OPERATIONS OPTIMIZATION OF RAM PRESS MACHINE BY FRAME ASSEMBLY TECHNIQUES

Pairoj Bootpeng, Yuttapong Naksopon, Nuttawut Pebkhuntod, Pattana Charuenying, and Pakawadee Sirilar*

Received: August 22, 2012; Revised: June 17, 2013; Accepted: June 20, 2013

Abstract

This is a comparative study in the operations of 2 types of frame, the assembled frame and the conventional one. SolidWorks, an engineering 3D design software, was used to design the assembled frame. Then, the steel frame and the plaster mold were made. The actual testing was performed by a hydraulic press with 30-T force. Finally, static testing and analysis were simulated in SolidWorks. A comparison of the operating time and mechanical properties of both frames was studied. The results showed that 1) the assembled frame with 8 nuts at 4 corners was assembled in 5 min and disassembled in 10 min. The total operating time of the assembled frame was 75% less than the conventional frame. 2) The maximum stress of 286.73 MN/m^2 occurred at the top corners of the assembled frame, while the general stress of 57.35 MN/m^2 was on its body. The maximum strain and maximum displacement at the top corners were 9.68×10^{-4} and 8.85×10^{-2} mm, respectively, while the general strain and general displacement occurring on the body were 2.16×10^{-8} and 8.04×10^{-3} mm, respectively.

Keywords: Frame, plaster mold, forming, operating time, mechanical property

Introduction

Forming technology with high pressure pressing (Ram Press or Ram Process) is particularly suitable for forming ceramic products because it can produce in large quantities, about 4-10 times greater when compared with other methods. However, the Ram Press mold is still limited by the size and shape of the work piece. Moreover, the special type of high strength and heavy weight plaster mold is difficult to assemble, disassemble, and remove from the machine.

The objective of this project was to design and develop the Ram Press frame to improve the operations. The comparison of the operating time, such as the assembling and disassembling times, was performed in an actual pressing process. Mechanical properties, such as stress, strain, and displacement, were tested and analyzed with an engineering simulation program.

Program of Ceramics Engineering Technology, Faculty of Industrial Technology, Loei Rajabhat University, Muang, Loei, 42000, Thailand. Tel.: 0-4283-5223-8 # 47104; Fax.: +0-4283-5232; E-mail: pakawadee.si @lru.ac.th

* *Corresponding author*

Materials and Methods

The flat bar structural steel used in the experiment was DIN 17210. SolidWorks design software (provided by Appli CAD Co., Ltd., Bangkok, Thailand) was used to design the steel frame. The 3 steps of the operations testing were as follows: (1) the steel was cut and used to makea rectangular frame. Figure 1 shows the assembled frame and the conventional one. Their dimensions and properties are shown in Table 1. (2) The plaster mold was prepared by mixing C-200B molding plaster and water with a 100:32 ratio by weight. The mix was soaked for 3 min and mixed for 5 min before pouring. A cloth weave tube was put above the product model in the frame and fixed by plastic wire. The mix was poured into the frame andaged for 24 h before testing. (3) The apparatuses were fastened onto the hydraulics platform and the actual forming was performed by pressing 30-T force on 300 g of clay cake in to the mold cavity. The operating time to assemble and disassemble the frames was reported. Figure 2 shows the operations testing of the frames. Mechanical properties, such as stress, strain, and displacement were tested and analyzed by the SolidWorks statics simulation program. The AISI 1010 materials were applied and the external load of 30 T was pressed on the top of the frame. A comparison of the properties between the assembled frame and the conventional one was carried out.

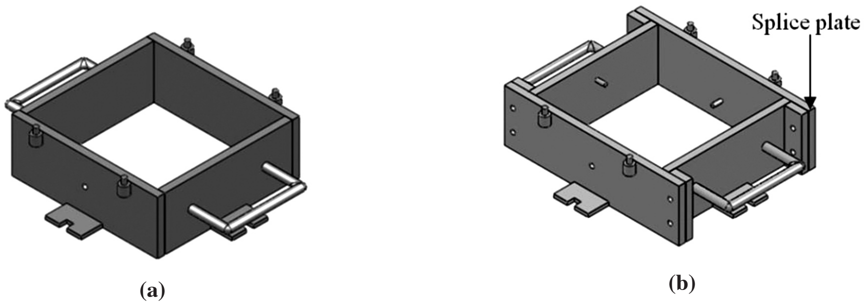


Figure 1. Steel frames: (a) conventional frame and (b) assembled frame

Table 1. Dimensions and properties of the frames

	Specification	Conventional frame	Assembled frame
1	Length (cm)	40.5	50.5
2	Width (cm)	35.5	35.5
3	Height (cm)	15	15
4	Thickness (cm)	2	2
5	Splice plate (cm)	-	5× 15×2
6	Number of splice plates (piece)	-	4
7	Assembly technique	Welding	Nut and screw
8	Weight (kg)	17.90	21.43
9	Percentage of weight gain(%)	-	19.74

Results and Discussion

The assembling time of the assembled frame was 5 min and the disassembling time was 10 min, while, the disassembling time of the conventional frame was 60 min. Therefore, the total operating time of th eassembled frame was 45 min or 75% less than that of the conventional frame. The assembled frame was designed to solve the problem of breaking the mold during disassembling. Thus, the mold could be reused. In the event that any damage may be caused to any part of the frame, replacement parts could also be supplied for the manufacturing process. Therefore, the assembled frame could enhance productivity using the replacement parts. As a result, the time, labor, and costs of manufacturing can be saved (Phaomtase, 2008). Table 2 shows the operating time ofthe apparatuses.

Mechanical properties such as stress, strain, and displacement of the assembled frame were as follows: the maximum stress of 286.73 MN/m^2 occurred at the top corners of the frame, and the general stress of 57.35 MN/m^2 was on its body. The maximum stress of 235.00 MN/m^2 was less than the yield stress of the flat bar structural steel (ISO 1499-2541) (Osteel Co, Ltd., 2012). This means that the internal resistance of the frame was less than the external force due to the deformation of the area (Narmashiri and Jumaat, 2011; Zhang and Chen, 2012). The maximum strain of 9.68×10^{-4} or an elongation of 0.0968% occurred at the top corners. The general strain of 2.16×10^{-8} or an elongation of 0.0000000216% was on its body, whilethe calculated strain was 1.14×10^{-3} or an elongation of 0.114%, using 206 G N/m^2 elastic modulus for carbon steel. Thus, the maximum and general strains were less than the calculated strain. The maximum displacement at the top corners was 8.85×10^{-2} mm and the general displacement was 8.04×10^{-3} mm on its body. The mechanical properties–analysis of the assembled frame is shown in Figure 3.

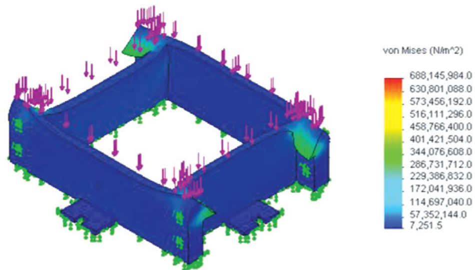
(a)

(b)

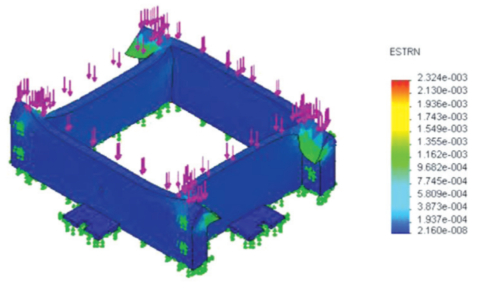
Figure 2. Operations testing of assembled frame: (a) forming efficiency and (b) disassembling the frame

Table 2. Operating time comparison of the frames

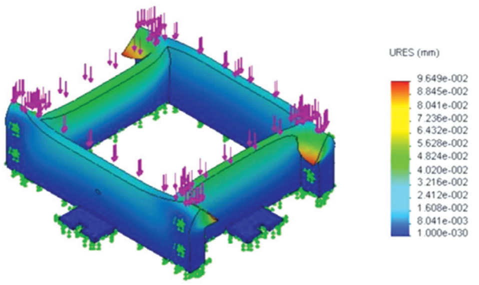
	Specification	Conventional frame	Assembled frame
1	Assembling time (min)	0	5
2	Disassembling time (min)	60	10
3	Total operating time (min)	60	15
4	Saving time (%)	-	75



(a)



(b)



(c)

Figure 3. Mechanical properties analysis of assembled frame: (a) stress, (b) strain, and (c) displacement

The comparison of the mechanical properties between the assembled frame and the conventional one is shown in Figure 4. The maximum stress of the assembled frame was 286.73 MN/m^2, while the maximum stress of the conventional frame was 48.74 MN/m^2. The maximum strain of the assembled frame was 9.68×10^{-4} or 0.0968% elongation, while the maximum strain of the conventional frame was 1.75×10^{-4} or 0.01750% elongation. The maximum displacement of the assembled frame was 8.85×10^{-2} mm, while the maximum displacement of the conventional frame was 3.49×10^{-2} mm.

Conclusions

The operations optimization of the Ram Press machine was studied with 2 types of frame: the assembled frame and the conventional frame. The results were as follows;

- Steel consumption of the assembled frame was about 20% with splice parts, but the frame could reduce total operating time by 75%.
- Stress, strain, and displacement of the assembled frame occurred at the top corners, while they occurred on the body of the conventional frame. The position that outside the body of the frame which would not affect the strength of the frame as a whole.
- The assembled frame could enhance productivity according to economics by designing replacement parts and allowing the mold to be reused.

Table 3. Comparison of materials, costs, and operating time of the frames

	Specification	Conventional frame	Assembled frame
1	Steel weight (kg)	17.90	21.43
2	Steel height (cm)	152	192
3	Steel cost (Baht)	3532.50	4230
4	Steel consumption (%)	-	19.74
5	Total operating time (min)	60	15
6	Saving time (%)	-	75

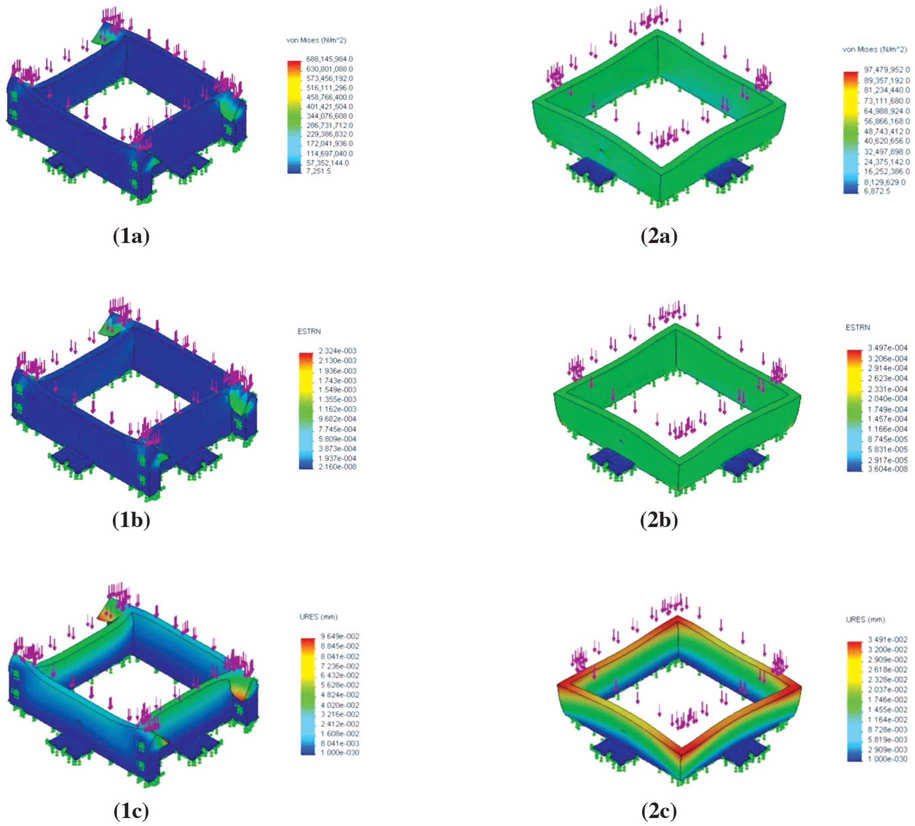


Figure 4. Mechanical properties analysis comparison between assembled frame (1) and conventional frame (2): (1a-2a) stress, (1b-2b) strain, and (1c-2c) displacement

Acknowledgements

This project was supported by the National Research Council of Thailand. The authors gratefully acknowledge Appli CAD Co., Ltd., Bangkok, Thailand for providing SolidWorks academic year 2011-2012 educational version software.

References

Narmashiri, K. and Jumaat, M.Z. (2011). Reinforced steel I-beams: A comparison between 2D and 3D simulation. Simul. Model. Pract. Th., 19:564-585.

Osteel Co, Ltd. (2012). Available from: http://www.osteel.com. Accessed date: April 17, 2012.

Phaomtase, P. (2008). Tools, Dies, Jig and Fixture Design. Loei Rajabhat University, Loei, Thailand, 209p.

Zhang, D. and Chen, G. (2012). The numerical simulation for extrusion forming of magnesium alloy pipe, [abstract]. Phys. Procedia, 25:125-129.