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BUILDING WITH MATERIALS FROM DEMOLITION PROJECTS

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ABSTRACT: Students of Eindhoven University of Technology have developed a sustainable and innovative hikers' cabin, called "Trek-In" for SNK, a Dutch coordinating organization of natural campsites. By now, three Trek-Ins are in commercial use, while SNK intends to exploit over 100 Trek-Ins in the coming years. This case study shows current possibilities of recycling in an architectural context, because nearly all materials used are derived from demolition waste materials. The structure as well as inner and outer finishing, but also plumbing, wash hand basin, toilet bowl, light switches, wall sockets, kitchen, et cetera, are all reclaimed from demolitions.A Trek-In exists of two modules that are fully assembled in a factory. The two modules are brought together on-site, where a simple foundation will do. This foundation is also made out of demolition waste materials. Making the foundation and placing the two modules can be done in just one day.The paper describes this exciting students' project from start until realization of a prototypes. Principles of the way demolition waste is applied are also described, as well as the way Trek-Ins are constructed..

Keywords – reuse of demolition waste, industrialized building, sustainable design and detailing, Trek-In

1. INTRODUCTION

In 2010 the Dutch association for hikers' cabins (STN) and the Dutch coordinating organization of natural campsites (SNK) contacted Eindhoven University of Technology (TU/e) for a collaboration to develop a new concept of the hikers' cabin. A hikers' cabin is meant for people travelling from cabin to cabin on foot or by bike, staying one or two nights. SNK is an organization that coordinates hikers' cabins in more than 300 locations in the Netherlands, Belgium, Luxembourg and Germany (STN, 2013). A hikers' cabin is in principle a log cabin, cozy and soberly but practically furnished. Some hikers' cabins have two bedrooms and a separate small bathroom with toilet and sink; others offer only very basic places to sleep. SNK wanted to have a more modern appearance of the outmoded log cabin as well as a pronounced durable expression.

TU/e and SNK made a proposal that was drawn up for SBIR (Small Business Innovation Research - Innovation for Recreation and Space), a grant scheme of the Dutch Ministry of Agriculture, Nature and Food Quality. The proposal was granted twice (phase 1 and phase 2) with a peculiar stipulation: the obligation to not only design but also to deliver a working prototype (NL Agency, 2011), see Figure 1.

Receiving these grants was the beginning of an exciting students' project that took about 2,5 years from the beginning of the design up to the delivery of the prototype. The two authors participated in this case study from beginning to end; Faas Moonen as initiator, already involved in describing the SBIR proposal, but also involve as one of the students' tutors, and Kristel Hermans as one of the students who is involved in every aspect of this case study.

Figure 1. final result: Trek-In exposed at the Dutch Design Week in Eindhoven

2. DESIGN PHASE

The project started with an open competition, inviting students of several departments and institutes to submit a design concept for a durable hikers' cabin. This competition was won by two students of the Department of the Built Environment of Eindhoven University of Technology: Tim van der Grinten and Xaviera Burón Klose. The winning design was based on the concept that refers to the jagged tent structures that can be found on campsites. Another important design theme was the balance between closed and open. Closed on the one hand to create a sheltered place that provides privacy, and open on the other hand, to be one with the environment. Since the competition resulted in only a concept, it was decided to make this the subject of a multidisciplinary studio where six students would collaborate in a semester project to further develop the concept. This multidisciplinary studio was very special because of the subject, but also because how the design team was made up: the winners of the competition Tim and Xaviera (at that time 1st year MSc-students coming from Higher Professional Education) collaborated with Kristel Hermans (a 1st year MSc-student), and Wendy van Kessel, Paul Kemme and Luuk de Kluiver (at that time 3rd year BSc-students). Tim & Xaviera were focusing on Architecture, Kristel & Wendy were focusing on sustainable building technology and Paul & Luuk were focusing on energy-friendly solutions for services. This curious mix of students, disciplines and the unusual subject turned out to be a real challenge in the beginning. Already after some weeks the six students managed to find a through spirit of cooperation that led to an outstanding result. In 2011 they even won the WoodChallenge 2011 with this design for the Trek-In (Juryrapport WoodChallenge, 2011; Hermans & Burón Klose & van der Grinten, 2012; WoodChallenge, 2011).

After finishing the design phase, all students considered the "real design" done. So only three students continued in the next phase; however they learned the very important lesson that the realization phase also required lots of design effort. And also that drastic design decisions are required in this phase to implement possibilities and impossibilities of builders, clients, hoisting equipment, transport trucks, limited construction budgets, local requirements of codes, et cetera. They learned that it is really important to be involved in this phase to

guard the coherence of the design. But perhaps more important, they also discovered that most of the practical issues they hit upon required a simplification of the building; instead of lowering the quality, the alterations turned out at the end of the day to even enforce the essence of the concept. This requires a clear vision as well as a very close working design team.

Looking back at the whole project it turned out to be a rather exceptional experience for all students involved, seeing how the Trek-In became much smaller, quite simplified, and far less expensive. But it was also an eye-opener to experience that the final design was much stronger than the initial ideas.

Figure 2. The Trek-In is fully build of-site, mainly made of reclaimed wood

3. BUILDING WITH MATERIALS FROM DEMOLITION

The Trek-In is designed from the very beginning as an outstanding demonstration project of sustainable building. Selecting proper materials and using these in a correct way has always been number one on the agenda. However, the initial design was still developed on rather traditional construction principles. The initial focus was primarily on the inner en outer finishing materials and on the type and thickness of insulation.

This changed dramatically when the design team came into contact with A. van Liempd Demolitions. Director Arie van Liempd is already for years highly motivated to show in real practice that demolition materials deserve a high quality second life. The philosophy of this company sounds “responsible demolition … builds the future”. To emphasize this principle Arie van Liempd founded another company, called 2Life-Art, which is specialized in producing furniture and other applications from recovered wood from demolitions. Inspired by these possibilities the design of the Trek-In was drastically changed to become a demonstration project of reused materials. The possibilities of reusing materials were integrated into running research of TU/e regarding industrialized

building with lightweight panels. This research focused on insulated sandwich elements made of two thin chipboard plates glued to a rigid EPS core (Moonen, 2001; Moonen, 2011; Moonen & Seijkens, 2008) and was easily altered in using reclaimed interior doors (made of two plates hardboard glued to a cardboard core with a honeycomb structure). Interior doors from demolition have hardly no reusable value, because doors are almost always (slightly) damage during demolition. Since recovering these doors is laborious and new doors are quite cheap, there is no market to reuse inner doors with a honeycomb core. Yet dumping is relatively expensive because of the large volume of the doors.

In the new design for the Trek-In, the reclaimed inner doors now form the basis of all walls, roofs and floors. To be efficient, the doors are sawn in pieces to compose a panel with reclaimed timber to connect and to strengthen. This composition combines high load-bearing capacities with extreme light-weight (approximately 14 kg/m^2). Therefore all floors, roofs and walls are made like this.

Figure 3. Principle for floor, wall and roof, and example of reclaimed materials

Figure 3 shows how reclaimed inner doors are connected to I-shaped parts (made of small reclaimed timber and hardboard). A special feature is that this composition makes a cavity at the inside as well as at the outside of walls, floors and roofs. At the inside the cavity can be useful to conceal pipes and services (for water supply, heating, electricity et cetera). The I-shaped elements also form the battens to nail the inside finishing (made out scrap wood, sawn into planks).

The cavity on the outside of the base panels is filled with additional insulation. Reclaimed ceiling parts are collected in large quantities in the demolition of offices and used in this outside cavity. Ceiling parts are made of mineral wool and thus ideal to be used as insulation material.

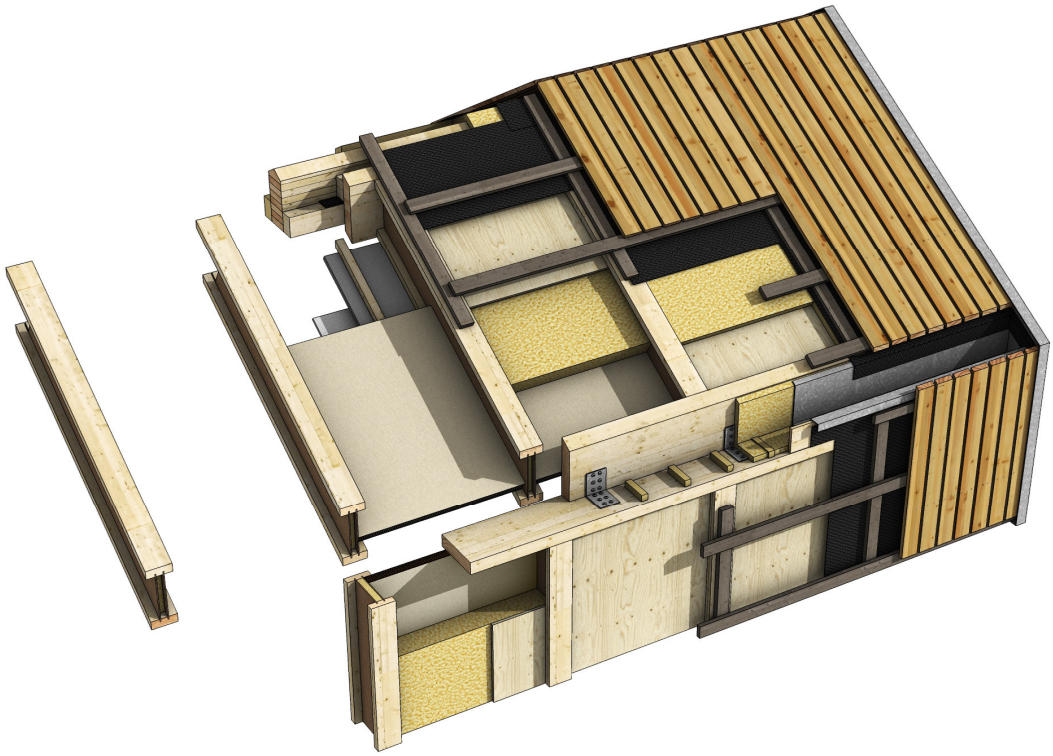

Figure 4. connecting panels forms the tent-like shape.

After placing the insulation at the outside a hardboard layer is applied to support a waterproof layer. For this layer we use new material to guarantee water tightness. On top of this a wooden finishing of timber is applied for aesthetic reasons. This finishing also comes from reclaimed beams and purlins, sawn into planks with afterwards a thermal modification treatment. This makes the planks better suited for outer finishing. In applying the outer finishing great care is given to optimal ventilation to improve the durability.

4. INDUSTRIAL PRODUCTION

The choice to make the Trek-In of lightweight materials also made industrialized production much easier. The design of the Trek-In is geared to optimize production and transport, resulting in two ready-to-use modules that have to be brought to a location. This transportation to the location expresses a great mark on the design. In fact, the dimensions of a loader determined the dimensions of the two modules.

In addition to transport, the design is also entirely focused on optimal coordination of separate specializations in construction, according to the *Slimbouwen*® principle (Lichtenberg, 2005). All supplies for heating, ventilation and sanitation are grouped. This makes it possible for a plumber to compose a special box where all heating, ventilation et cetera is put in. The plumber can install the box in his workshop to a level that all equipment is functioning and tested. When building a Trek-In, the plumber simply places the integrated box, and applies very limited additional piping. Also the electrician can apply all pipes and wiring in one sequence. After the plumber and electrician have completed their work, the interior finishing is applied. This optimal unraveling of subcontractors, reduces costs, improves the quality and shortens the delivery time (Lichtenberg, 2005; Strandberg & Josephson, 2005).

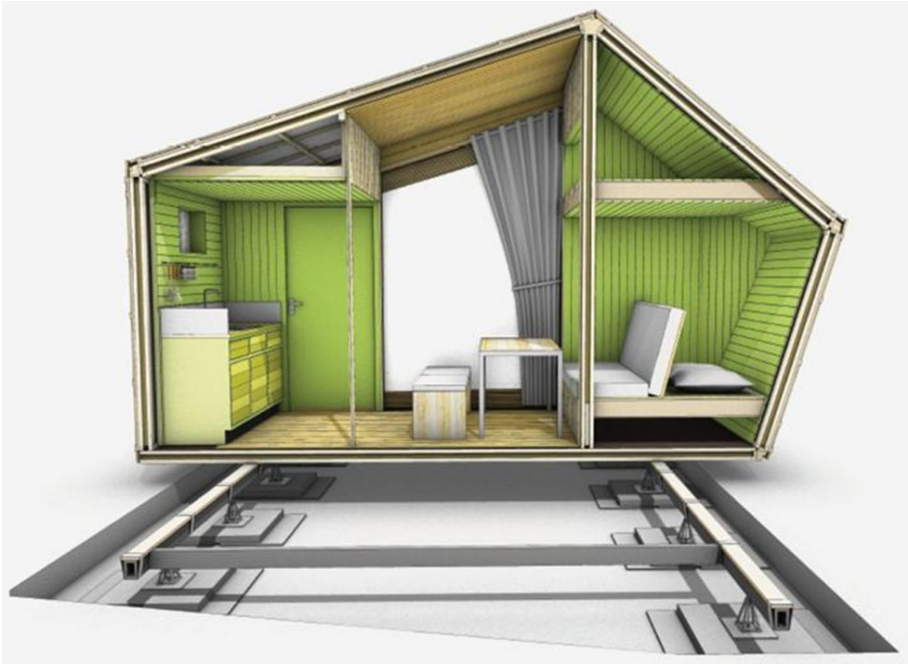

Figure 5. A light-weight module can be placed on a simple foundation.

5. SPECIAL FOUNDATION

The small weight of the modules (and its' stable form that transportation requires) makes it possible to apply a very simple foundation. This foundation is designed as detachable system to correspond to the principles of the modules. Another precondition was that making the foundation could be made as fast as possible. For this reason a casted foundation made of concrete was not preferred, because this takes several days to build and cure. Instead a system was designed based on precast concrete tiles (recovered from demolition) that support a bracket. Due to the small weight of the modules it was found that eight supports were needed. The brackets are placed on concrete tiles to spread the load. Because of the low weight, uplifting is a bigger point of interest than the soil resistance underneath the tiles. Therefore a galvanized bar with screw thread cut at the end, will be dug into the subsoil to fix the bracket. To rows of brackets supports two galvanized steel beams. The two modules are placed on and fixed to these beams. In case the foundation settles in the beginning the brackets can be adjusted in height, if this should be necessary. The foundation can also be completely removed at the end of it's life time.

Apart from making a foundation that is fast to make, an important advantage of this foundation is also that the Trek-In has an optimum venting underneath. Good venting benefits the service life of timber. If a standard concrete foundation would be used, ventilation is not possible. This is why existing cabins often have problems with decay where the wood touches the concrete.

Making this type of foundation takes about 3 hours for a Trek-In. This is important because the complete delivering of a Trek-In (including foundation and all connections) is aimed for setting up in a day. So in the morning the foundation shall be made, around noon the two modules arrive and can be placed by a crane. After that a small strip of waterproofing can be applied where both modules are connected. In the afternoon the interior and outer finishing will be completed as well as connecting the sewage and supply pipes to the local grid. In this sequence a mounting team can finish all work within one day.

Figure 6. industrial production, transportation and placing.

CONCLUSION

As described above, designing the Trek-In has become a very special project for all students involved. To experience a full range from initial concept to optimization of working drawings (even focusing on mass production) is very unusual in an educational setting. And also the chosen materials resulted in an exciting journey for everyone, as well as the many meetings that were full of new ideas to reuse "unusable" demolition materials into high-quality applications. The precondition to align transportation to design and detailing is very special and very instructive. The feasibility of the design is already tested several times, with:

- the prototype of the Trek-In being first transported to a camping site, where it was tested by some 20 people;
- after that the prototype returned to the workshop for small improvements (as a result of the user survey);
- next the prototype was moved to the TU/e campus to be part of the exhibition in the Dutch Design Week (DDW, 2012);
- after that the prototype was transported to Hardenberg to be shown on the Recreation Trade fair;
- and then the prototype finally returned to the campsite in Beers (where it is now in use and is commercially rented).

By now three Trek-In are in commercial use, one in the north of the Netherlands at camping site “it Dreamlân”, one in the middle of the Netherlands at Marina “Marnemoende” and one in the south of the Netherlands at camping site “de Barendonk”.

Figure 7. Three Trek-Ins are already in commercial use.

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