We present the concept and contextualization of a robotic fabrication system for bespoke, unlimited and monolithic timber slabs. Towards an On-site Fabrication System for Bespoke, Unlimited and Monolithic Timber Slabs

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ABSTRACT

In contrast to current paradigmatic approaches of mass-produced slabs, the development of bespoke slabs with variable dimension, arrangement and material allows for improved environmental performance and functional flexibility. This paper presents an on-site fabrication concept for bespoke timber slabs. Two fabrication scenarios are proposed that enable such slabs to be produced efficiently and economically. The first scenario involves the arrangement of flat, thin LVL panels onto the mobile timber fabrication platform and the application of glue, followed by automated nail-gun fixation. The second scenario involves the arrangement of a thin timber layer and subsequently applying glue and automated nail-gun fixation. In both scenarios, the robot scans the already built structure after each iteration and adapts the subsequent fixation of the components with each robot movement. A modular reinforcement of the slab in various directions and span dimensions. Two Scenarios are proposed in both of which an initially laid out process of boards gets incrementally fulfilled by a topologically optimized beam network made from glued together boards. In Scenario A the boards are arranged on the mobile timber fabrication platform, the applications such as still limited – especially for the on-site fabrication of structural wood systems.

II. CONTEXT - CONSTRUCTION ROBOTICS

The ABB IRB4600 robot has a payload of 40kg and a reach of 2550mm. With the glue application head and then place and fix the piece in place. In addition to the adhesive application, the tool station also provides tools, such as drill, blade, and screwdriver, which the mobile robot platform can reach a range from the floor up to 2.15m. In Scenario B the mobile platform is composed of three parts, an ABB IRB4600 robot, a track platform (Fig. 3). The platform has a width of 1000mm and a length of 3000mm, which is sufficient for the mobile platform to be placed onto a building site or workshop. The platform is composed of three parts, an ABB IRB4600 robot, two chains, and a track platform (Fig. 3). The platform has a length of 3000mm, which is sufficient for the mobile platform to be placed onto a building site or workshop.

Fig. 5. The design of the proposed demonstrator structure to be fabricated by the authors at the Digitalfabrik 2020 Workshop in Tongji University.

VI. FURTHER RESEARCH AND CHALLENGES

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Fig. 3. The robotic platform was designed to be flexibly deployable for various timber construction tasks. It is equipped with a comprehensive set of tools (SKL).

I. RELEVANCE

Building construction is trapped inside a development dilemma of high performance and cost. While currently responsible for roughly 40% of global energy consumption, waste production and greenhouse gas emissions [1], the construction industry is increasing in contribution to these problems. In order to lessen a rapidly growing global urban population [2], this is still true. In an increasing pressure of construction due to growing population, one of the major challenges is the efficient use of available materials. The robotic fabrication system for large-scale, monolithic, multi-directional slabs does not yet exist. This results in multi-directional, bespoke timber slabs of unlimited dimensions and continuous stiffness gradients.

In Scenario A, the application of glue is performed before the fixation of the components with each robot movement is performed. This can be sufficient. To achieve higher relative accuracy for the positioning of elements on construction sites: DimRob, “IEEE Int. Conf. Intell. Robot. Syst., pp. 2804-2809, 2015.”

V. CONCLUSION

The mobile robot platform is developed, that can scan the already built structure after each iteration and adapt the subsequent fixation of the components with each robot movement. The platform is composed of three parts, an ABB IRB4600 robot, two chains, and a track platform (Fig. 3). The platform has a length of 3000mm, which is sufficient for the mobile platform to be placed onto a building site or workshop.

The robotic fabrication system for large-scale, monolithic, multi-directional slabs does not yet exist. This results in multi-directional, bespoke timber slabs of unlimited dimensions and continuous stiffness gradients.