After the earthquake in 2015 that struck Nepal, students of the Delft University of Technology commenced the multidisciplinary project program "Shock Safe Nepal". This report describes the effort of the sixth group of students who travelled to Nepal. Following conclusions and specific recommendations of Team 5, the present research has one main goal. This research focuses on improving the overall quality of CSEB and making sure that the final strength of the bricks is constant. This is done by predicting the final strength of CSEB during the early curing stage and using this knowledge to develop a testing method, so the Nepali can monitor the CSEB quality easily and accurately on site in an early production stage. The secondary goal was to perform a dynamic seismic analysis of the pilot house in Ratankot and to get a better understanding of earthquake engineering in Nepal. To predict the final strength of CSEB, a research into the existence of a drying/hardening curve was performed. Different regions in Nepal ask for different CSEB mixtures because of differences in humidity, temperature, altitude and soil consistency. The biggest influence of the change in hardening process is presumably the cement percentage and therefore also the water/cement ratio. In the Nepali practice this percentage is between 5 and 15 percent, depending on local soil type. Therefore, in this research all soil parameters were kept constant except cement percentages, they range from 5 till 15 percent. To develop a hardening curve, bricks were tested after 5, 8, 14, 21 and 28 days. This was done using a (calibrated) compression machine. Results of these tests showed wide spread. The tested bricks were still moist and it was decided to test the CSEB after 38 days as well. This resulted in an even bigger gain in strength such that the bricks after 38 days were twice the strength of the bricks after 28 days. General conclusion can be drawn that the time period between the curing and testing of the brick makes a significant difference in the results, so this has to be monitored accurately. Furthermore continued curing does not necessarily contribute to the strength of the bricks or might even have a negative effect. Results from the compression test showed that the general quality, and thus compression strength, of the bricks was lacking. Only bricks with 15% cement surpass the minimum strength of 3.50 MPa after 38 days. This showed that production site was not working properly, therefor Build Up Nepal was informed. This lack of strength is probably caused by a change in variables. The weather in the winter is very different than in summer, but the curing process wasn’t modified. Also the soil composition differs every time new soil is brought to the site, which can change the strength drastically. While researching the hardening curves for CSEB, an alternative testing method was developed. Multiple ideas have been tested, such as a torque wrench with vice, a drop test and finally a lever arm test. The first two methods were deemed unusable as they broke down or were not able to produce reliable results. The lever arm test was most promising as this method produced constant results. Against expectations, the strength of the bricks tested by the lever arm tested was much higher than the strength of the bricks tested with the compression tester. This indicated that not exactly the same properties were measured. The results cannot be directly compared to each other. Before the method can be implemented there is more research necessary about which property is tested with the lever arm and the converting factor.

Website University
https://www.tudelft.nl/
Weblog student
https://shocksafenepal.wordpress.com

Students: Jim Tijdgat, Rens Nijman, Janna Worp, Stephan Backx

Period: Q2 2017-2018