGS) 06 10 00, Rough Carpentry, to include structural-grade plastic lumber products. The applicable section of the specification reads as follows:

> 2.1.5 Plastic Lumber
>
> HDPE lumber must contain a minimum of 90 percent total recycled content. Mixed plastics and cellulose lumber must contain a minimum of 100 percent total recovered materials content, with a minimum of 50 percent post-consumer recycled content. HDPE/fiberglass lumber must contain a minimum of 95 percent total recovered materials content with a minimum of 75 percent post-consumer recycled content. Other mixed resin lumber must contain a minimum of 95 percent total recovered materials content with a minimum of 50 percent post-consumer recycled content. Provide data identifying percentage of recycled content for plastic lumber.

In addition to pursuing the use of recycled plastic lumber in such pioneering structural applications, DoD has updated existing UFC and UFGS, as well as published new UFGS, to provide for, and promote the use of, recycled plastic lumber in more typical applications. These technical documents include:

UFC revised to allow use of recycled plastic lumber:

- UFC 4-151-10: General Criteria for Waterfront Construction
- UFC 4-152-01: Design: Piers and Wharves
  Excerpt:

> **4-1.4 Composites.**
> Composites made of concrete and steel, concrete and fiberglass, plastic and fiberglass, and plastic and steel have been successfully employed in piers and wharves. Composites offer many advantages over conventional materials but often have limitations that need to be considered. Some advantages may include improved corrosion resistance, lightweight, and ease of construction. Some of the disadvantages may include low strength, UV light deterioration, long-term durability and high cost.
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> **4-1.6 Plastics.**
> Fiberglass-reinforced plastics (FRP), ultra high molecular weight (UHMW) plastics, and high-density polyethylene (HDPE) are being increasingly used in waterfront construction. FRP grating and shapes

are highly durable in the marine environment when shielded from ultraviolet rays. UHMW plastics are useful in fender systems design as rub strips where a high abrasion resistance and low coefficient of friction are required. UHMW plastics are available in various grades. The use of corrosion-resistant FRP components including reinforcing bars, prestressing tendons, structural shapes, and unidirectional or woven fabrics, are being developed and have been successfully used in the repair of piers and wharves. Consider using these materials when the situation warrants, but give special attention to the design of connections. Carefully evaluate the use of FRP components as structural elements for new construction.

5-3.2.4 Composite Fender Piles.

There are two primary types of composite fender piles. One type of composite pile is made of fiber reinforced plastic (FRP) in the form of a tube that can be filled with concrete for greater strength and stiffness. Figure 5-6 shows an FRP fender pile system. Because of a higher susceptibility to abrasion and impact damage, the thermoset FRP tube type pile should have rubberized abrasion strips installed at potential contact points with berthed vessels.

The second type of composite pile is made of thermoplastics (such as high-density polyethylene, HDPE) and reinforced with either steel or FRP strands. Figure 5-7 shows a plastic fender pile system. The reinforced thermoplastic type pile generally exhibit larger load-deflection properties compared to conventional wood, steel or concrete piles.

Figure 3: Plastic Fender Pile System
Plastic piles, plastic block, cylindrical rubber fender, and floating plastic log camel. (*Marine Fender Systems*).

- UFC 4-152-07: Design: Small Craft Berthing Facilities
  Excerpt:

  6-4.2 Anchoring Floating Docks.
  Floating Docks may be constructed of many types of materials, similar to fixed docks. In addition, plastic and fiberglass materials are finding increased use in floating dock construction. Modular factory fabricated floating dock systems are now in common use. Figure 6-7 shows some typical fabricated floating dock systems. Consideration should be given to using an appropriate commercial product, preferably one with a proven track record over many years of experience. The basic dock structure consists of the flotation pontoon, the structural frame, the deck, and the anchorage. In some proprietary systems the flotation, frame and deck are unitized so that system assembly consists essentially of bolting the modular pontoon units together. The basic dock structure should be finished with all of the appurtenances noted previously for fixed piers.

6-5.2.1 Horizontal Rub Rails.
Generally a continuous recycled plastic lumber, rub rail running the full length of the berth is attached wherever a vessel can contact the pier or dock. Additional protection may be provided by means of a continuous vinyl bumper strip attached to the top edge of the rub rail, largely to reduce marring of the vessel hull, but also to provide some cushioning.

UFGS revised to include recycled plastic lumber:

- UFGS 06 10 00: Rough Carpentry
- UFGS 11 68 13: Playground Equipment
- UFGS 12 93 00: Site Furnishings
- UFGS 32 18 16.13: Playground Protective Surfacing
- UFGS 35 59 13.16: Marine Fenders
- UFGS 35 59 13.19: Arch-Type Rubber Marine Fenders

New UFGS specific to recycled plastic lumber:

- UFGS 35 20 15: Fiber-Reinforced Plastic (FRP) Composites for Low-Head Water Control Structures
- UFGS 35 59 13.14 20: Polymeric Piles

The Department continues to pursue applications of this unique construction material consistent with the mandate to acquire life-cycle cost-effective facilities in support of resilient defense installations.