FOLIA FORESTALIA POLONICA
Seria B, zeszyt 27, 1996

TIMBER CONSTRUCTION BETWEEN TECHNIQUES AND ECOLOGY*

Jean Luc Sandoz, Julius Natterer

Swiss Federal Institute of Technology in Lausanne

Problem of mutual links between the technical uses of wood and the ecology are broadly enlighted and thoroughly discussed. The resulting opinion stated that the technical characteristics of timber perfectly meet vital requirements of the modern structural engineering. On the other hand, wood is an ecologically friendly material, self renovable in the forest, quite easily available and well competing with many other materials. For all these reasons it is not only traditionally favoured but also presently most esteemed as structural material.

Key words: renewable raw material, demographic pressure, ecological effect, new technologies

INTRODUCTION

Since the summit of Rio de Janeiro, Brazil, in June 1992, new considerations have been approached in terms of development regarding society, technology and environmental effects. A concept of sustainable development have been agreed by every country, meaning that the projection of our development in a long term does'nt affect the nature in irreversible way.

The well known favourable ecological role of forest mainly consists in lowering the harmful surplus of the CO_2 share in the atmosphere. Also the wood yielded by forests is self-renovable raw material, widely dispatched over the surface of our planet. So, its local use is quite easy, needing no long transportation distance. It is also well suited to the use in building structures and in many engineered constructions. Accordingly, wood based products - first

* The paper presented at the Symposium on Wood As Engineering Material in 50th Anniversary of Wood Technology Faculty in Warsaw Agricultural University SGGW, on February 16th, 1996.

of all the timber itself - may be considered as providential materials, perfectly meeting the ecological needs, not only as a traditional fuel but also as a competitive structural material.

These fundamentals are positive for timber construction, for facing the needs of the society, even including demographic pressure, but at the same time timber construction has to integrate the last scientific and technologic developments in order to be actually efficient.

DISCUSSION OF THE PROBLEM

Ecology

At the summit of Rio de Janeiro, Brazil, in June 1992, concern with the interactions between development and environmental questions for the planet, it has been concluded on two main points: firstly, the increase CO_2 emissions would be, at short , associated to climate changes, and secondly the drastic reduction of the tropical forest will add the first conclusion. The second conclusion was much more related by the media, and then conceal the first one, to bring at the public that the main problem was the planet deforestation, fig. 1.

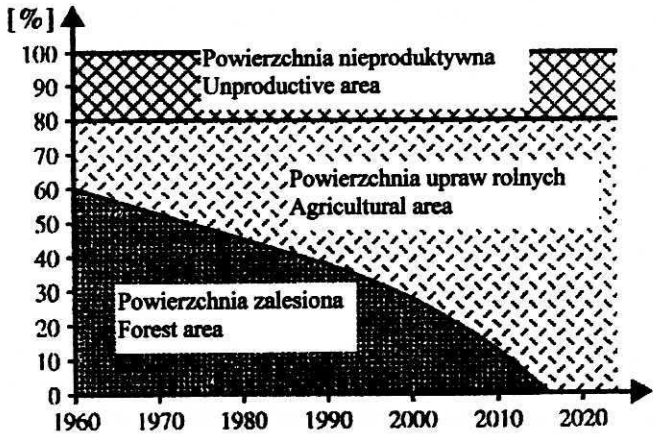

Fig. 1. Evolution of the tropical forest area versus time, for a scenario of demographic growth of 2.5% per year and agricultural productivity constant [Sing 1993]
Rys. 1. Przebieg zmian w powierzchni lasów tropikalnych przy założonym wzroście demograficznym na poziomie 2,5% rocznie i stałej produktywności rolniczej [Sing 1993]

In fact, the scientific considerations relative to CO_2 emissions and forest interactions were already discussed in Paris in September 1991, at the occasion of the 10^{th} word forestry congress. At the Paris declaration, its written that deforestation is more the under-development problem of local societies associated to an demographic pressure than a forest exploitation problem. It is although noted that everywhere in the world, we have to increase the forest

potential as technique for CO_2 fixation, as well as to use wood products as an alternative development material [Anonimus 1991].

The ecological problem of CO_2 emissions and the associated climate change effects were recently treated on the summit of Berlin, in Spring 1995. There, it was confirmed that forest was a chance to contribute to CO_2 fixation. Incidentally it was demonstrated that CO_2 reductions will be associated in the future to a global change of resources management and to a switch from fossil raw material and energy to natural renovable resources.

Demography and resources

The global causes of the actual discussions on ecology and environmental perspectives are related to demographic pressure and historic resource management. It has been observed for example that CO_2 in the atmosphere and demographic evolution curves versus time, were superimposable. That means, at least, that ecology is strongly dependent of demography. Futhermore, it is admit that CO_2 in the atmosphere is basically produce by the industry, and then by the North hemisphere. At the same time, fossil reserves are observed to be more and more limited for the future, and the next century will cross the point of inversion between needs and reserves. These considerations drive to the general picture, fig. 2, showing fossil resources, demographic, CO_2, and energy need evolution versus time. Parallel, the XX^{th} century has been observed as a weak period for wood product consumption, fig. 3. This can be explained by the explosion of new synthetic derived material, and by the general use of fossil energy (petrol, gas, ...) in place of wood energy. Consequently, the forest reserves in the North hemisphere are larger as never, and almost any countries are registrating a growth rate between 0,5% to 2% the year, as its shown on fig. 4.

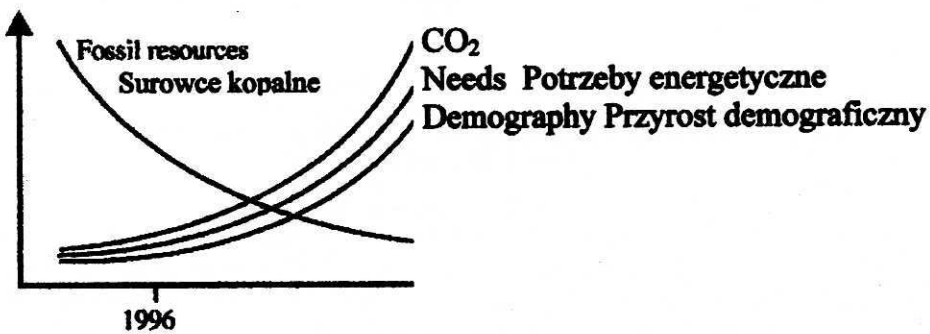

Fig. 2. Tendencies of the evolution of fossil resources, CO_2 athmospheric, energy needs and demography versus time

Rys. 2. Kierunki zmian w zasobach surowców kopalnych i atmosferycznego CO_2 oraz wskaźniki zapotrzebowania na energię i zmiany demograficzne

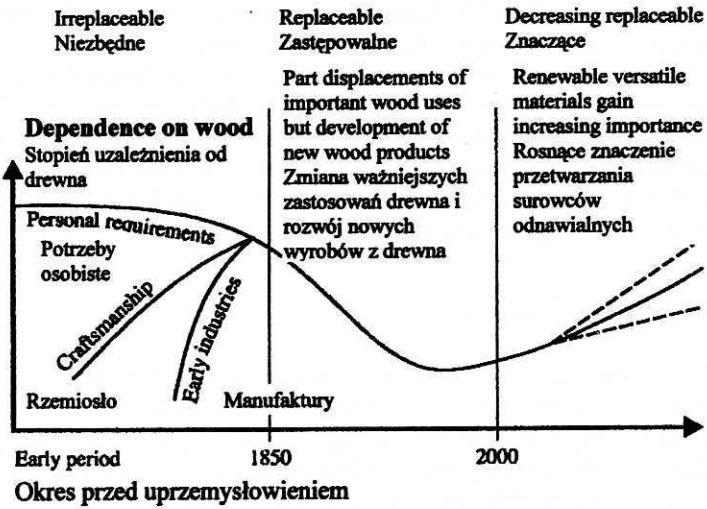

Fig. 3. History of wood utilisation showing the three phase evolution [Schulz 1993]
Rys. 3. Historia użytkowania drewna przedstawiona w trzech fazach rozwojowych [Schulz 1993]

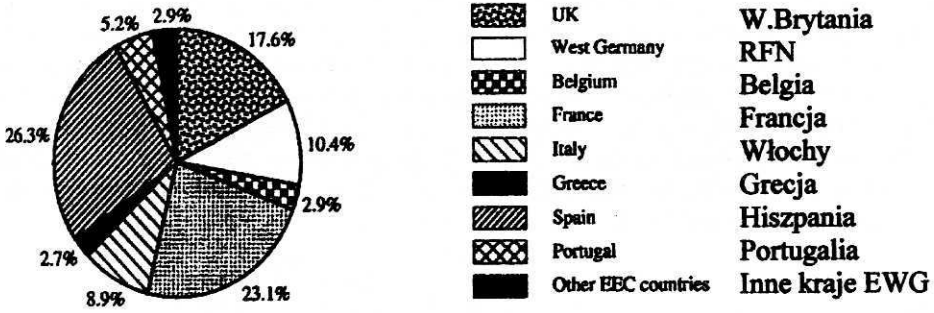

Fig. 4 Volume growth of forest reserves in european countries, for the period 1980-2000 [Leveque, Péguret 1988]
Rys. 4. Przyrost zasobów leśnych w krajach europejskich w latach 1980-2000 [Leveque, Péguret 1988]

This situation shows that forest can support more exploitation, at least in North hemisphere and can furnish a renovable raw material, as a key for the problem discussed fig. 2. Furthermore, the actual forest reserves on the North Hemisphere are leading to an ageing effect on the forest. Consequently, more harvesting is needed from the ecological point of view as well. Based on that, timber constructions are filling the requirements for a sustainable development for the next century. Nevertheless, new technology have to integrated modern constructions, in order to promote wooden constructions.

New techniques in timber construction

New techniques in timber construction have to be improved in two main directions. Firstly, in the reliability domain regarding structural applications, and secondly in construction systems, like prefabricated elements, in the economic and competitive area.

From the reliability point of view, one of the first requirements is a better grading or a better quality control of the individual members. It concerns both solid timber and glued laminated timber. Using NDT (non destructive testing) methods, several new technologies have been developed in the last 10 years. Because of its large potential of application, the ultrasonic method is one of the most efficient. Fig. 5 shows the ultrasonic device Sylvatest®, applied for timber, and useful for tree evaluation or diagnose of existing structures as well. New high performance strength classes have been introduced in Switzerland, based on ultrasound, since already six years. Now, ultrasonic quality classes are linked to the new European strength classification.

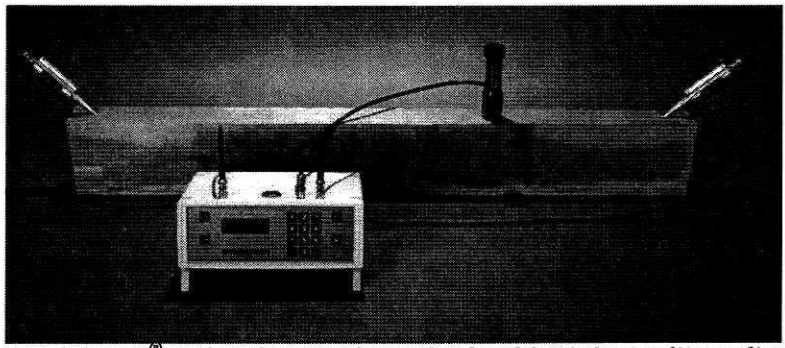

Fig. 5. Sylvatest®, timber ultrasonic device, developed for timber quality grading and tree evaluation
Rys. 5. Sylvatest® do jakościowego sortowania drewna na zasadzie przewodzenia ultradźwięków w tarcicy i pniach drzew

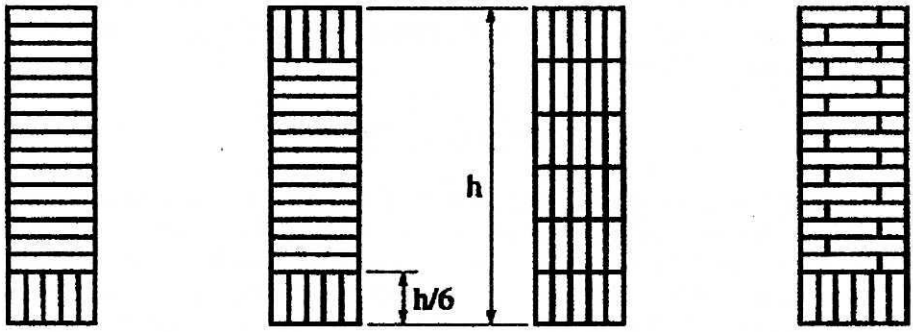

Fig. 6. Different execution modes of Multi Glue Laminated Timber (MGLT) [Sandoz 1994]
Rys. 6. Drewno wielowarstwowo klejone (MGLT) w różnym wykonaniu [Sandoz 1994]

Using high quality plank, glued laminated timber can be improved in the direction of modulus of elasticity. For improving bending strength, the multi-glue laminated timber have been developed, fig. 6. Reinforced by a vertical laminate sole, bending and transverse compression strength are strongly increased, because mechanical variability is much reduced. Furthermore, the depth effect is reduced as well.

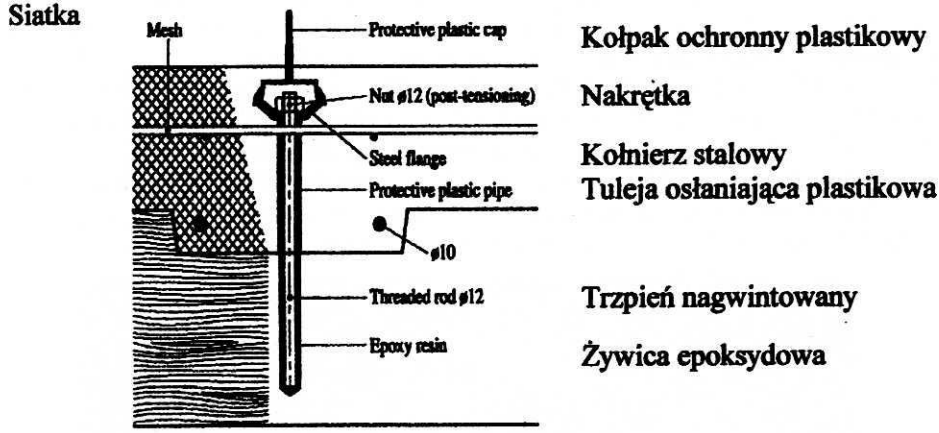

Fig. 7. Adapted connector for the structural application of mixed timber concrete floor for multi-storey buildings [Natterer, Herzog 1991]
Rys. 7. Łącznik używany przy montażu podłóg drewniano-cementowych w budynkach wielokondygnacyjnych [Natterer, Herzog 1991]

New structural systems have been recently improved for floors. In place of concrete floor, multistorey buildings can be erected using mixed timber-concrete floor, linked together by a special connector as show fig. 7. This system allows to strongly reduce concrete needs, and purges steel out of floor. Timber is working in tension, concrete in compression. Beside ecological interest, this system is economical in the way that structural timber can be the finished ceiling. Because of the plate surface, fire behaviour is no longer a limit for the wood structural component.

RECAPITULATION

Construction is an economical sector of our societies which is strongly involved in the new considerations of the sustainable development of the planet, as it was defined in Rio de Janeiro in 1992. Timber, as a renovable material deduced of a large forest resource potential is leading as a providential building material for the next century. That is for the green side (ecology), in relation to forest management and demography needs.

On the technical side, timber as a building material has to be modern and competitive. That is the reason for developing new high performance materials like the multi glue laminated timber for example, or for improving systemati-

cally timber performances by ultrasonic grading, applied to round timber, sawn timber and glued laminated timber. On the other hand, constructive systems like floors and walls can now be done using timber. There are for example, the massive plank floor or the mixed timber-concrete floor system. Integrating new technologies, timber construction is becoming modern, and can be an answer to the architectural needs. Timber constructions design between techniques and ecology will have, more as ever, a new chance in the next century.

REFERENCES

Anonimus (1991): Forest, a heritage for future. Acts 9 of the X^{e} Wood Forestry Congress, F - Paris, June 1991. Révue forestiére franaise. ISSN 0035-2829.

Singh K. D. (1993): The 1990 Tropical forest resources assessment. Unasylva 44(3): 10-19.

Schulz H. (1993): The development of wood utilisation in the 19th, 20th, 21st centuries. Forestry chronicle 69 (4): 413-418.

Sandoz, J. L. (1994): Reliability assurance of structural timber using ultrasound. First European Symp. on Nondestructive Evaluation of Wood. Sept. 21-23., Sopron, Hungary.

Sandoz, J. L. (1994): The multi-glue laminated timber. Pacific Timber Eng. Conf., Gold Coast, Australia. June 11-15.

Natterer, J,; Herzog, Th.; Volz, M. (1991): Holzbau Atlas Zwei. Institut für internationale Architektur-Dokumentation GmbH. München.

Leveque, F., Péguret, A. (1988): Forets et industries du bois. Economica.

TECHNICZNE I EKOLOGICZNE UWARUNKOWANIA KONSTRUKCJI Z DREWNA

Streszczenie

Konstrukcje drewniane są przyjaznym naturalnemu środowisku wytworem pracy ludzkiej, jak to wykazano w Rio de Janeiro w 1992 roku. Drewno, jako materiał odnawialny z olbrzymią bazą surowcową, będzie również materiałem budowlanym dwudziestego pierwszego wieku. Zarówno potrzeby wzrastającej populacji ludzkości, jak i zasady gospodarowania zasobami leśnymi, powinny uwzględniać ekologiczne aspekty użytkowania drewna.

Z technologicznego punktu widzenia drewno, jako materiał budowlany, powinno być konkurencyjne w stosunku do innych materiałów. Wymóg ten spowodował rozwój nowych, ulepszonych tworzyw w rodzaju np. drewna klejonego warstwowo, a także stymulował upowszechnianie nowoczesnych metod jakościowego sortowania drewna okrągłego, tarcicy i elementów klejonych - także przy użyciu techniki ultradźwiękowej. Tarcica konstrukcyjna jest wykorzystywana m. in. na podłogi i ściany budynków, które mogą być jednak wykonywane również z płyt cementowo-drewnianych. Poprzez integrację różnych technologii konstrukcje drewniane stają się coraz bardziej nowoczesne i lepiej zaspakajają intencje architektów. Projektowanie konstrukcji drewnianych w aspektach technicznym i ekologicznym ma, jak nigdy wcześniej, nowe szanse w nadchodzącym stuleciu.

Author's address:
Jean Luc Sandoz, professor
Julius Natterer, director
Swiss Federal Institute of Technology
IBOIS - Chair of Timber Construction
CH-1015 Lausanne SWITZERLAND