WOOD AND FIBER SCIENCE

JOURNAL OF THE SOCIETY OF WOOD SCIENCE AND TECHNOLOGY

VOLUME 37 JANUARY 2005 NUMBER 1

WOOD ENGINEERING/MECHANICS—SOME PERSONAL OBSERVATIONS

My former classmates and roommate, Geza Ifju, who is the Editor of *Wood and Fiber Science*, twisted my arm to write an editorial about the subjects of wood engineering and wood mechanics. After all, he reasoned "You have just received the Forest Products Society's Wood Engineering Lifetime Achievement Award and must have attained some wisdom on this topic after working in these fields for half a century." I had a hard time rejecting his request, so here I am writing this editorial.

Over the years, many editorials and commentaries have been written on the subjects of wood engineering and wood mechanics. What can I write about that has not been already covered? Not much I am afraid, but will try my best. After all over a half a century of professional activities, I have worked on a variety of engineered wood products, such as stress graded lumber, glulam, laminated veneer lumber, particleboard, plywood trusses, timber piling, wood utility poles, I beams, and other wood composites, both in their developments and their field evaluations.

Wood mechanics is the foundation of wood engineering. This subject covers the basic knowledge concerning the effects of forces on the response of the product in question. In addition, a critical area of wood mechanics is the knowledge of the effects of the various environmental factors, such as moisture, temperature, biological agents, etc. on the behavior of wood products. This knowledge is supposed to be embedded in the concept and design of an engineered wood product.

Wood engineering has been around for many centuries. The Romans built timber bridges over rivers more than two thousand years ago. With the industrial revolution, wood engineering flourished. Mine timbers, dock facilities, railroad trestles saw their golden age at the turn of the twentieth century. Glulam members have been used for decades in church and industrial structures. With the arrival of the metal plate-connected trusses, housing construction has been revolutionized. Lately, built-up I beams have further enhanced the field of wood engineering.

Currently, the focus of wood engineering is on the creation of advanced composites. This includes combinations of wood or wood fiber and other reinforcing agents, such as fiberglass or carbon fibers. This type of product is quite complex in composition as well as in behavior.

So, with all this progress in the field of wood engineering, what is left to be accomplished? I am afraid I have a somewhat negative view concerning the progress of wood engineering. I believe that while we made great progress in creating new engineered wood products, we failed in understanding the complex behavior of these products under field applications. This is the area on which I would like to focus my comments.

We are doing a good job of developing new products and mass-producing them, such as I beams and roof trusses. We do a good job of quality control during their manufacture. We even protect them well during their delivery to the job site. However, it is at this point where the problem often begins.

These highly engineered wood products often lie on the ground, exposed to the elements for relatively long periods of time. Then, when installed, they are installed with typically low skilled labor, ignoring many of the installation details needed for satisfactory performance. Just ask any of the wood engineering consultants, who make a living inspecting damaged wood structures caused by improper installation. Invariably, moisture penetration into the structural components causes the most damage. Most often, the problem manifests itself in swelling, warping, sagging, and biological deterioration. For example, the concept of all-weather wood founda-

Wood and Fiber Science, 37(1), 2005, pp. 1–2

tion is a good idea. However, its complex installation requirements create enough opportunities for errors that one cannot trust that the product is installed properly.

As is well known through wood mechanics, water affects every aspect of engineering properties of wood products. Be it strength, stiffness, creep, dimensional change, biological deterioration, etc., they are all altered by the presence and change in moisture. Regular detailed maintenance is required to control the migration of moisture and to minimize its effect. Unfortunately, very few installed engineered wood structures receive regular maintenance. The result is a failure of the structure, which is blamed on the wood product itself and not on the lack of maintenance.

Newer engineered wood products, mostly in the form of reinforced composites, are hitting the market lately. While these products offer special engineering and economic advantages, they are more difficult to manufacture and to apply effective quality control on them during their manufacture. Once these products are in use, they are hard to evaluate as to the degree of damage caused by their deterioration. Inspecting a more complex wood composite in use is difficult, to say the least. Pity the poor inspector who will need to quantify the degree of damage and to make recommendations as to the repair method needed for an advanced wood composite.

Lately, the wood science profession is paying more attention to the inspection and maintenance of wood structures in general. Several conferences are being held on these topics. These efforts should yield some tangible benefits in the performance of engineered wood products.

In conclusion, I want to state that in one man's opinion, we need to refocus our development effort of engineered wood structures to their installation and maintenance, instead of continuing to develop newer, more exotic products the long-term performances of which are not yet understood. We need to pay much more attention to the issue of moisture in engineered wood structures. Every effort should be made to keep water out of the structure. There are plenty of issues associated with water penetration of already existing wood products, especially when it comes to their installation and maintenance. Neither the installation details nor the maintenance programs can be overlooked if one is to provide long-term satisfactory performance for engineered and secondary wood products.

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