International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 7 Issue 12 Ver. IV || Dec 2018 || PP 47-56

Design Analysis and Modeling by FEA of Small Scale Balcony Crane

Kassahun Gashu Melese* [1], Abel Moges [2]
[1] *(is Ph.D. Candidate with the Indian Institute of Technology, Roorkee, Department of Mechanical and Industrial Engineering; 247667, India.).*
[2] *(is BSc.in Mechanical Engineering Design stream at Aksum University; Ethiopia)*
Corresponding Author: Kassahun Gashu Melese

***Abstract**: Transporting goods in Ethiopian condominium for those who live above the first floor have been a major problem. Since they have joined their new house and their day to day life. Originally the design of the condominium building does not include lifting mechanism of goods for resident it has been hard to lift heavy goods like furniture, refrigerator and other home appliance that are heavy to handle using a stair. The small scale balcony crane project is focused on design of lifting mechanism for goods with a good aesthetic and ergonomic value to solve the existing problems of Ethiopian condominium and apartments. In this paper the design analysis of the small scale balcony crane is done by analytical method and design is done for the different materials, it's very significant component used for lifting of goods. By identifying customer need the product development process is done. Design analysis and modeling are done both by hand calculation and software like, Ansys and Solid Work. ANASYS 15.0 where calculations are performed The deflection values, Von Misses stress etc., are obtained using the static analysis. The detailed drawing of various parts of the crane is obtained from Solid Work 16.*

***Keywords**: FEA, ANSYS, Solid Work, Von Misses stress and Total deformation.*

Date of Submission:15-12-2018 Date of acceptance: 31-12-2018

I. Introduction

A balcony crane is a type of material handling machine, generally equipped with a hoist, wire ropes or chains, and guide frame structure, that can be used both to lift up and down materials vertically. It is mainly used for lifting Condominium residence goods, appliances and construction finishing materials mainly vertically and also horizontally to building floor specifically on balcony side [1]. It uses one or more simple machines to create mechanical advantage and thus move loads beyond the normal capability of a human [2]. It stands on the balcony of the buildings. Unlike construction cement lifting crane which uses rectangular frame structure as support, this balcony crane uses a simple supporting frame or guide as a rail and this kind of frame make the balcony crane to lift wide cross sectional area materials, it also differs from cement lifting crane because it is movable or mobile unlike the cement one is fixed on the building or its structure [3].

Condominium housing is a name given to the form of housing tenure where each resident household owns their individual units, but equally shares ownership and responsibility for the communal areas and facilities of the building, such as hallways, heating system, and elevators or lifts [4]. Addis Ababa is in state of fundamental transformation in terms of physical, socio-economic and spatial aspects. One of the main changes is happening through the provision of affordable housing in the grand housing program since its launch in 2004 [9]. The Integrated Housing Development Program (IHDP) is a government-led and financed housing provision program for low-and middle-income households in Ethiopia. The program was launched in 2004 (1996 in the Ethiopian calendar) by State Minister, then the Mayor of Addis Ababa [12].

The rapid growth of population in Addis Ababa presents extraordinary pressure on the existing housing policy and on the entire infrastructure like water, electrical power supply, drainage and roads. Addis Ababa is among the 10 largest cities in Sub-Saharan Africa. It has an annual population growth rate of 3.8%. The population is forecasted to reach 5.7 million in 2020 [6].

At present condominium blocks are ground floor + ten story's (G+10) in height, in some case (G+12) therefore avoiding the need for mechanical lift, which minimize associated constriction and maintenance costs [8]. Lift is one type of material handling equipment used to lift or transport materials only in the vertical direction. Elevators or lifts used in many building for human transportation. In construction site a simple lift mechanism used to transport material.

Fig1. Ethiopian 40-60 condominium at Addis Ababa City [2].

1.1 Literature Review:

Literature review is one of the scope studies. It helps in a way to get the information regarding structural analysis Gantry Crane. From the early stage of project various literature studies have been done. Research journals, books, printed or online conference article were the main source in project guides.

Camelia Bretotean Pinca, 2009: had used shell type elements with three or four nodes per element in order to find out the best sizes for resistance structure in tension and deformation state. Here cosmos software was used for analyzing the tension and deformation state of the resistance structure of an overhead crane bridge. This was performed in iron and steel department of continuous casting. The maximum equivalent tension calculated according to the theory of the specific form modifying energy (the theory of von misses). Finite Element Analysis (FEA) is applied to solid model of resistance structure. They had distributed the tensions within the resistance structure of the crane bridge more appropriately. All features which cause tensions and deformations in resistance structure were described mathematically by differential equations. In this way like evaluation of stress state and pointing out the critical areas we can increase solidity and bearing capacity of the strength structure for the rolling bridge. After analyzing the stress fields, they were realized by the fact that there are two critical areas that we have to take into consideration [1].

Ismail Gerdemeli, 2010: had carried out the research on developing new Finite Element Analysis (FEA) technique and here they had used new techniques rather than using old Finite Element Methods (FEM). All calculations of elements related rubber tired container stacking crane were done and then it was modeled. In addition of this, they stress and deformation analysis of crane bridge girder and buckling analysis of the crane legs were performed. ANSYS workbench was also used for Finite Element Method (FEM) and modeling was done on Autodesk Inventor 2010 program. Comparison of calculations regarding Stress, deformation and buckling analysis were done by author. There is no significant difference between the analysis and calculation result for the stresses and deformations. Therefore, analysis result can be taken into consideration. The main aim of this work is to achieve best Finite Element Methods than conventional methods for getting advantage of new methods. Result shows that stress values remain under the yield strength of the steel which was used for Crane Bridge and legs. They concluded that it is new method but it gives better result than conventional method [2].

The Smart-Rig T1, 2012: Portable mini crane is made to lift, drop, drag, pull, tug, transport, carry, stack, move, hold and set loads and heavy materials in any situation in interior or exterior of buildings. Small enough to fit inside a residential doorway, elevator, narrow aisle, hallway or back of a truck, this vertical lifting mini crane allows rigging in tight spaces. Dual batteries allow mobility and easy transport. Electric 120v winch option available. Industries that use small floor cranes and portable hydraulic floor cranes include HVAC, pipe, steel, ports, military, oil refineries, warehouses, marinas, manufacturers/fabricators, water plants, glass, glazing, shipping yards, film/tv/theatre rigging & production, concrete removal, plumbing, factories, airlines, utility companies, disaster deployment operations, aluminum installation, spa installment, farms, sewage, window installation, mining, AAC concrete installation, cement, petrol exploration, railroad, and many more. Unlike material lifters from beneath, the mini crane lifts from above via cable and winch [3].

Some key features in this design are:

- Small cranes utilize a light-weight pull-out manual boom.
- Utilizing pick and carry features for rigging, moving, transporting and traveling heavy objects.
- Adjustable, folding, versatile full power straddle crane is smaller and more affordable compared to expensive spider cranes, davit cranes, or crawler cranes.
- Light duty with articulating boom arm, able to work on rough terrain or indoors makes the Smart-Rig mini crane a full power portable lifting crane.

Hoist, 2012: This new indoor hoist is light weight. When installed against the ceiling and the upper floor, it can easily lift goods from ground floor to upper floors. For higher buildings with no elevator it would be tiring to move heavy or wide materials inside, but with our hoists it becomes much easier, you can directly lift materials inside the building through windows. With accessional support frame, it's suitable for both indoor and outdoor hoisting, and also applicable for outdoor large projects when fixed with scaffolding [4].

Boom Crane Pulley,2012: Moving into a new house with nice new hardwood floors is hard enough. But if you need to climb not, one but two skinny staircases to get to the living room, moving in is simply a nightmare. Grills, couches, TVs, fridges, etc. are a pain to lift as it is, let alone attempting to traverse stairs. So instead of performing move-in gymnastics while breaking our backs, I decided to simplify things by building our own boom-crane pulley system. So the basic idea is that this is a 3-story house with roof deck. The living room is on the third floor, and has a balcony. The crane is mounted to the floor of the roof deck (the 'fourth' floor). This will allow us to pull things from the street level up to the third floor balcony. So the boom crane is saving us from having to bring things up two flights of stairs [5].

Cranes and Derricks: With respect to cranes, a large concern about wind is out of service storm loading. Among certain crane types, especially tower cranes, it is a principal design consideration. Yet there is no board-based agreement on treating cranes with respect to storm wind. The FEM standard is commonly used around the world, but the FEM treatment of wind is most appropriate for typically mild continental European climates [6].

Ministry of Work & Urban Development, 1995 E.C: Ethiopian Building code standard, basics of design and Action structures states Imposed load on buildings cause by; normal use by persons, furniture and movable objects (e.g. light weight movable partitions, storage, the contents of containers), machine and vehicles. The self-weight of structural and nonstructural components and of fixed equipment shall be taken in to account. Imposed loads are modelled by uniformly distributed loads or a combination of these loads. In case of Category A which contains Balconies, stairs which has a specific use on area for domestic and residential activities, they are capable of concentrated load 4 KN/m2 and uniformly distributed load of 2 KN [7].

II. Problem of Statement and Justification

Now a day the number of Ethiopian people living in condominium increases rapidly. Peoples use different materials to make their living comfortable such as furniture such as sofa, bed. Refrigerant, washing machine, cabinet and other materials that are not easy to transport vertically form one floor to other using a stair. In Ethiopia most of condominiums are built with minimum G+4 floor and they have no lift even passenger lift for elders and disabled residents. The new condominium having 10th and 12th floor building now have only passenger lift (elevator) for the last two floors but it is not still used to transport heavy goods. Here below are the problem identifications:

- **Back pain**: Handling goods or materials using stairs requires more Energy cause of this more man power is needed to handle material manually or without the aid of machines.
- **Time Consuming**: Handling goods 12 story long buildings takes more time in addition to Energy requirement.
- **Material damage**: since the stair width is not compatible with some goods such as (cabinets, sofas, beds ….) the wall scratches and also cause partial damage on the goods.
- **Costly**: it requires a minimum of 100 birr per one labor to handle materials traditionally on a small or no story buildings, since handling house goods 12 story long buildings needs more than 100 birr per labor and also requires more than 2 labors.
- Decreases the interest of people to buy materials that are easily broken and heavy.
- Close the stair during transport the goods.
- Noise problem

Fig 2. Transporting goods using Stairs by labor laborers

III. Product Development Process

i. Mission Statement

Table 1. Mission of overall statement

Product Description	• Motor driven Mobile Balcony Crane, able to lift 200kg up to a maximum distance of 40 meter.
Key Business Goals	• Product introduces in 2016 G.C/ 2008 E.C. • To produce 50 Balcony Cranes for 40/60 G+12 Condominium per year. • To get 20% Profit per a product. • Distribute the product across Ethiopia, Addis Ababa G+9 and G+12 Condominium's.
Primary Market	• Condominium residence owners • Lifting service groups
Secondary Market	• Any other Interested Business Organizations
Assumption and Constraints	• Motor Driven hoist • Four wheels • Has Counter weight • Operate on balcony • Has a guideway for a bucket • Remote Controlled • Has a weight meter.
Stake Holder	• Purchaser and user. • Manufacturing operations. • Distributor and resellers. • Small and medium size enterprises

ii. Prepare List of Metrics

Preparing the list of metrics based on customer needs as per customer interest and assigning values 1-5 denoting critically important needs.

Table2. List of metrics based on customer needs

Metrics no	Need nos.	Metrics	Imp	Units
1	1,3,4,,6,8	Total weight	4	N
2	1,4,6	Area of material holder	5	m^2
3	2,4,5	Diameter of wheel	4	m
4	6	Operator	4	quantity
5	2,8,9	Maintenance	5	Subj.
6	2,4,8	Cross sectional area	4	m^2
7	1,2,3,5,7,8,9,10	Unite price (machine)	5	Birr
8	6,9	Aesthetics	4	Subj.
9	1,5,8,10	Production rate	5	Subj.
10	1,2,3,4,5,6,7,8,9,10	Lifting Height	4	m
11	1,2,3,5,6,7,8,9,10	Lifting Capacity	5	Kg
12	2,3,5,6,8	Counter weight	5	N
13	6,8	Time to assemble and disassemble	4	Sec.
14	9	Service time	5	Hr.
15	4,6,8	Portability	4	Subj.
16	1,3,10	Lifting speed	3	m/min

Table3. Collect competitive benchmarking information

Metric no	Need nos.	Metrics	Imp.	Units	Marginal Value	Ideal Value
1	1,3,4,,6,8	Total Weight	4	N	<3500	<2000
2	1,4,6	Area of material holder	5	M^2	>3	<4
3	2,4,5	Diameter of wheel	4	M	80	<70
4	6	Operator	4	Qty	2	< 3
5	2,8,9	Maintenance	5	Subj.	-	-
6	2,4,8	Cross sectional area	4	M^2	<0.595	>2
7	1,2,3,5,7,8,9,10	Unite price (machine)	5	birr	40000	30000 birr
8	6,9	Aesthetics	4	Subj.	-	-
9	1,5,8,10	Production rate	5	Subj.	-	-
10	1,2,3,4,5,6,7,8,9,10	Lifting Height	4	M	>36	<40
11	1,2,3,5,6,7,8,9,10	Lifting Capacity	5	Kg	<250	<300
12	2,3,5,6,8	Counter weight	5	N	>1740	<2000
13	6,8	Time to assemble and disassemble	4	Sec.	> 1200	<900

14	9	Service time	5	Hr.	_	-
15	4,6,8	Portability	4	Subj.	-	-
16	1,3,10	Lifting speed	3	m/min	>4.7	<4.7

ii. Concept Testing

An assumption underlying the concept test is that the population of potential customers surveyed reflect that of the target market for the product.

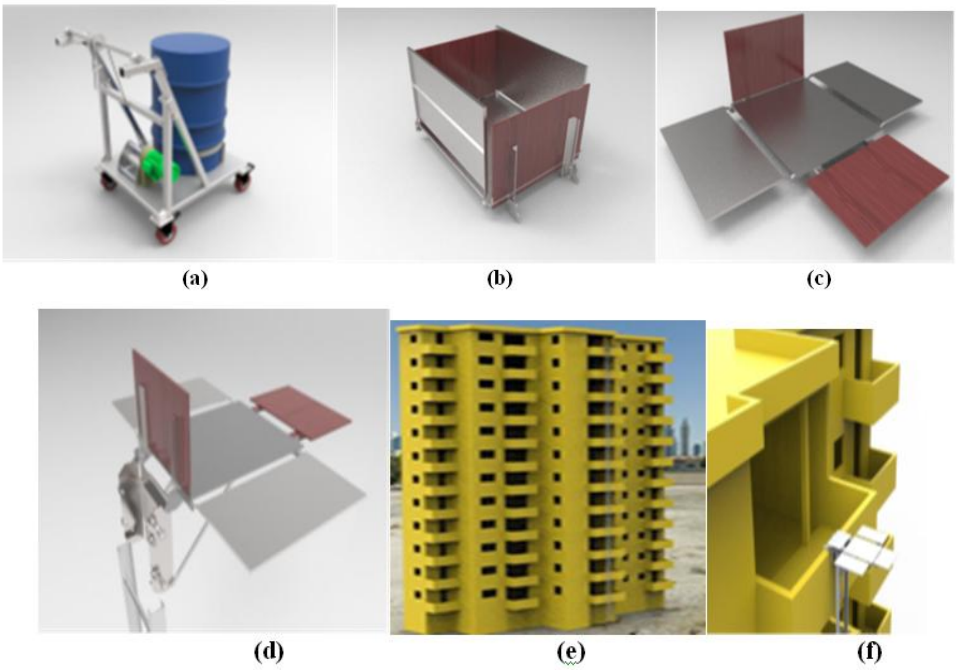

Figure3. Modeling by SOLID WORK16 (a) Rendering of balcony crane (b) rendering of material holder car closed (c) rendering of material holder open (d) Rendering of material holder guide and support assembly (e) balcony crane fully assembled isometric view (f) balcony crane with condominium building

IV. Concept Selection

Table 4. Concept selection criteria for balcony crane was finalized by taking into consideration the customer needs

Objectives	**Weights**	**90° Support**		**30° Support**		**30° Support Cart**	
Safety	12%	4	0.48	2	0.24	4	0.48
Cost	17%	2	0.34	3	0.51	4	0.66
Ease of Use	8%	4	0.32	2	0.16	4	0.32
Manoeuvrability	11%	3	0.33	4	0.44	4	0.43
Durability	7%	4	0.28	2	0.24	4	0.29
Reliability	11%	3	0.33	1	0.11	3	0.32
Adjustability	9%	4	0.36	4	0.36	4	0.37
Capacity	9%	2	0.19	3	0.27	3	0.16
Operational Speed	9%	3	0.18	3	0.27	3	0.15
Operational Range	7%	4	0.28	3	0.21	3	0.21
	Total score	3.09		2.81		3.39	
	Rank	2		3		1	
	continues	yes		No		yes	

V. RESULT AND DISCUSSION

i. Software Simulation Result

A. Balcony Crane Frame

The balcony crane frame simulation checked by both Ansys 15.0 workbench and SolidWorks 2016, considering advisor recommendation the Ansys 15.0 simulation result is Generated and discussed in this section. The forces are applied at balcony frame at former bearing area of the support frame equally on both frame face 1250 N each, totally 2500 N which is the maximum lifting capacity of balcony crane, and the balcony frame structure is fixed on the former position of the castors. since the software simulation result and calculated (conventional) result is different than by the below calculation they can be calculated and if the result is >10% the correction and recalculation will procedure.

Name	Type	Min.	Max
Factor of Safety	Von misses stress	101.64 Pa	157.8849e+007 N/m^2

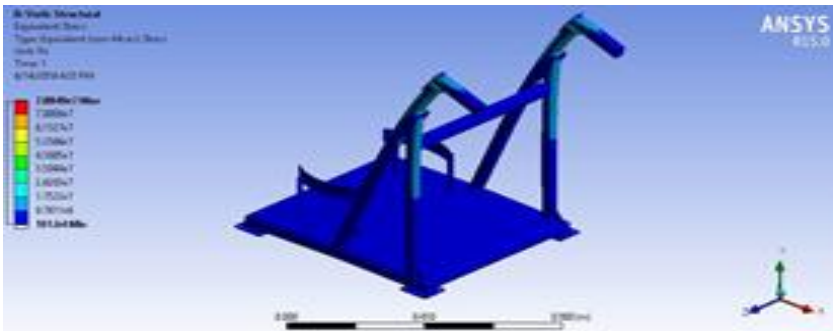

Figure 4. Von misses stress analysis by ANSYS 15.

Name	Type	Min.	Max
Displacement	Resultant Displacement	0 m	0.00060163 m

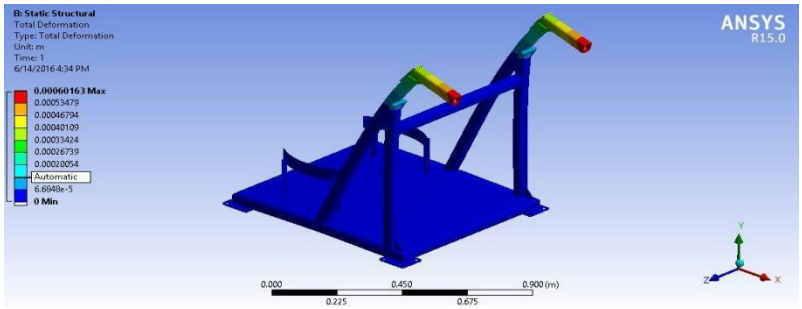

Figure 5. Frame total deformation analysisby ANSYS 15.0

B. Material Holder Frame

Material holder is used to carry car (material holding frame), it is subjected to 2000 N distributed force, since it is assembled with material holder with the pins at the end and the connecting rod, the at these points fixture are applied. The allowable deformation on beams are 1/600 of their length, then calculating deformation or deflection 700mm/600 is 1.1666 mm. since the deformation on simulation which is 0.71324 <1.166mm then the design is safe to go.

Name	Type	Min.	Max
Stress	Von misses stress	590.43 Pa	7.207e+007 N/m^2

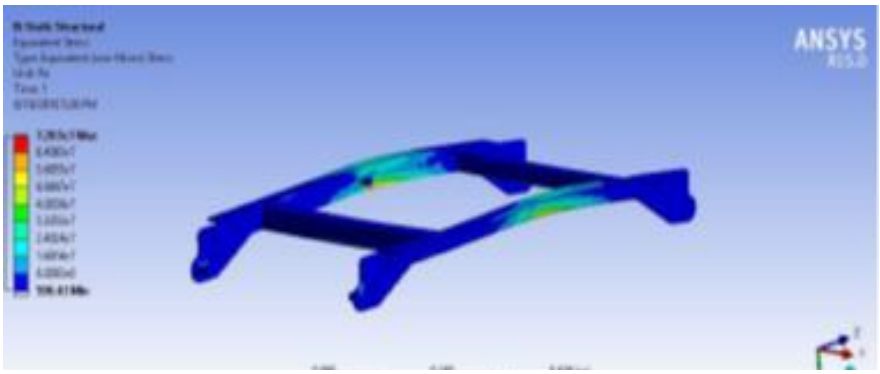

Figure 6. Von misses stress analysis for material holder support

Name	Type	Min.	Max
Displacement	Resultant Displacement	0 m	0.00071324 m

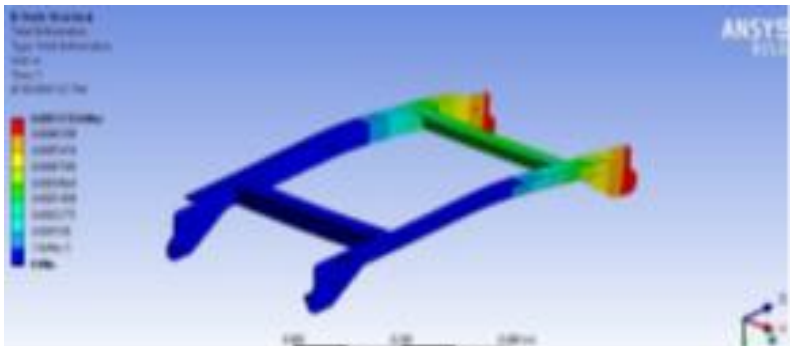

Figure 7. Total deformation analysis for material holder

C. Material holder support

Material holder support is balcony crane component which is assembled with material holder frame and a car. It is assembled with a rope so the rope drags it in order to lift the object. It rolls about a ladder frame by its wheels. The simulation is made by creating a cylindrical contact fix on wheels' o rollers and applying a force of 2500N on its beam at centre. The allowable deformation on beams are 1/600 of their length, then calculating deformation or deflection 450mm/600 is 0.75 mm. since the deformation on simulation which is 0.36294 <0.75 mm then the design is safe to go

Name	Type	Min.	Max
Stress	Von misses stress	56238 Pa	5.7625e+007 N/m^2

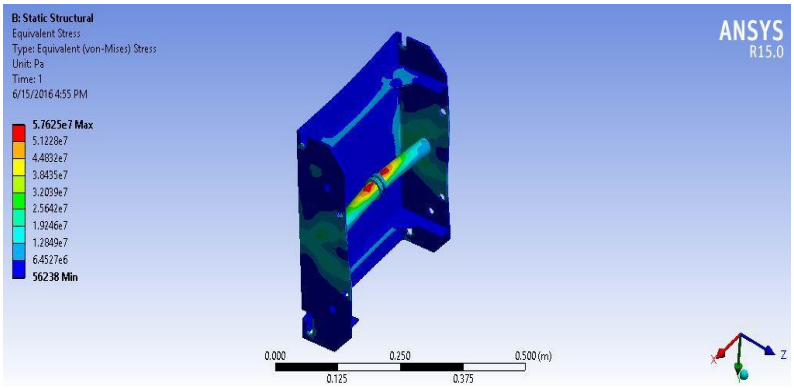

Figure 8. Von misses stress analysis for supporter

Name	Type	Min.	Max
Displacement	Resultant Displacement	0 m	0.00036294 m

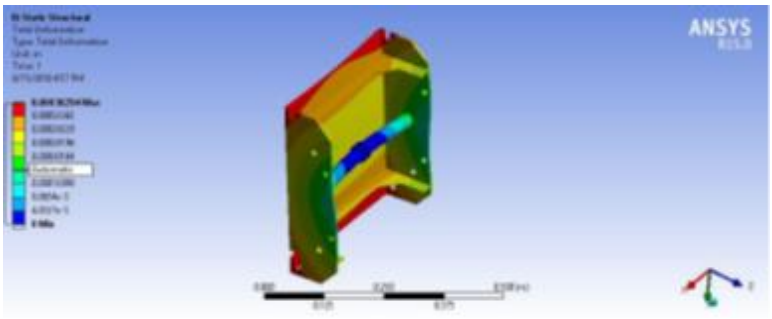

Figure 9. Total deformation analysis for supporter

D. Material Holder Assembled

Material holder assembled includes both material holder support and material holder frame. This simulation is done to check what the effect is if both are assembled and tested. The simulation is done by: cylindrical support is applied at 4 rollers and 2000N for applied at material holder frame face. Comparing with unassembled simulation, the maximum stress and minimum Factor of safetyobserved on assembled simulation is observed.

Name	Type	Min.	Max
Stress	Von misses stress	453.94 Pa	9.717e+007 N/m^2

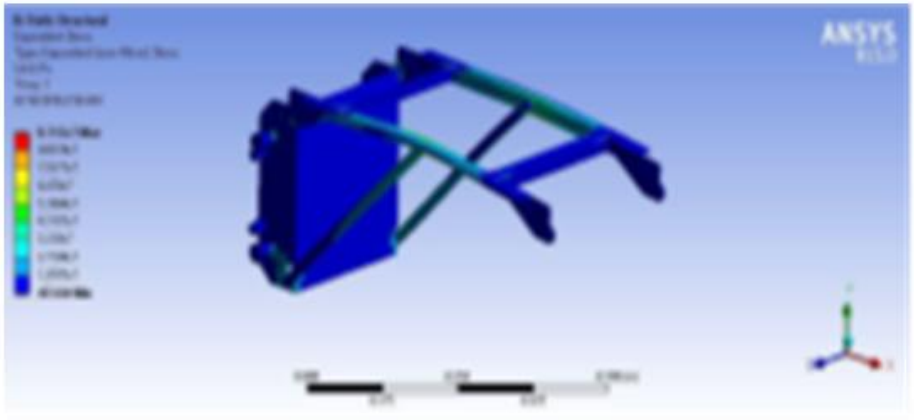

Figure 10. Material Holder Assembled Structure Von misses stress simulation.

E. Guide Way Ladder Subjected to Wind Load

Guide way ladder is used to guide the material holder when the material is lifting up and down. Its material is Aluminium, the guide ladder is made by assembling U-channel Aluminium beams, the ladders are connected by pins, and there is no weld assembly on the ladders. The will be assembled on operation with the upper frame by means of pins, they will stand vertically. The wind load which is calculated in previous section 114.22N is applied on material holder face, the material holder settled at the centre of assembled ladder guide for the simulation to determine maximum deflection and stress, the ladder guide is fixed at the top and bottom of its end face.The allowable deformation on beams are 1/600 of their length, then calculating deformation or deflection 40000/600 is 66.67 mm. since the deformation on simulation which is 10.007mm <66.67 mm then the design is safe to go.

Name	Type	Min.	Max
Stress	Von misses stress	10007 Pa	3.3065 e+007 N/m^2

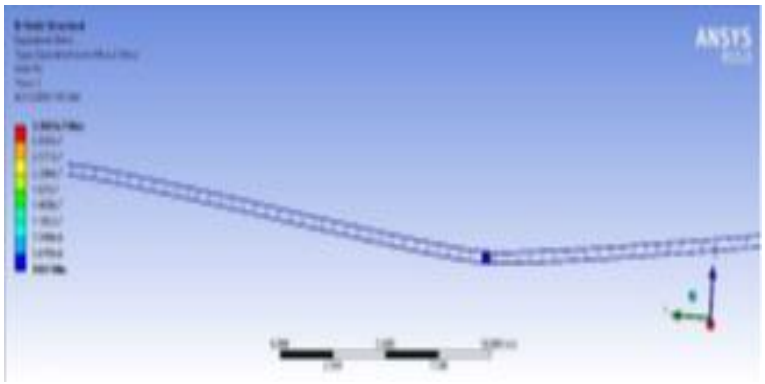

Figure 11. Guide way ladder Von misses stress simulation

Name	Type	Min.	Max
Displacement	Resultant Displacement	0 m	0.010007 m

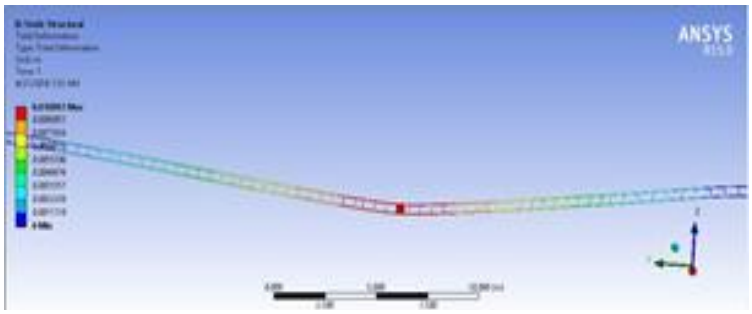

Figure 12. Guide way ladder total deformation simulation

iii. Tabulated (Calculated) Result and discussion

A. Counter Weight

- The minimum or the least permissible counter weight for the balcony crane at maximum operating weight (250 kg) is 173.2 kg.
- Container which has 0.5m diameter, 1m length is the least or minimum allowable counter weight Container length.

B. Drum and Rope

- According to DIN standard the nearest value of the cross sectional area A for the rope with 114wires is 14.3mm2. Therefore, rope diameter, d= 6.5mm, wire diameter 0.4mm, breaking load of rope is 1860Kg.

C. Motor selection

- The minimum power of motor capable to drive the drum is 0.23 Kw and operating speed at top layer 6.903 m/ min. recommended motor for this speciation is (0.25-0.37Kw) or (0.33-0.5hp) x 200rpm, it has its reduction gear box and brake with remote control.

D. Shaft

- Shaft is calculated against bending, shearing and combined bending and shearing and with selected material A-36 which has 250 Mpa yield strength. The maximum shaft diameter observed from calculation is 24 mm, but considering the bearing bore diameter 25mm is taken.

E. Castors

- Wheel diameter 80 mm and length 108 mm, Approximate weight load = 0.7 kg
  Part number EF/PN80/30BJ
  Maximum load rating 100kg
  From this stand it can be calculated all wheel can carry a maximum load of 400 kg or 4000 N.

F. Wind load/

Net Pressure

- The net wind pressure across an element is the difference of the pressures on each surface taking due account of their signs.

$$W_{net} = W_e - W_i$$

$= 0.5439 \text{ KN/m}^2$

Wind Load on faces

- The material holder face is the area subjected to wind load which is $0.21m^2$

Wind force on material holder = Wind pressure on material holder face **X** Material holder face
= 0.114219 KN

VI. Conclusion And Recommendation

A. CONCLUSION

The small scale balcony crane was designed to solve the current Ethiopian condominium residence material handling problems. Software's are used to determine the critical points and manufacturing process of the balcony crane. By Using software's called Ansys and solid Work stress, factor of safety and deformation are determined and according to simulation result improvement measures were taken.

The balcony crane maximum capacity which is 200 kg are determined by both conventional paper work and software's.

The maximum travel or conveying speed is limited by remote control the machine is designed only to house goods.

B. RECOMMENDATION

Finite Element Analysis (FEA) is an essential tool for helping in determining the cause of problems. It also recommends the solutions. Finite Element Analysis (FEA) of structural failure should be adopted as standard tool in failure analysis. If engineer is trained, then Finite Element Analysis (FEA) is very quick methodology. It is also easy to deploy. With exponential increase in computing power, Finite Element Analysis (FEA) is easy to carry out. It is widely available with user friendly commercial software.

When the operation of lifting material is started whether pulling or pushing of ladder guide is completely restricted. Skilled person should operate the machine. The materials must be tightening on material holder table. In order to avoid danger and injury care must be taken. All materials must be packaged:

- The object to be lifted must not exceed 200 kg.
- Supply power must not exceed 220 v.
- The ladder guide must be stand on flat surface.
- After operation is completed it is recommended to disassemble and set the balcony materials on dry or proper place.

References

[1]. Chetan N. Benkar, Dr. N. A. Wankhade "Finite Element Stress Analysis of Crane Hook with Different Cross Sections" in International Journal for Technological Research in Engineering, volume 1, Issue 9, May-2014, ISSN 2347-4718.
[2]. "Crane Safety. Issue No. 8: Occupational Safety Observer."Internet:http://tis.eh.doe.gov/docs/oso/oso93_08.html [Dec27 2011].
[3]. Finite Element Simulations with ANSYS Workbench 15, SDC publications.
[4]. Rajpandian R, Design and Analysis of Overhead Crane Structural Columns, IOSR Journal of Electronics and Communication Engineering, PP 69-75.
[5]. Jung, Y. C., Lee, S. H., Koo, K. J., and Hyun, C. T. 2006. A Forecasting Model for Rental Prices of Tower Cranes, Proc. Architectural Engineering National Conference, ASCE, 1-15.
[6]. Marks' Standard Handbook for Mechanical Engineers, Eleventh Edition; by Eugene A. Avallone, Theodore Baumeister
[7]. Cook R., Finite Element Modelling for Stress Analysis, John Wiley & Sons, 1995
[8]. Ajinkya Karpe, Sainath Karpe, Ajaykumar Chawrai, Sachin Vankar Rajaram,"Validation of Use of FEM (Ansys) for Structural Analysis of Tower Crane Jib and Static and Dynamic Analysis of Tower Crane Jib Using Ansys", International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163, Volume 1 Issue 4, 2014.
[9]. Apeksha. K. Patel, Prof. V. K. Jani, "Design and Dynamic Analysis of 70T Double Girder Electrical Overhead Crane" in Journal of Information, Knowledge and Research in Mechanical Engineering Vol.2, Oct-2013, ISSN-975-668X.
[10]. Ju, F., and Choo, Y. S. 2005. Dynamic analysis of tower cranes,Journal of engineering mechanics, 131(1), 88-96.
[11]. Apeksha.K. Patel, Prof. V.K. Jani, Design and Dynamic Analysis of70t Double Girder Electrical Overhead Crane, Journal of Information, Knowledge and Research in Mechanical Engineering.
[12]. Nishant soni, "crane-hook shapesoptimization and thermal analysis using finiteelement too" in international journal ofadvanced and innovation research", ISSN:2278-7844.

Kassahun Gashu Melese. " Design Analysis and Modeling by FEA of Small Scale Balcony Crane " International Journal of Engineering Science Invention (IJESI), vol. 07, no. 12, 2018, pp 47-56