Chapter 1
Introduction

The aim of this monograph is to present the opportunities of using wood as construction material in which both the architects and the designer can achieve various useful, cheap and aesthetic facilities, even for the most fastidious user.

In modern times, wood is a re-discovered material due to its mechanical and eco-friendly properties. Wood is the unique construction material the production of which is accompanied by the absorption of many environmental pollutants, including carbon dioxide. In the photosynthesis reactions, in the presence of light, there follows the bonding of water collected by wood from soil and carbon dioxide from air. The products of this reaction are carbohydrates and oxygen. The generally known reaction follows according to the scheme:

$$6H_2O + 6CO_2 + \text{solar energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

While growing and increasing their weight, trees supply oxygen to the atmosphere. Wood is the unique construction material renewable in a friendly way to the atmosphere, and even reconstructing this environment contaminated by the heavy industry products, which was described by the authors Krutul D., Kozakiewicz P., in the publication [1] (1998).

As a comparison, the production of steel (from ore, e.g. Fe_2O_3—hematite of the highest iron content), used commonly in building industry, consists in the reduction with coal of oxide ores, supplying huge amounts of carbon dioxide to the atmosphere—CO. The simplified scheme of the metallurgical process is reduced to the reaction:

$$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO,\ Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2, C + CO_2 \rightarrow 2CO$$

Besides, wood is a construction material that is relatively easily treatable. Structures made from wood can be combined and adapted on the construction site, sometimes by the economic way, with the use of the simplest tools.

B. Misztal, *Wooden Domes*, https://doi.org/10.1007/978-3-319-65741-7_1

Wood is a particular construction material, richly provided by nature. The detailed learning of the structure, biology, chemistry and mechanical behaviour of wood under various environmental conditions, allows its correct application. The comprehensive testing was conducted within this scope at the Faculty of Wood Technology of SGGW, Warsaw University of Life Sciences. Professor Krutul D. with his team specifies the quantitative share of microelements, including metals, in the wood structure, e.g. [2] (1996) [3] (1996). The chemical structure affects the resistance or susceptibility to corrosion, e.g. biological corrosion.

The increase in the durability of wooden structures, especially prestigious ones, can be achieved by using natural defensive mechanisms of wood, by resigning from some methods that destroy its structure, in particular mechanical properties. The susceptibility of wood to external factors can be used, revealing its beauty, like in the furniture items by Michael Thonet described by Sassone A. et al. in the work [4] (1997) or by impregnating it, e.g. with vacuum-pressure methods, destroying its mechanical properties.

In this area, particularly valuable is the testing carried out by the team of Bednarek Z., Kaliszek-Witecka A., demonstrating the destructive impact of salt impregnates on the properties of wood. The test results were described in the work [5] (2004) revealing that salt preparations used for wood impregnation decrease its strength. This information is of basic importance in the securing of wood used in the construction of thin-wall shells, including domes.

Among many systems built from wood, domes have been selected, as the most advanced technologically types of wooden structures. Their historical development has been tracked, pointing out to optimum solutions, suitable for a general application.

The shaping of domes from solid wood differs from that of domes made from other materials. It requires some knowledge on the realization of wooden elements of load-bearing constructions, on connections, on the geometrical shaping of the dome sphere adapted to the properties of wood.

Since the dawn of the building trade, prestigious building facilities roofed with domes from solid wood have been known. The cases of catastrophes of such domes for causes other than fires are ignored. Unfortunately, the information on the wooden domes burnt down are fragmentary. Neither are unknown reports about the destruction of wooden domes, e.g. due to biological corrosion.

Wars and random cases produced that those works vanished in fire, also due to the human ignorance. For instance, a fire broke out during the overhaul of the roof of the central dome (Fig. 1.1a) on the building of the Trinity-Izmailovsky Cathedral in Petersburg, crowned with 5 domes. The authors Orłowicz R., Kosiorek M. in their publication [6] (2007) described the impact of the fire on the inside masonry dome. Figure 1.1 shows the view of the domes before the fire and the fire of the central dome.

The outside, wooden structure, shielding the masonry shell, burnt down fully. For the analysis of the masonry dome, just a section of the wooden structure shielding it earlier is attached. The figure of the structure of the burnt-down dome is

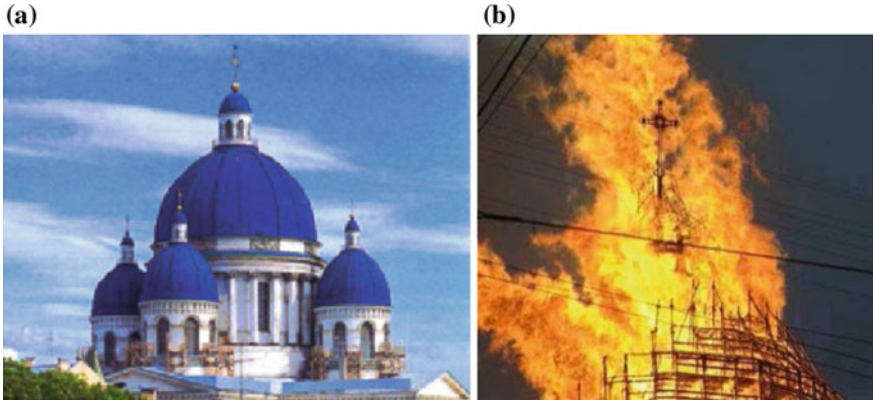

Fig. 1.1 Domes of the Trinity-Izmailovsky Cathedral of 1826 to the design by the architect Stasov V. P. [6] **a** domes of the cathedral before fire, **b** fire of the wooden central dome

shown in Chap. 3 in Fig. 3.17c made up on the basis of [6]. The wooden dome built in 1826 burnt down on 25 August 2006.

Wooden domes are vanishing before our eyes, along with the knowledge that made up their creation. We know about them only from fragmentary, disordered reports by various authors. Most often, the descriptions of the decorations of the dome palate are specified, and not of the structure on which details were made.

Attention, however, should be paid that wooden domes known from laconic descriptions were built with a high feeling of the structural stability and the properties of wood. It is all the more noteworthy that they also were created in the severe, continental climate of Eastern Europe where considerable loads by wind, snow and temperature appear. The research on the development of the structures of wooden domes is not only a tribute paid to the work and skills of the builders, but it also teaches the rational application and fabrication of useful wooden structures in present times.

Domes belong to the building facilities of architecture in which the form was shaped over centuries, while finding the proper structure for them. In this work the development of the structure required to accomplish the form of wooden domes has been discussed. The testing allowing to better learn the properties of wood necessary for their construction have been suggested. The technology based on the mechanics of wood can make the building of domes a cheap and eco-friendly undertaking.

While tracking the development directions in the designing and realizations of domes throughout the world, the author has started her own search for dome structures from solid wood, as eco-friendly structures, created at the minimum wood consumption and associated minimum destruction of the environment. Owing to the research of the literature to describe the existing, but also forgotten facilities, various solutions of domes from solid wood have been tracked, arranging them in a typological series, starting with the roofings of dome-like domes up to thin-wall

shell domes with an imposingly low consumption of material in relation to the surface being covered. Those systems were considered to be an attractive proposal for contemporary researchers, designers and users.

The documentation of many domes from solid wood, and not glued laminated timber, has been reconstructed from rudimentary information found. Models from wood and computer visualizations of forgotten structures have been plotted and built.

It is the intention of the author to summarize the status of the knowledge on the domes made from solid wood, in order to ensure their further transformations based on the contemporary knowledge, using contemporary tools and calculation methods. **Despite many presently accomplished structures from glued laminated timber, the experience in the area of building domes from solid wood is precious and their propagation is recommended**.

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