IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 7, Issue 3, June - July, 2019
ISSN: 2320 – 8791 (Impact Factor: 2.317)
www.ijreat.org

DESIGN AND DEVELOPMENT OF MATERIAL HANDLING EQUIPMENT FOR CORDIERITE SLAB

S Senthil Gavaskar[1], Kovuru Ashok[2], M Mariselvan[3], A Mohamed Akram[4], P Panneerselvam[5]

[1] Associate Professor, Department of Mechanical Engineering, RMKCET, TN
[2,3,4,5] Student, Department of Mechanical Engineering, RMKCET, TN

Abstract

The material handling equipment guarantees the convenient conveyance of wanted amount of material at wanted restriction with least expense and greatest security. Due to daily invention of new technologies over material handling equipment are undergoing continuous automation. The problem arises in a system while turning the soft material like cordierite ceramic material before firing in the kilns. During turning the soft materials are undergoing cracks which are mostly cannot be seen by naked eye. The turned product must be carried by a bat for kiln. The product is turned by using a clamping lot up. Two clamps are used to turn the material along with two ratchet belt to hold the product.

Keywords:- cordierite , clamp, belt.

Introduction

Cordierite ceramic is a magnesium aluminium silicate material that has been widely used in applications where thermal shock resistance is important. Cordierite ceramic is also useful because it has a first thermal expansion and good electrical insulation compared to other ceramic materials. It can be formed into a variety of composite geometries by employing several characters of manufacturing process such as axial press, isotactic pressing, shot molding and extrusion.

Ceramics are proven to be nonpareil materials for sensible thermal depot in concentrated solar power, industrial heat recovery, etc. due to their good thermal constancy and high strength. Among them, cordierite ceramics that are featured of low toll, low thermal expansion coefficient, good chemical stability and high refractoriness show great potentials and have been used as thermal storage medium or containers of latent heat materials for decades. Cordierite ceramics have also extensive applications in other orbits, such as refractory, energy, exhaust purification catalyst and aerospace industry, etc.

Material, product or goods will always run within and/or across the facility such as a plant, warehouse, between buildings, a transportation or distribution spot in decree to complete the function of its availableness in that facility. The stuff menses is related to the movement for handling the stuff itself which can be done by using human power or mechanical equipment and can be time consuming, expensive and troublesome. Since material handling equipment (MHE) is used, the circumstance certainly lead to the decision-fashioning for the proper survival of the fittest. The hardware must be worth for the material dealing with tasks since material taking care of basically utilizes asset, for example, work and existence. In superior general practice session, material handling operation accounts for 25% of all employees, 55% of all factory space and 87% of production time. Because of that factor, choice of MHE ought to be led cautiously and completely. Past studies are concerned with MHE selection by taking an effort to uncovering the best alternative of MHE. Some of the studies select the best MHE through evaluation under multiple criteria such as nature of work, time consumption, number of workers, workspace provided, etc.

Problem Statement

The cordierite slab product which weighs more than 100kgs are difficult for man power to lift and rotate. The rotation of the slab is done to remove bottom plunger. Because of more weight it is difficult for the workers to rotate and also during rotation cracks are formed. The cracks formed are sometimes noted by the naked eyes and many times cannot be visible to the naked eyes. It can be able to detect the damage only after the firing process. The test for the checking of the crack is sound test. One skilled person test the sound produced on each and every part of the product by knocking it with rod. If the

sound produced is different in some places that means that part has an internal crack on it. When the internal cracks are not viewed due to various distractions the cracks were formed after the firing cycle. The firing cycle takes about two days. After two days the cracks are formed tends to material and manpower waste as the material were reprocessed before the firing cycle.

DESIGN AND METHODOLOGY

STUDY OF CURRENT METHOD

Initially the cordierite material is obtained from igneous rock and the some additives like adhesives. Then the particles are finely crushed to certain proportions in order to get required material properties. Once the material properties were attained and they were passed through the wooden plunger to get required material quantity and shape. As the cordierite material stands for higher firing cycle and sticking properties due to the presence adherence material.

Cordierite materials were used to produce ceramics and they are also produced in hallow form in order to reduce weight and hence material cost tends to be minimised. The hallow slab were produced by rods while pouring the materials. When the materials were poured in shaper and they are locked with the screws to avoid the misalignment and to obtain particular shape under heavy loads. The materials were pressed in the presser either vibrator or hydraulic presser to get required properties and shape.

Usually the vibrator is used as a presser as the gaps between the grains of the materials were filled whereas the hydraulic press were not able to fill the gaps between the grains structure as it simply presses the material with heavy load. Although the vibrator requires human force to hold the material slab while pressing where hydraulic press do not requires human force to hold. The pressed cordierite material is moved from the vibrator then the top and bottom plunger were opened. The bat made up of cast iron with number of ribs based on the required material size. The bat is placed over the pressed material. The materials were inspected thoroughly in order to identify the cracks over the surface of the cordierite material as the material is soft and sensitive to handle before they passed through the firing cycle. The cracks were formed over the surface due to uneven load from the workers.

The bottom plunger tightened and the material is turned with the bat through the human force. When the material is turned back the cracks were inspected through the sound testing which is handled by the skilled person who identifies the sound variation and it tends to determine the internal cracks.

The cracks over the surface were viewed through the naked eyes whereas the internal cracks were identified through the sound testing which involves the skilled person knocking with the testing probe thus the difference in sound over the surface results the internal cracks. Once the cracks were identified then they were considered as scrap and they were reprocessed in order to develop the economy. The sound testing is not so effective in every time. The material without cracks they were passed through the firing cycle. The firing cycle takes two days to produce the final product. Once the material with internal cracks were processed in furnace then the material is tends to consider as waste and they are not able to reprocess where the material before firing cycle they are crushed and reprocessed.

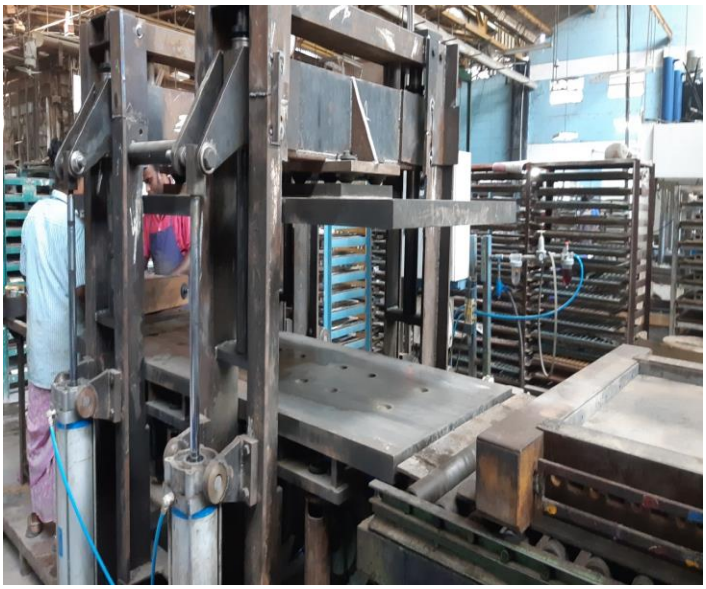

Figure 1

PROPOSED DESIGNS:

Proposed Design 1:

Rotating Table:

The material is ejected from the vibrator and they are moved over the roller assembly. The adjustable table is placed at the

end of the roller assembly. The rotating table consists of top and the bottom plunger. The top plate is opened and then the material is moved along with the plunger. The rotating table consists of cushioning foam. The material is placed in the rotating table and the bat with number of ribs. The top plate is closed and they are tightened. The ends of the rotating table consist of ball bearing in which it helps to rotate the table and hence the materials were rotated.

LIMITATIONS:

- The product has various heights and here there is no provision to adjust the height.
- It also occupies more area.

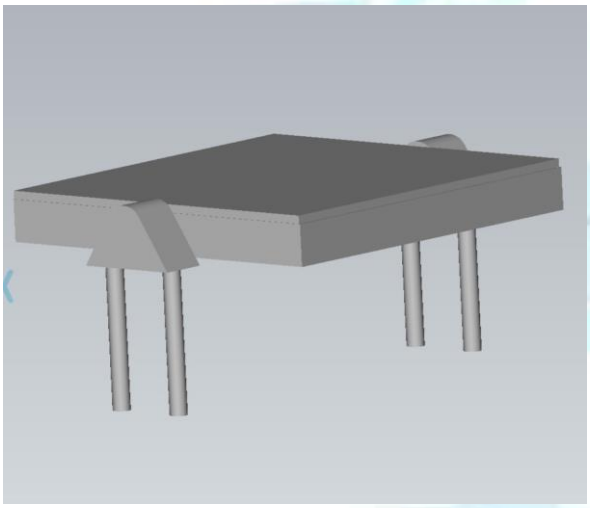

Figure 2

PROPOSED DESIGN 2:

MOVING TABLE:

The moving table consist of two tables moving table and receiving table. The receiving table is placed immediately after the roller arrangements. The moving table consist of two belts for locking the product. The belts are placed on the back side of the table. The product is placed on the table and bat is placed over the product. The product along with belt is tied by using belt. The moving table rotates along with the product and belt for 180 degree. The receiving table is placed adjacent to the moving table. The moving table has designed in such a way that belts will return to normal position immediately after the release for next cycle. The heights of the table are designed in such a way that the workers can easily operate. The receiving table has only frame on the top and it is supported at the bottom.

LIMITATIONS:

- It requires additional area.
- The material transfer is also required.

PROPOSED DESIGN 3:

CLAMPING ARRANGEMENT:

Two clamps with projections on one side which is used to hold the product. The clamp is designed in such a way that it can hold minimum to maximum range of heights in product. The clamp has soft foam to produce cushioning effect. The clamp contains one screw rod for tightening the product and guide rod for support the load. The set up contains electric hoist conveyor for lifting the product.

The third idea is selected because it can afford variable heights and the material is rotated in the same place. No additional area is required for set up.

CLAMP:

A clamp is a device used to hold the piece in a proper position without any shaking. It will hold the product by applying inward pressure. There are many different types of clamp available for different purpose. Some are used to fix components position while others are intended to be permanent..

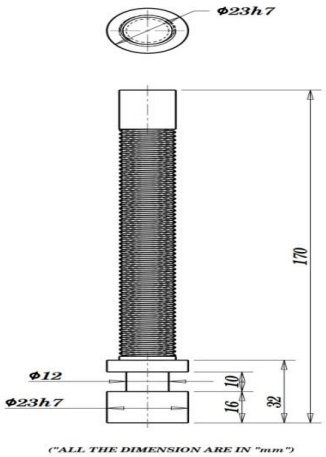

Figure 3

A. Screw Rod:

Screw rod is used for the movement of mid plate. The screw rod is provided with pitch 16mm.

B. Handle Bar

Handle bar is provided to lift the product material. Spacer is provided for rotating motion of the clamp.

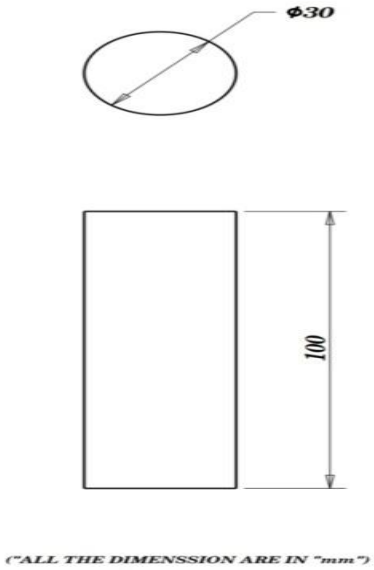

Figure 4

C. Spacer

Spacer is provided separately. The spacer is welded in another rod, the rod is used to lift the product and spacer allows the clamp to rotate.

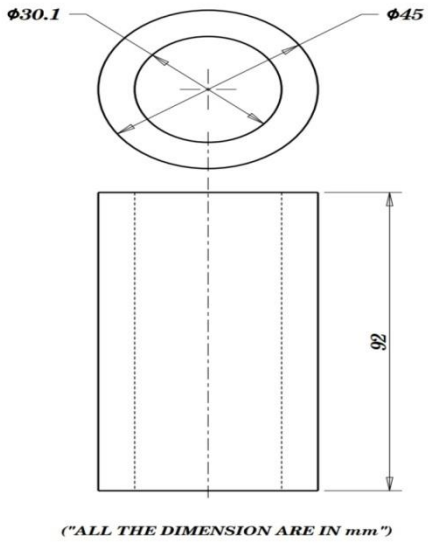

Figure 5

D. Guide Rod

Guide rod is used for support the screw rod. The load acted on the mid plate is distributed equally on screw rod and guide rod. The guide rod is machined by centreless grinding for smooth movement.

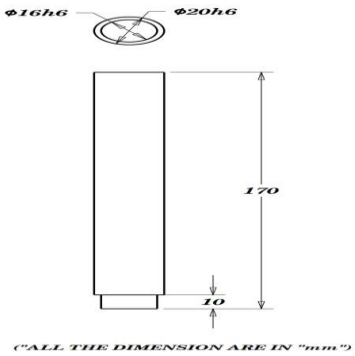

Figure 6

E. Bottom Plate

The bottom plate are designed in such a way that it can hold the product comfortably.

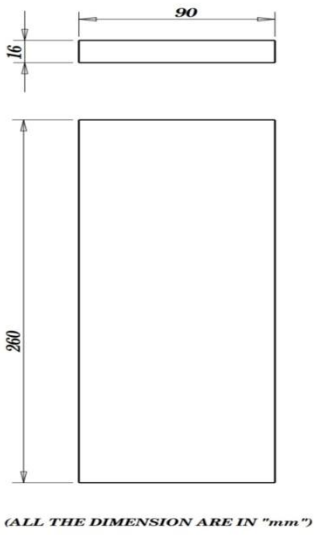

FIGURE 7

F. Top Plate

The top plate has a hole on the centre for screw rod and another hole for bush. To hold the bush four holes of 6.8mm.

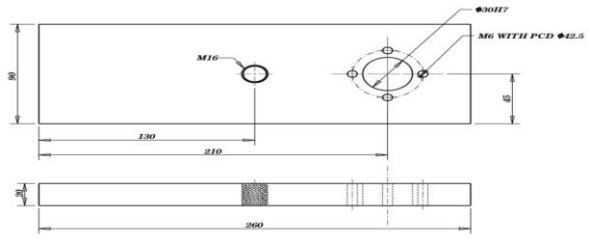

FIGURE 8

G. Soft foam

Soft foam is used to give cushioning effect to the product. Since the product has very less strength the cushioning is provided.

FIGURE 9:

H. Sling belt

Sling belt is used to tie the product with the bat. To hold the product firmly two belts are used. The belt is uses ratchet mechanism to tight the belt.

FIGURE 10

I. BUSH

The bush is act as a guide way for guide rod. The centre of the bush is provided centerless grinding for smooth movement of the guide rod.

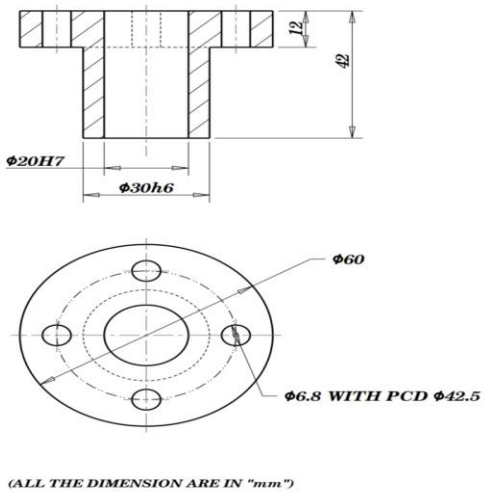

FIGURE 11

J. CLAMPING ARRANGEMENT

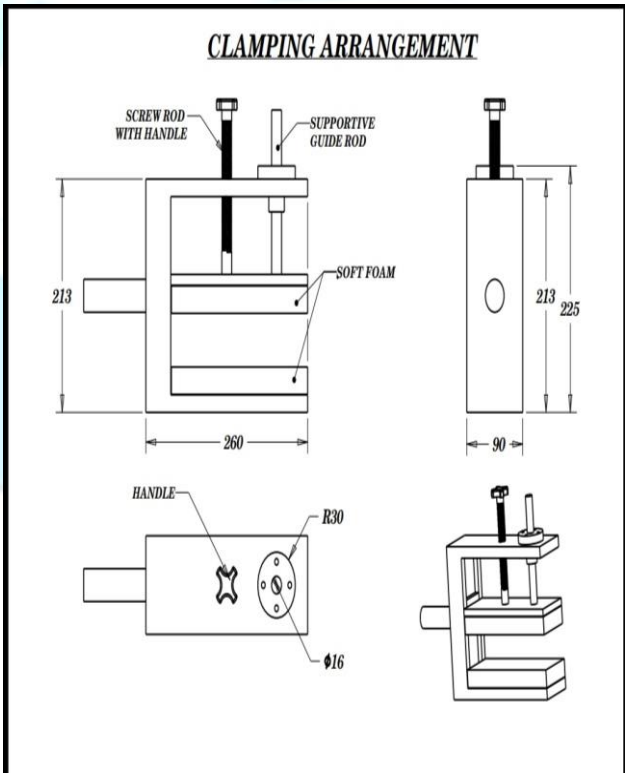

FIGURE 12

III. WORKING

The spacers are welded in a c shaped rod. The c shaped rod is designed in such a way that it can have more than half the breadth of the product and it is connected to the electric conveyor by using a hook which is connected in the electric conveyor. The wheels of the conveyor run on the guides placed there. The electric hoist conveyor can be operated by manually controllable device.

The clamp is placed in the spacer on two sides. The product along with the bottom plunger is pushed out by using an ejector. The product along with the bat and bottom plunger is sent inside the gap between mid plate and bottom plate. The screw rod is tightened to clamp the product. The two belts are used to hold the product in correct position during rotation of the product.

The product is lifted along with clamp by the electric conveyor and the whole set up is rolled inside the spacer. The screw rod is loosened and the product is removed. The product along with bat is placed inside the kiln for firing.

DESIGN CALCULATIONS:

CLAMP DESIGN

HEIGHT:

External height-213 mm.

Internal height-181 mm

The internal height is designed in such a way that it can hold 38-45mm product with bottom plunger of size 45mm and a bat of size 16mm. It should also hold a mid plate of 10mm a tolerance of 10mm is given.

WIDTH – 90mm

The width is designed in such a way that it can hold at least two rods of the bat for good support. The distance between each rod in the bat is 50mm.

BREADTH:

Internal breadth -220 mm

External breadth-260 mm

The breadth is given to provide more contact area between the clamp and the product.

SCREW ROD:

M16 thread is given for screw rod. The stand pitch for m16 screw is 2. Nominal tensile strength is 500 N/mm^2. The maximum allowable load for M16 thread is 120 kg.

ELECTRIC CONVEYOR:

SPECIFICATIONS:

Capacity - 500kg

Wire rope - 12 mtr

Lifting speed - 220/230 V

FEATURES:

- Cut off limit switch is included.
- Automatic braking action.
- Only for small jobs.

SLING BELT:

FEATURES:

- Orange colour
- Length 25 * 6 m.
- With hook on one end and a lock on another end.
- Can with stand weight upto 2 tons

SOFT FOAM:

- Cross section 220*90*25 mm.
- No of pieces needed -4.

GUIDE ROD:

Diameter - 30mm.

Length - 170mm.

.

V. MATERIALS AND ITS PROPERTIES

1. MATERIAL SELECTION

The materials used in the process are discussed below

- Cordierite is used in product
- Bat uses mild steel
- Mild steel for clamp
- Soft foam for cushioning effect

2. MATERIAL PROPERTIES

Mild steel:

MATERIAL	**COMPOSITION (%)**
Carbon	0.16
Manganese	0.7
Silicon	0.13
Sulphur	0.04
Phosphorus	Remaining

Table 1

PROPERTIES:

It's a great conductor of electricity

It is malleable

It can be easily magnetised

CORDIERITE:

MATERIAL	COMPOSITION (%)
Magnesium	6.4

Ferrite	6.4
Aluminium	12.9
Silicon	16.12
Oxygen	56.04
Others	2.06

Table 2

PROPERTIES:

- It has more adhesive property.
- It provides high strength after firing.
- It has high thermal resistance.

SOFT FOAM PROPERTIES:

- Easy to process and handle
- Excellent impact and vibration absorption.
- Very low migration onto partnering material
- Low compression set.

ADVANTAGE AND APPLICATION

ADVANTAGE:

- The number workers is reduced
- The turning time is lowered.
- The no of failure is decreased.
- The cracks are reduced.
- Easy to work.
- Easy to operate.
- The equipment cost is lower.
- No additional work space is required.
- The production rate is increased.
- Reduce work force.
- Reduce walking distance.
- Risk and accidents are prevented.
- Simplified handling activities.
- No higher skills are required to operate.
- Increase profitability.

DISADVANTAGE:

- After rotation it is difficult to position the clamps on a normal surface.
- Surface of clamp get rusted over some period.

FUTURE PROGRESS:

An additional c shape channel is provided to eliminate the above error. The c shaped channel will act as base after rotation so that it will act as a base so that it can be placed on a normal surface.

APPLICATION:

The project is used to hold and rotate the material with ease method. The safety application and proper quality of the material is the main theme of the material handling equipment. It rotates the product for the further firing process. It also reduces the workers effort and easily to lift the products and enhance safety.

COST ESTIMATION:

S.NO	DESCRIPTION	AMOUNT IN INR
1	Mild steel	800
2	Foam	210
3	Hardening	1600
4	Machining	3200
5	Ratchet belt	780
6	Total	6590

Table 3

VII. ANNEXURE

Figure 13 Developed clamp

CONCLUSION

The clamp developed is fully operational and gives the resulted motion. The product result is tested and it gives a positive income. The design can be changed for the convenience, the changes include additional portion to cover the top. The material can also be changed for future purpose to reduce the weight. The intent of the project is to reduce the cracks formed on the surface of the cordierite material.

REFERENCES

[1] Fonseca, D. J., G. Uppal, and T. J. Greene. 2004. "A Knowledge-based System for Conveyor Equipment Selection." Expert Systems with Applications 26 (4): 615–623. doi:http://dx.doi.org/10.1016/j.eswa.2003.12.011.

[2] Simon Chinguwaa, Wilson R. Nyemba, Kudzai Boora, Charles Mbohwa. 2006. "Feasibility study of the materials handling and development of a sustainable conveying system in plastics recycling and manufacture" Procedia Manufacturing 33 (2019) 383–390

[3] Dafnomilis. I, Lodewijks. G, Junginger. M, D.L. Schott. 2018 . "Evaluation of wood pellet handling in import terminals". https://doi.org/10.1016/j.biombioe.2018.07.006

[4] Miguel florez de la colina, Manuel rivas cervera . 2016. "handling heavier loads in construction." Procedia Engineering 161 (2016) 1127 – 1134.

[5] Haidar, A. D., and S. G. Naoum. 1996. "Opencast Mine Equipment Selection Using Genetic Algorithms." International Journal of Surface Mining, Reclamation, and Environment 10 (2): 61–67. doi:10.1080/09208119608964801.

[6] Karande, P., and S. Chakraborty. 2013. "Material Handling Equipment Selection Using Weighted Utility Additive Theory." Journal of Industrial Engineering 2013: 1–9. doi:10.1155/2013/268708.

[7] J. Munoa, M. Sanz-Calle, Z. Dombovari, A. Iglesias, J. Pena-Barrio, G. Stepan. 2020. Tuneable clamping table for chatter avoidance in thin-walled part milling. CIRP Annals - Manufacturing Technology (2016), https://doi.org/10.1016/j.cirp.2020.04.081

[8] Jiang, M., Lawson, Z.T., Veysel, E., Pervere, S., Nan, T., Robbins, A.B., Feed, A.D., Moreno, M.R., Clamping soft biologic tissues for uniaxial tensile testing: A brief survey of current methods and development of a novel clamping mechanism, Journal of the Mechanical Behavior of Biomedical Materials (2015), doi: https://doi.org/10.1016/j.jmbbm.2019.103503.

[9] Davide Leonetti, Johan Maljaars, Giacomo Pasquarelli, Giuseppe Brando. 2010. Rivet clamping force of as-built hot-riveted connections in steel bridges. Journal of Constructional Steel Research 167 (2020) 105955. https://doi.org/10.1016/j.jcsr.2020.105955

[10] Ahmed, A., and S. S. Lam. 2014. "Material Handling Equipment Selection Using Multi-attribute Utility Theory and Monte Carlo Simulation." Proceedings of the 2014 Industrial and Systems Engineering Research Conference, Toronto, Canada.

[11] Bard, J. F., and T. A. Feo. 1991. "An Algorithm for the Manufacturing Equipment Selection Problem." IIE Transactions 23 (1): 83–92. doi:10.1080/07408179108963843. Braglia, M., R. Gabbrielli, and D. Miconi. 2001. "Material Handling Device Selection in Cellular Manufacturing." Journal of Multi-criteria Decision Analysis 10 (6): 303–315. doi:10.1002/mcda.310.

[12] Burt, C. N. 2008. An Optimization Approach to Materials

Handling in Surface Mines (Doctorate). Perth: Curtin University of Technology.

[13] S.Z. Mafokwane, D.V.V. Kallon, M. Nkosi and F. Chiromo. 2019 . " Design of a tri-adjustable automated heavy-duty handling system based on Industry 4.0 principles." Procedia Manufacturing 35 (2019) 187–196

[14] Mahdavi, I., B. Shirazi, and N. Sahebjamnia. 2011. "Development of a Simulation-based Optimisation for Controlling Operation Allocation and Material Handling Equipment Selection in FMS." International Journal of Production Research 49 (23): 6981–7005. doi:10.1080/00207543.2010.534826.

[15] Chakraborty, S., and D. Banik. 2006. "Design of a Material Handling Equipment Selection Model Using Analytic Hierarchy Process." The International Journal of Advanced Manufacturing Technology 28 (11–12): 1237–1245. doi:10.1007/s00170-004-2467-y.

[16] Chu, H. K., P. J. Egbelu, and Chung-Te Wu. 1995. "ADVISOR: A Computer-aided Material Handling Equipment Selection System" International Journal of Production Research 33 (12): 3311–3329. doi:10.1080/00207549508904876.

[17] Chamzini-Y, A., and S. Shariati. 2013. "Selection of Material Handling Equipment System for Surface Mines by Using a Combination of Fuzzy MCDM Models." International Research Journal of Applied and Basic Sciences 5 (12): 1501–1511.

[18] Chan, F. T. S., R. W. L. Ip, and H. Lau. 2001. "Integration of Expert System with Analytic Hierarchy Process for the Design of Material Handling Equipment Selection System." Journal of Materials Processing Technology 116 (2–3): 137–145. doi:http://dx.doi.org/10.1016/S0924-0136(01)01038-X.