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DESIGN, RESEARCH AND DEVELOPMENT ON EMERGENCY ARCHITECTURE DESIGNED BY ARCH. SHIGERU BAN

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ABSTRACT

After the outbrak of war in Ukraine on 24th February 2022, the team from Wroclaw University of Science and Technology, with the help of dr Hubert Trammer from Round Table of the New Europen Bauhaus was asked by arch. Shigeru Ban to support emrgency projects for Ukrainian refugees and Internally Displaced People. Interdyscyplinary team took the effor to conduct two project of Paper Partition System and Styrofoam Housing System.

The Paper Partition System works by dividing larger spaces, such as halls, into smaller 2x2m units (Fig. 1). The PPS takes advantage of the ability to realise a large number of temporary shelters in the shortest possible time using environmentally friendly and widely available materials, and due to the simplicity of the solution, no skilled personnel or specialised equipment is required. One unit consists of 8 paper tues, paper joints and fabric surrounding the unit. After the prototype was realised, a further 319 units were created in a few days in the Tesco warehouse in Chelm and 63 units in the BWA hall at Wrocław Central Station, creating spaces that provide privacy during the first days of the migration.

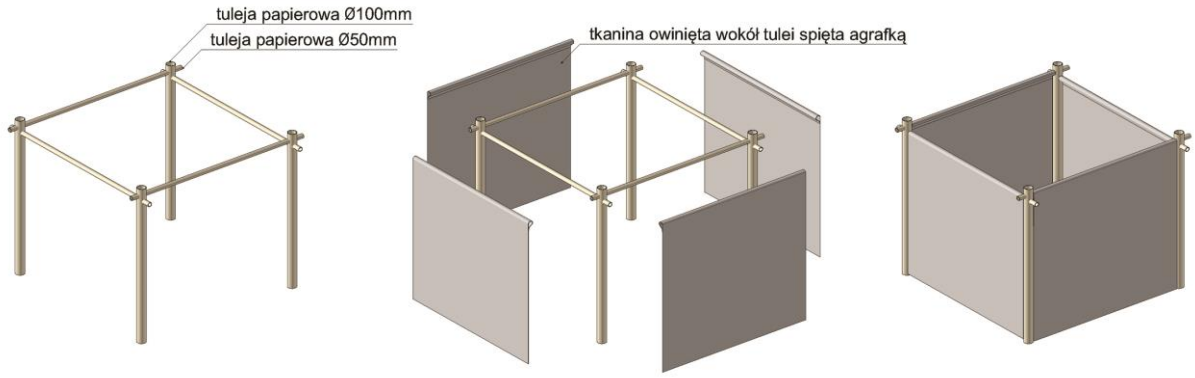

Fig. 1. Paper Partition System

The next step in Shigeru Ban's assistance to Ukraine was the implementation of the Styrofoam Housing System (SHS) (Fig. 2). The SHS is intended to provide more than just a sense of privacy, but to ensure long-term shelter in the form of a single-family temporary house. SHS involves the use of several types of repetitive, prefabricated panels made of EPS styrofoam, epoxy resin and fibreglass, which makes the unit uncomplicated to prefabricate, as well as quick and effortless to install. The materials used to create the SHS are widely available anywhere in the world, they are also relatively cheap, and prefabrication of the panels and assembly can be done by unskilled workers. The design of the modular unit was adapted to Polish-Ukrainian conditions, and then two prototype units were manufactured - in Wrocław in September 2022 prefabricating the panels by hand lamination and in Lviv in June 2023 using vacuum techniques to achieve better panel performance. Acoustic, strength and thermal tests were also carried out on the panels before the second unit was built.

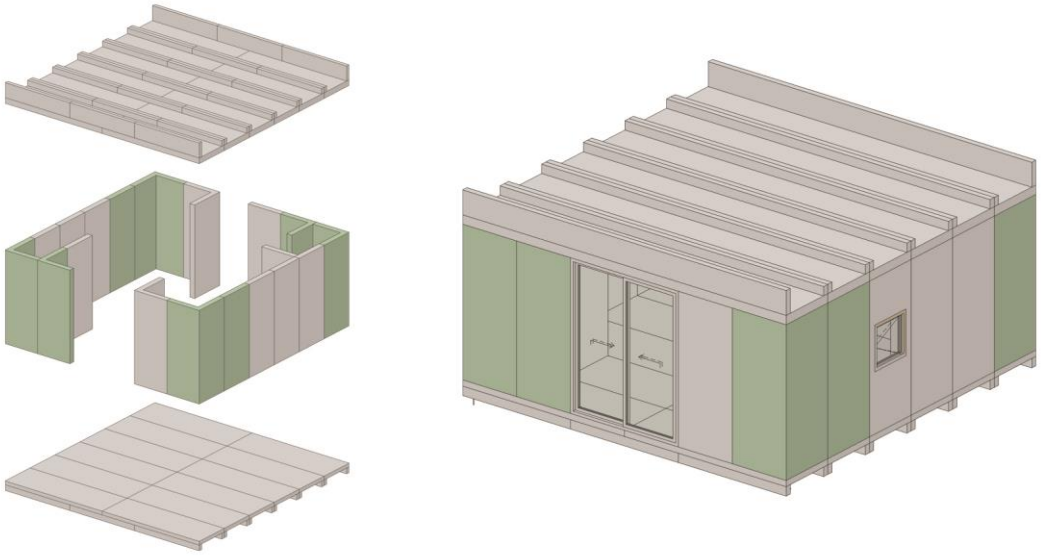

Fig. 2. Styrofoam Housing System

The process of building the SHS prototype in Lviv took three days and was included in four stages. The first was to place the floor panels on a concrete slab which took 8 hours. The second step was to finish the floor with plywood plates which took 6 hours. Then the wall panels were placed on the floor in 6 hours. The last part of assembling the prototype was the location of the roof panels on the walls which took 3 hours. The entire construction process was concluded in 23 hours.

In the structural part of work, the preliminary tests of the mechanical properties for polystyrene samples and polystyrene samples reinforced with laminate of glass fibres embedded in epoxy resin were performed. The main goal of the tests was to study the influence of the addition of layers of laminate on the mechanical behaviour of expanded polystyrene under load. Compression tests and bending tests were performed with the use of Digital Image Correlation method. The obtained results seem to be promising in the context of the possible application of composite panels made of polystyrene and laminate as building partitions.

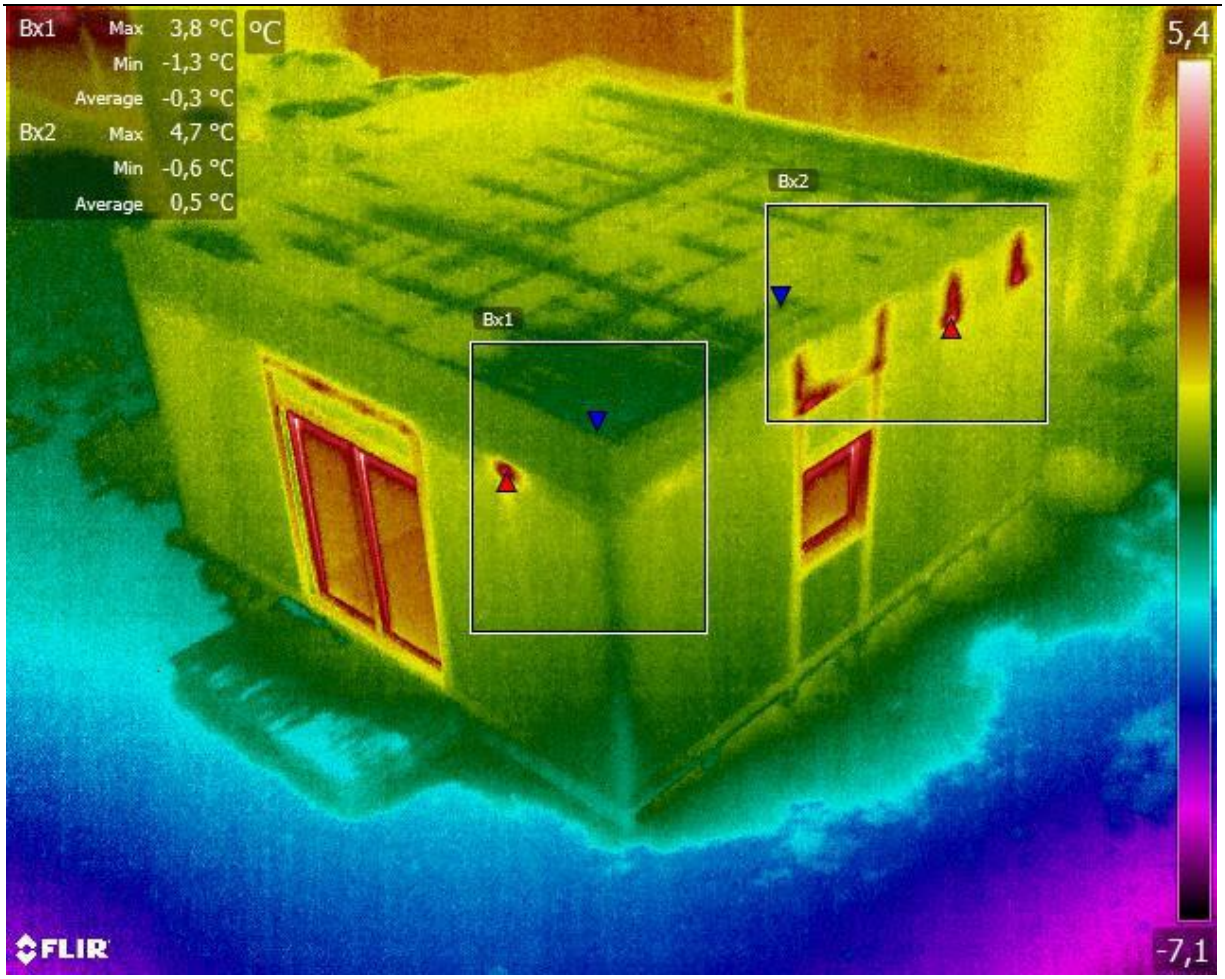

Fig. 3. Thermal image of the SHS

Energy calculations and thermal imaging tests were also performed for the designed aid facility. The entire 3D facility was simulated in the WUFI PLUS software and its demand for heating and cooling energy was verified throughout the year for the Wrocław location.

Additionally, in the winter, thermal imaging examinations of the external walls and the flat roof (using a drone) were carried out (Fig. 3). These tests showed good insulation of external partitions and indicated the location of thermal bridges in the thermal envelope of the building.

The Apparent Sound Reduction Index (R') tests were conducted using the sound intensity method on two representative walls of SHS. The weighted SRI values obtained for the front wall (with a balcony) were R' (C,Ctr) = 17 (-1,-1) dB, while the SRI for the side wall with a window was R' (C,Ctr) = 14 (-1,-1) dB. The analysis indicates that the SRI is notably lower in the frequency range of 1000-2000 Hz. These findings suggest the potential for straightforward enhancement of sound insulation in future works.