RTB Working Paper

Low-drudgery novel press for cassava dewatering

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NOVEMBER 2020

CGIAR
RESEARCH PROGRAM ON
Roots, Tubers
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Correct citation: Precoppe, M. Low-drudgery novel press for cassava dewatering. CGIAR Research Program on Roots, Tubers and Bananas (RTB). RTB Working Paper. Available online at www.rtb.cgiar.org

Published by the CGIAR Research Program on Roots, Tubers and Bananas
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INTRODUCTION

During cassava processing, the roots are peeled, washed, and grated into a mash. The mash is dewatered, and the press cake subsequently pulverized before being introduced to a dryer. The dried product is in the end milled into flour (Figure 1).

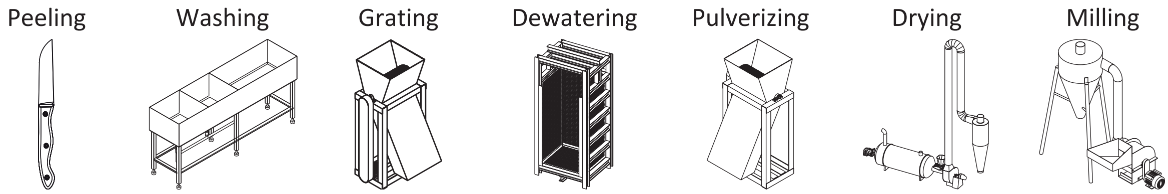


Figure 1. Steps needed to produce cassava flour.

Dewatering is a solid-liquid separation. For cassava it is usually done with presses, thus it uses a mechanical compression method, also referred to as expression. In this process, water is squeezed out from the cassava by mechanical action. Dewatering is an important step in cassava processing because it substantially reduces the amount of water that would otherwise need to be removed by drying, a much more energy-intensive process. To remove 1 kg of water from the cassava mash by mechanical dewatering, 60 kJ of energy is needed. To remove the same amount of water by drying, 6000 kJ of energy is needed. For this reason, as much moisture as possible should be removed mechanically before the material is sent to the dryer.

Different types of presses are used to dewater cassava, but most of the small size enterprises use a screw operated press, or a jack operated press (Figure 2), equipment notorious for its work drudgery (Figure 3). The objective of this work was to develop a novel design of press, of similar capacity and cost but with much lower work drudgery.

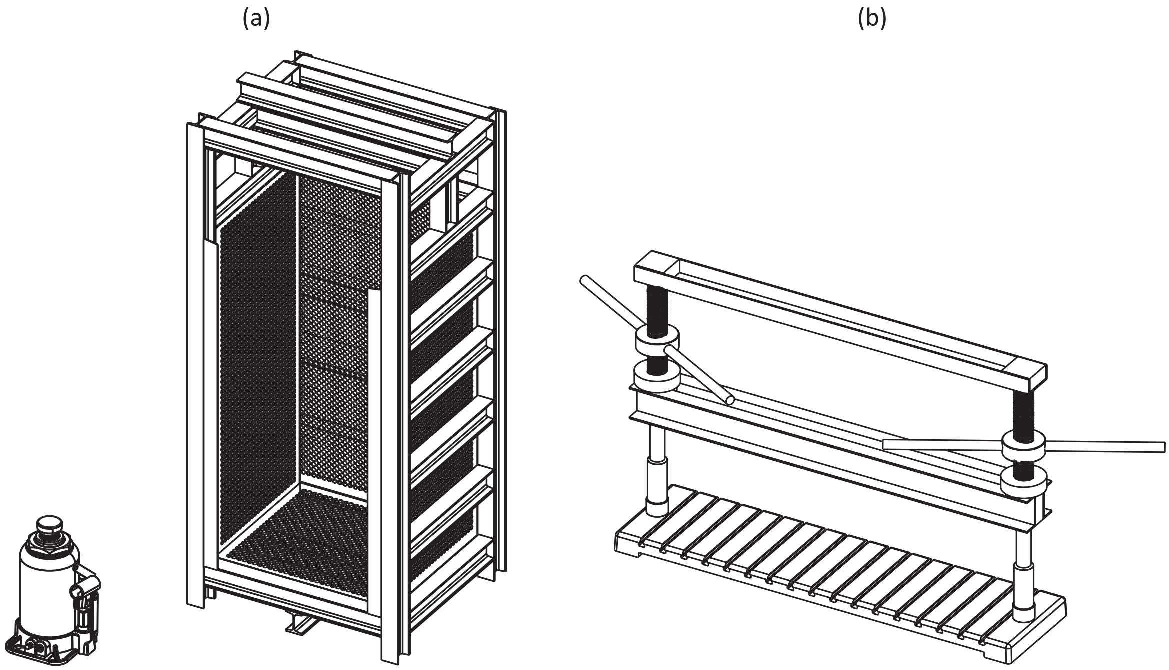


Figure 2. Small size enterprise use mostly (a) a jack operated or (b) a screw operated press.

(a) (b)

Figure 3. Both, (a) jack operated and (b) a screw operated press, are notorious for its work drudgery.

MATERIALS AND METHODS

A novel press was developed based on the concept of a cage press, also known as a basket press. In this kind of press, the material is placed in a perforated cage, and a top-plate is slowly lowered by a hydraulic system or a motor-driven screw. The mechanical action forces the liquid out and after pressing, the top-plate is raised, and the press-cake is removed. The basket press is widely used for apple juice, wine, and cider production.

Discrete Element Method (DEM) was employed to dimension the novel press. DEM is a numerical tool for modelling the behaviour of particles. The software Rocky DEM was used, and input parameters for the simulation were the cassava mash static friction, coefficient of rolling friction, coefficient of restitution, particle size and bulk density.

To assure that the structure can withstand the loads, static stress simulation was performed using Autodesk Fusion 360 software. This software uses the Nastran solver wherein calculations assume a linear response to the stress. The arrows in Figure 4 show the loads and constrains applied as input parameters for the simulation.

(a) (b)

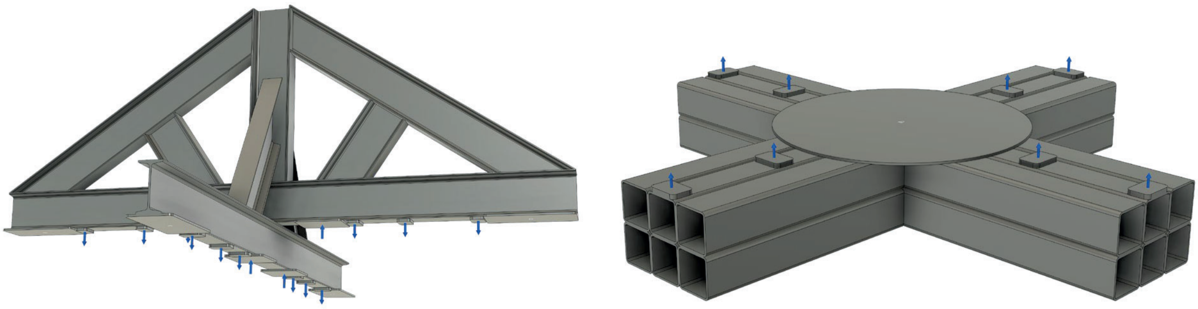


Figure 4. Loads and constraints applied to the (a) top structure and (b) base structure of the novel press, for static stress analysis.

RESULTS AND DISCUSSION

The novel press designed to dewater cassava mash uses 4 hand-operated winches and a system of pulleys to gain a mechanical advantage (Figure 5). The material is added to a perforated basket, that is lifted against a plunger, that compresses it, squeezing the water out (Figure 6).

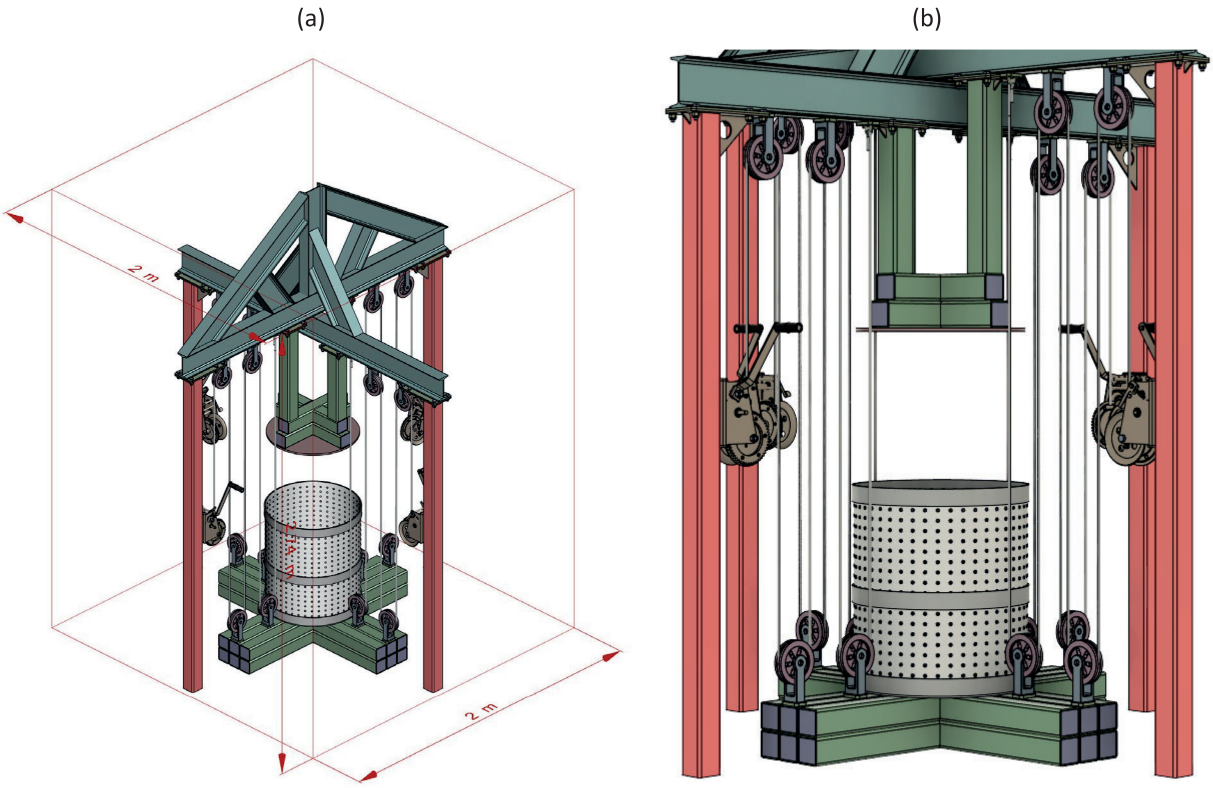


Figure 5. Novel hand-winch operated press (a) isometric view and (b) side view.

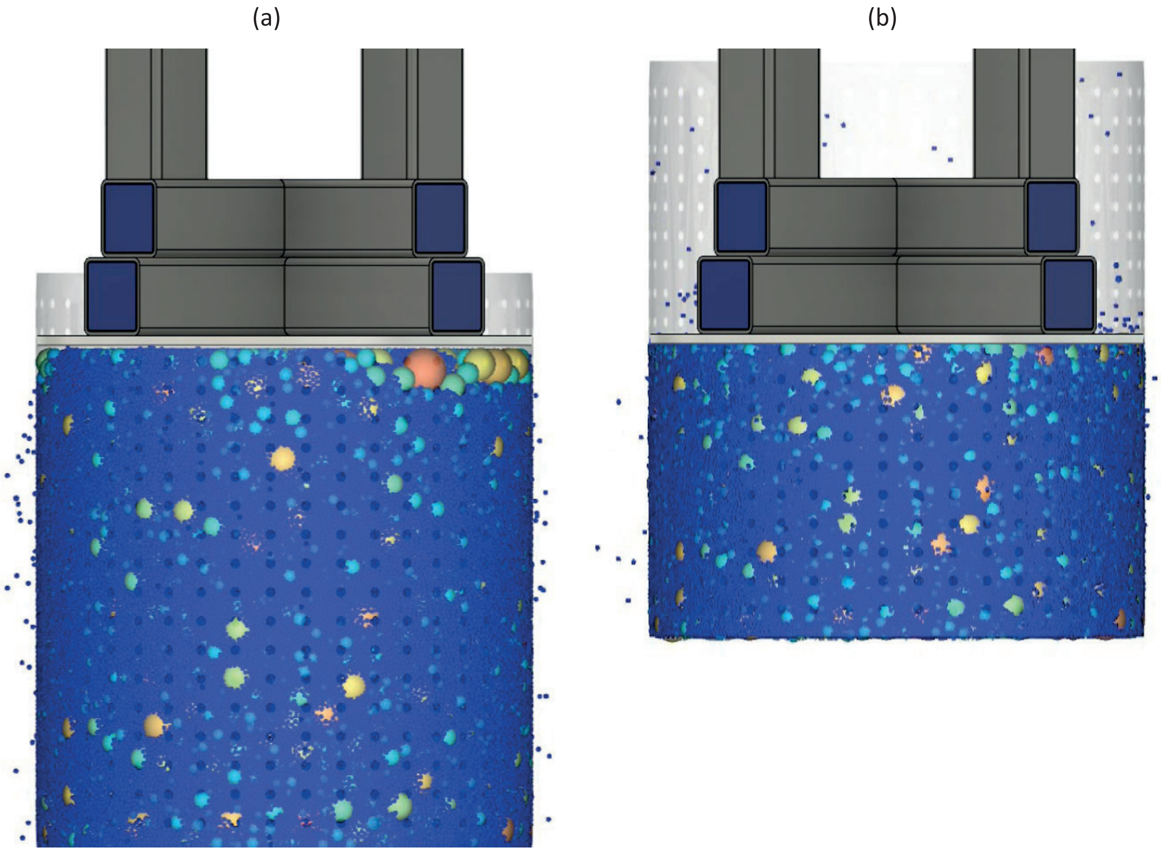


Figure 6. A basket containing the material is lifted against a plunger, squeezing the water out.

Figure 7 shows the results from the static stress analysis. A safety factor of a value of 3 was achieved, assuring that the design is sufficiently strong and will not bend or break when the loads are applied during the dewatering operation.

(a) (b)

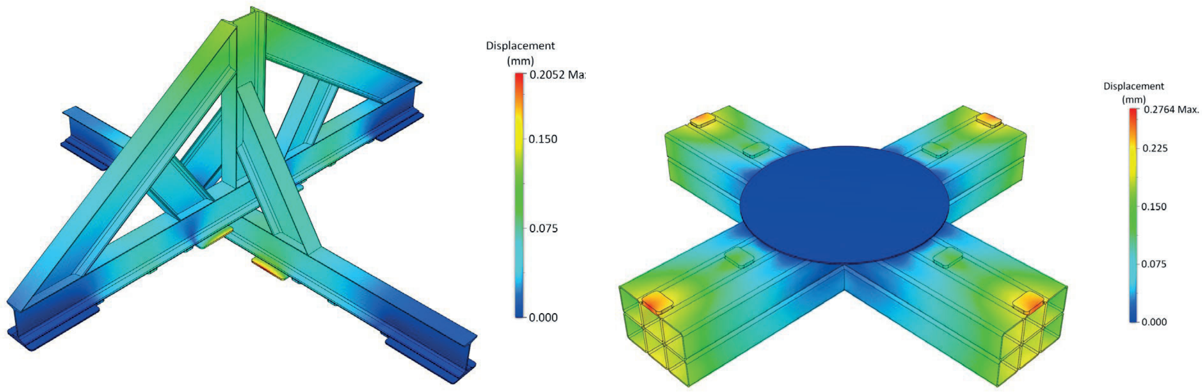


Figure 7. Results from the static stress simulation showing deformation on (a) top and (b) bottom structures.

A prototype of the novel press was built by First Product Enterprise, a manufacturer of cassava processing equipment located in Accra, Ghana. Subsequently, the press was installed at a cooperative processing cassava, also in Accra (Figure 8). The technology has been adopted and the screw operated press that the cooperative once had is no longer used.

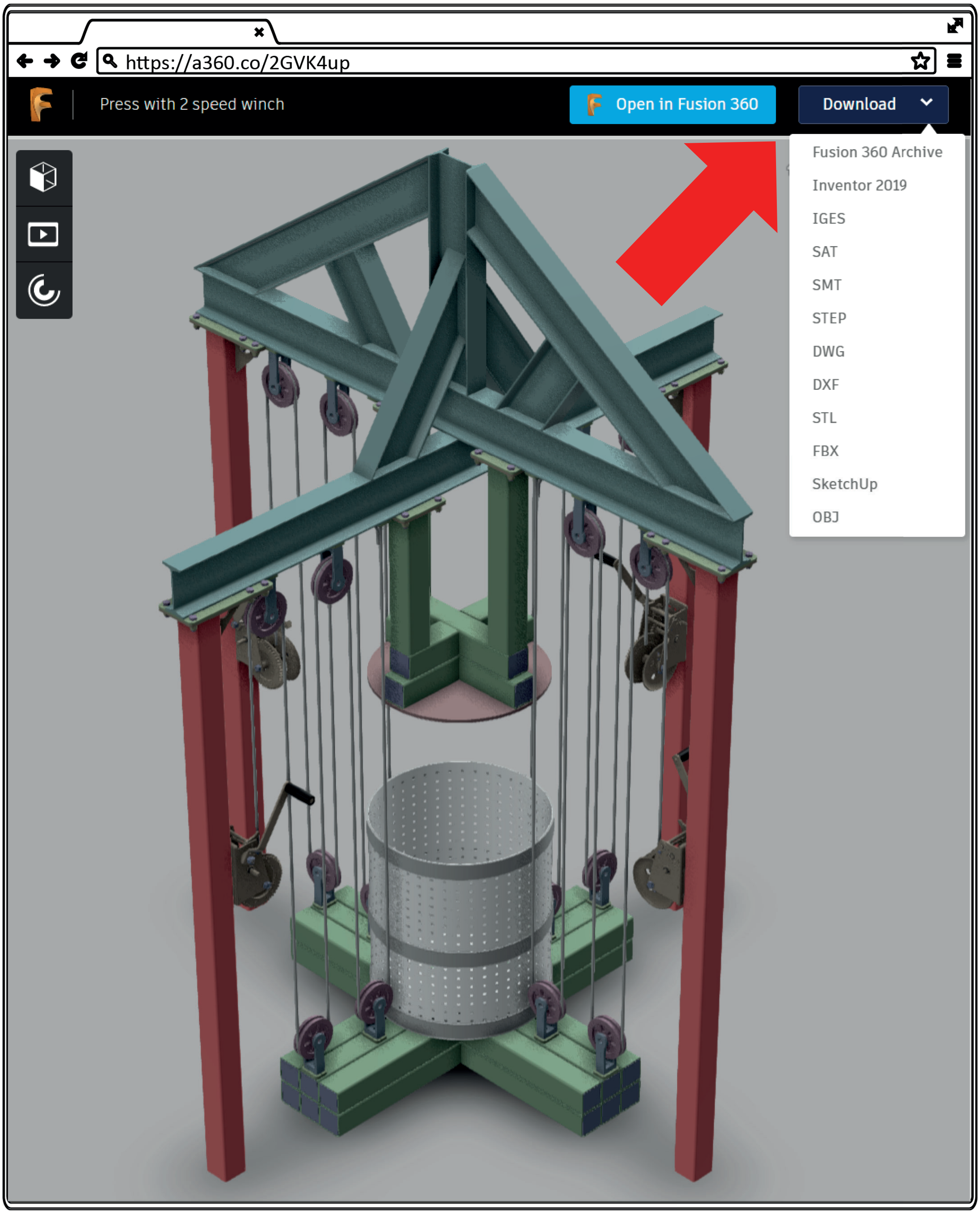
Figure 8. Prototype built and in use at a small size cassava processing enterprise in Accra, Ghana.

CONCLUSIONS

In this work, a novel press for mechanical dewatering of cassava was conceptualized, designed using simulation tools, built, and installed at a cassava processing enterprise. Work drudgery in this press is substantially less, as the force is divided by four operators and a system of pulleys provides a mechanical advantage. A video about this work was produced and made available on YouTube: https://youtu.be/ykJUxD4KX-Y. Finally, Appendix 1 and Appendix 2 provide instructions on how to visualize and download the 3D CAD drawings of the press.

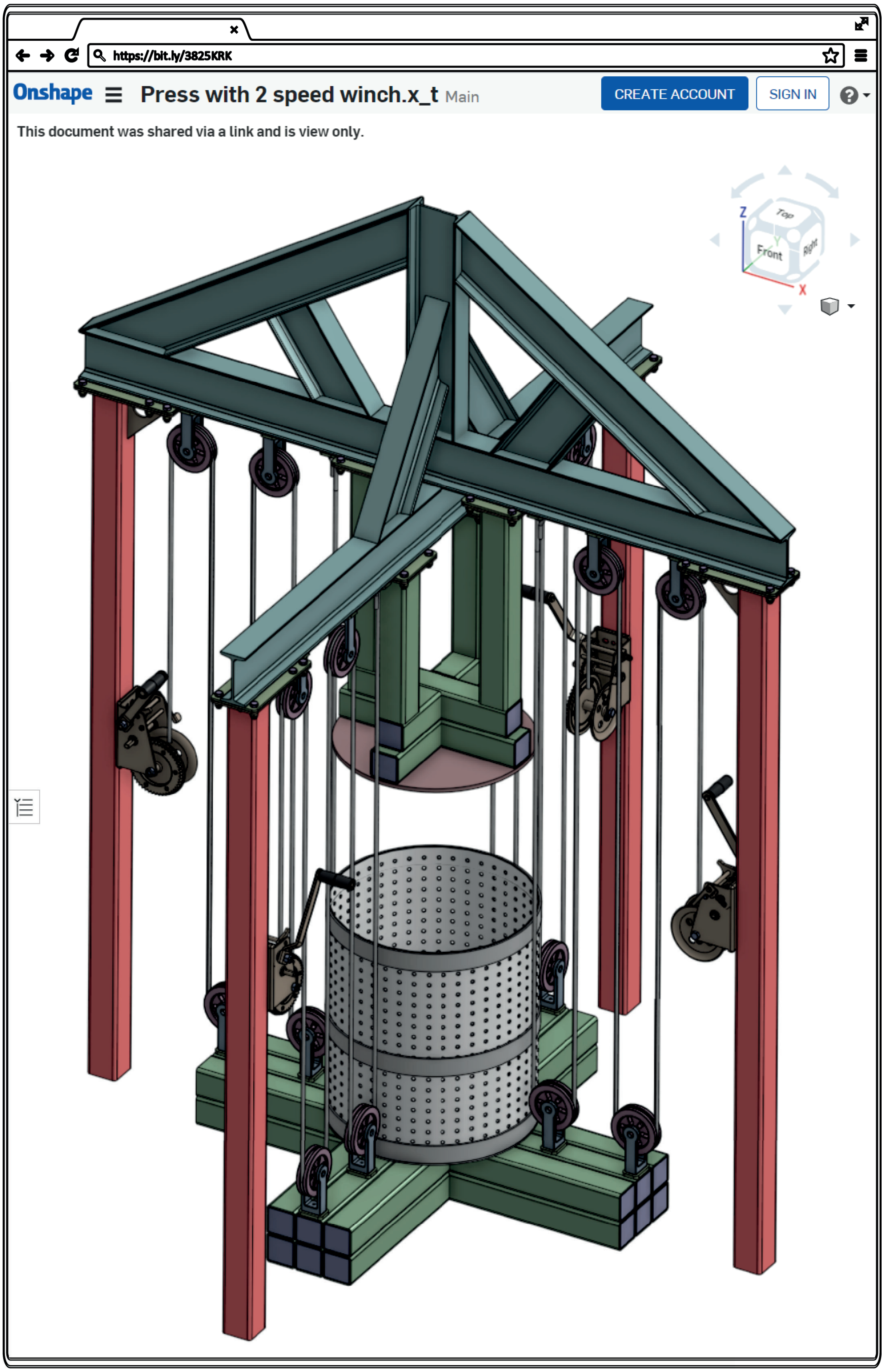
APPENDIX 1

To visualize or download the 3D CAD assembly, click on https://a360.co/2GVK4up. The file is stored at the Autodesk cloud service but does not require an Autodesk account nor the use of Fusion 360 software. To download it, click at the "Download" button on the top right corner of the screen, and choose the desired format, as shown below.



APPENDIX 2

The assembly can also be visualized from https://bit.ly/3825KRK. This service is provided by Onshape and does not require an account. However, this service provides visualization only.



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