The Use of Commingled Plastic Lumber as Construction Materials

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Introduction

A combination of increased environmentalism and decreased landfill capacity in recent years has increased efforts aimed at avoiding land filling post-industrial and post-consumer plastics. This has resulted in creating a supply of impure plastics at much reduced prices with respect to virgin plastics. The possibility exists to clean these materials and separate them for reprocessing, but at present this is only commercially achievable for limited cases. These mixed raw materials are particularly well suited for manufacturing bulky, thick items where imperfections would be of little consequence.

The opportunity to use this low-cost raw material has been seized by between twenty and thirty producers of commingled plastic lumber, but the demand for the finished goods has fallen quite short of expectations. The reasons for this limited demand are many and varied, and cannot be overcome by anyone of the producers themselves. As a result, many of the entrepreneurs in this fledgling industry have fallen upon hard times. An integrated effort by producers, university researchers, and the US Army Corps of Engineers is underway to facilitate applicability of these materials for the construction industry.

Current Problems-Demand Driven

Potential users of commingled plastics materials have encountered a number of problems when considering using this material instead of more traditional construction materials. These problems center around the lack of design work, property identification, and standards.

Of paramount importance in these litigious times, is that no engineering or professional organization recommends the use of commingled plastics materials for any purpose, including construction materials. Of course, this implies that there are no guidelines to follow when using this material for construction. As a consequence, any failure of a construction site using these materials, which would result in injury or property damage, would be rather inviting to those employed in the compensation industry. Furthermore, there are no standard designs that have been proven for these materials. No construction code approvals exist for commingled plastics. New materials and technologies are adopted slowly in the construction industry, and require construction/engineering guidance to follow.

In addition to these engineering-related problems is the issue that the price of commingled plastics per board-foot is generally higher than wood, varying quite a bit from manufacturer to manufacturer. This is perplexing to the potential user of commingled plastics, especially since many of the commingled producer's products look very similar. In fact, there are a wide variety of raw materials that are currently processed into commingled plastic lumber in the United States, including wire and cable scrap, LDPE/wood, milk bottles, mixed post consumer bottles, and industrial engineering resin scrap. The wide range of modulus values for commingled plastics produced at Rutgers University's Center for Plastics Recycling Research (CPRR) with different feedstocks is shown in Figure 1. How the manufacturers' products vary from batch to batch is yet another issue.

Current Problems-Supply Driven

Even the best qualified and most influential of commingled manufacturers face a daunting array of problems in trying to achieve adoption of their material for construction uses. There are no standard (or appropriate) test methods available for commingled plastics. This is related to the facts that 1) inclusions (voids, metal particles, and non-melted polymer chunks) are present in these materials, [1] and 2) a skin-core type of morphology is developed in the products during molding. Even if the material properties were known and verifiable, a grading system to allow easy and proper matching of the right material for each load-bearing construction use is not in place. It should be noted that God (or Mother Nature) already has taken care of many of these problems for wood for the traditional lumber producers/users. That is, each tree produces a different type of wood, which has properties that fall within an established range of values.

Equipment that is used to manufacture commingled plastic lumber is specialized, and much new technology has been developed only in the last few years. The effect that these different machines and manufacturing techniques have on the properties of commingled plastic lumber is not well known.

The lack of an easy mechanism for adoption of commingled plastic lumber by the construction industry has created a situation where the supply of these materials exceeds the demand. This has an obvious economic result on this fledgling industry.

Things That Could Work in Favor/Disfavor of Plastic Lumber

Several important circumstances may contribute to the ultimate success or failure of the use of commingled plastics as a construction material. These are discussed below.

Commingled plastics materials are expected to have increased longevity as compared to wood and treated wood in most situations. Because of this higher durability, life-cycle costs can be considerably lower for commingled plastics than for treated wood for the same application. On the other hand, all synthetically produced polymers have lower modulus as measured along the grain than even softwoods (which are at least 1 million psi).

An environmental issue is that creosote and CCA (chromated copper arsenate) treated wood are both hazardous materials. In fact, in many parts of the United States, a damaged structure made of these materials must be discarded in a hazardous waste landfill. Initial toxicity results for commingled plastics produced at Rutgers University's CPRR from post-consumer material show that these materials are considerably less toxic than CCA treated lumber (2). It may be possible to recycle commingled plastics structures by granulating them and reprocessing the materials.

It is interesting to note that the rivers of the United States are generally becoming cleaner, due to the increased restrictions on pollutants released by manufacturers. In New York City, this cleansing of the Hudson River is evidenced by the return of natural marine wildlife. Unfortunately for the Port Authority of New York and New Jersey, some of this wildlife is very destructive to wooden structures in the harbors. Figure 2 shows the increase in marine borer activity on the cross-sectional loss of timbers for the years 1974-1990 (3).

Even though there are currently no standards and design guidance for the use of commingled plastic lumber in place, these can be adopted and developed. There is a serious need for standardized materials specifications and design guidance so that the construction industry understands the properties of plastic lumber and can put it to use in appropriate applications. Towards this end, a joint project to help the industry is currently being undertaken by Rutgers University, the US Army Corps of Engineers, several commingled plastics manufacturers, and a fastener manufacturer.

Project Tasks To Help The Industry

The above-mentioned project has targeted several specific tasks aimed at helping improve the potential acceptability of commingled plastic lumber for construction applications. The tasks are divided into laboratory and field studies, and the most valuable information is expected to be developed from combining these two types of studies.

An evaluation of the products manufactured by US commingled plastics producers will be conducted as a first step in the project. Test methods suitable for reliably measuring the properties of commingled plastics will be developed. Mechanical property standards and specifications will be developed. Studies to determine and easily predict the long-term performance of plastic lumber (degradation, creep, stress relaxation, etc.) will (hopefully) be conducted. Guidance will be developed for the use of fasteners for use in constructing commingled plastics structures.

After the preliminary laboratory experiments yield results, field trials and demonstration construction will be carried out at a number of locations. The performance of these field trials will be related to the laboratory data to develop design guidance for the use of plastic lumber.

Information that is developed will be disseminated to the potential user communities of commingled plastic lumber. These communities will include construction, product manufacturing, scientific, and related areas.

The project is expected to have several end results or benefits associated with its completion. Material standards, test methods standards, and design guidance will be developed for the use of commingled plastics. Opportunities for the plastic lumber industry to survive and grow will open up. Commingled plastics will have the opportunity to displace more environmentally dangerous materials. By processing materials that would otherwise be land filled, increases in production of commingled plastics lumber will reduce the amount of plastics going to landfills. If the commingled plastic lumber industry has a chance to grow, an atmosphere will be provided which will lead to new, innovative products and processes.

The Future

The issues and problems facing the commingled plastics industry are complex and difficult to overcome. By themselves, the manufacturers have not been able to overcome all of these problems, and, indeed may not be able to. The authors of this paper believe that the coalition which is assembling has a much improved probability of achieving success in creating a system for construction acceptability of commingled plastic lumber than the individuals have by themselves. The eventual success of this industry will benefit all and deserves the support of all.

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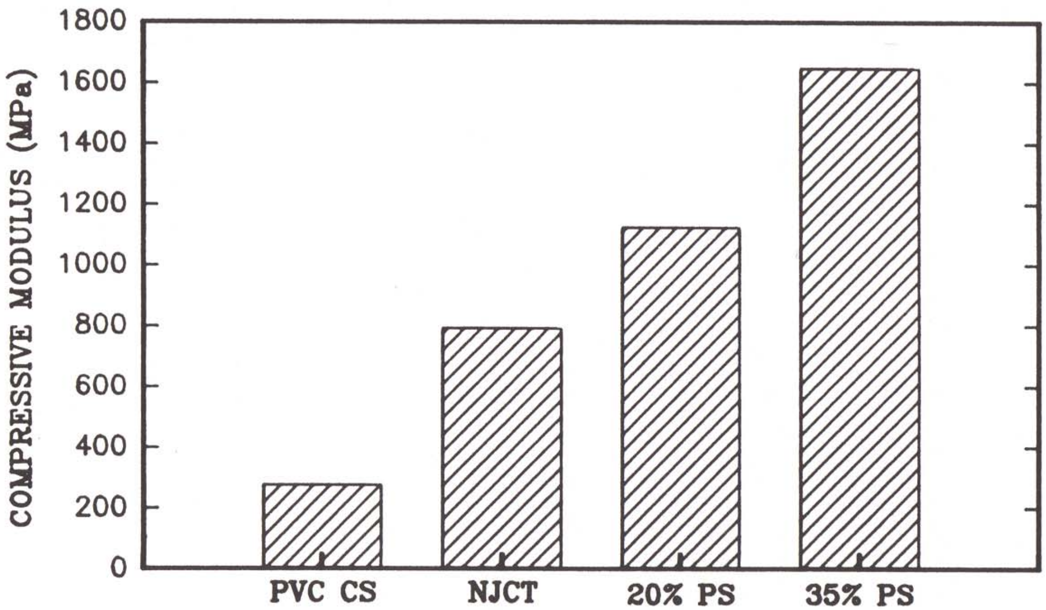

Figure 1: Examples of the wide range in modulus values obtained at CPRR

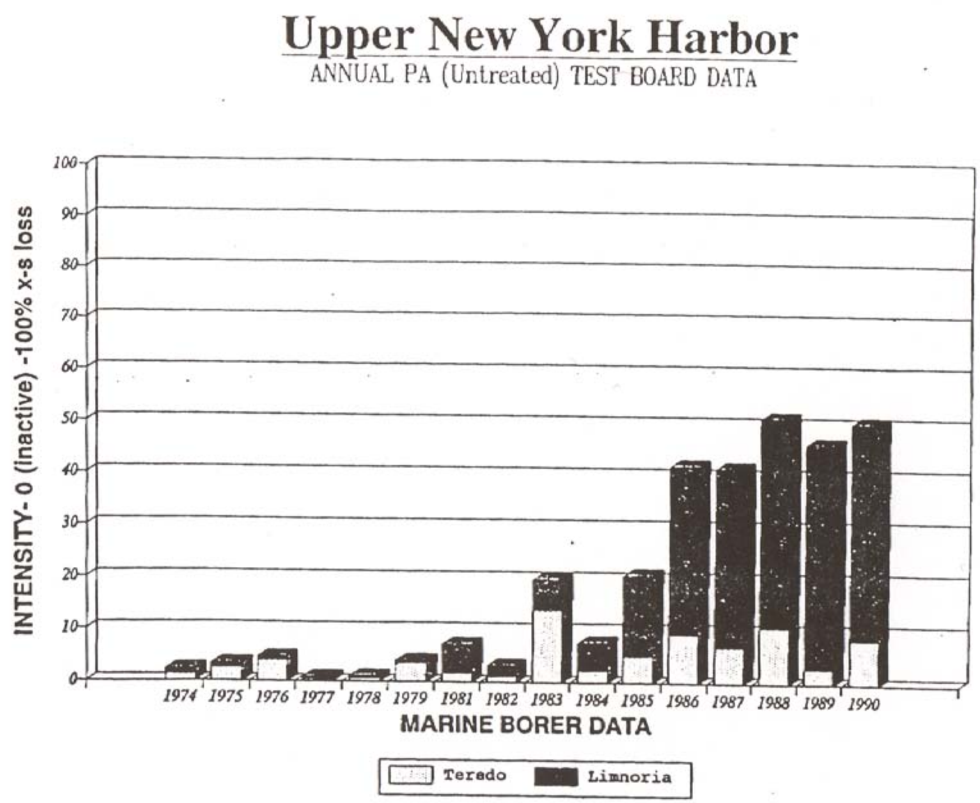

FIGURE 2: Percent Cross-Sectional Loss of Untreated Lumber in New York Harbor Per Year from Marine Borers