COMPARATIVE ANALYSIS OF DIFFERENT MATERIAL HANDLING EQUIPMENTS

SANTHOSH KUMAR DEVARAJU
M.Tech(Ph.D), Assistant Professor
Dept. of Mechanical Engineering
Mahaveer Institute of Science and Technology, Hyderabad
Email:devarajsanthu@gmail.com

G.K.SHANMUKH DEV
M.E(Ph.D), Associate Professor
Dept. of Mechanical Engineering
Mahaveer Institute of Science and Technology, Hyderabad
Email:gksdev@gmail.com

ABSTRACT

The movement of raw material, Semi-finished products and finished products through varied stages of production and storage is termed material handling. View of old tradition of material handling sees its operation as non-value adding and only contributing to the price of product. View of modern technology acknowledges the time and space utility of material handling operation. Equipment of Material handling is employed for output increase, control prices, and productivity maximization.

The various strategies used for material handling in vertical direction are inclined conveyor, lift, robots, spiral conveyors etc.

In this thesis, the design of material handling system using slider crank mechanism is compared with Lift System Conveyor and analyzed for their deformations, stresses, frequencies, directional deformations and shear stresses. The 3D models of both the designs are done in Creo 2.0.

Static Structural, Modal and Random Vibration analysis are done on both the designs by varying materials stainless Steel and Grey Cast Iron. The load applied on the Lift System Conveyor is 4 times more than that applied on the Slider Crank Mechanism.

INTRODUCTION

Material handling is loading, moving and unloading of materials. To try and do it fastidiously and cheaply, differing types of gadgets, equipment and are utilized, when the handling of materials is said as mechanical handling of materials. Any act involving materials would like material handling. However, within the field of engineering and technology, the term material handling is employed with relevance industrial activity. In any trade, be it huge or little, producing or construction work, material need to be handled as raw material, intermediate products or finished goods from the point of receipt and storage of raw materials, through production processes and up to finished products storage and dispatch points. It conjointly price money; thus it should be eliminated or at least scale back the maximum amount as attainable. Counting on the load, volume and turnout of materials, mechanical handling of materials could become inevitable. In several cases, mechanical handling reduces the price of manual handling of materials, wherever such material handling is extremely desirable. Of these facts indicate that varieties and extent of use of material handling ought to be fastidiously designed to suit the applying and that become price effective.

Nowadays the focus is on the material handling that takes place between 2 producing stations that are placed one above the other. Therefore a system is developed engaged on a mechanism that is obtained by fixing the crank of single slider crank chain. The system is compact and works on inversion of single slider crank chain type similar to piston cylinder arrangement in I.C. engine. In the guides provided piston reciprocates as the crank rotates. Height of piston is exaggerated in each step. Here six cranks are mounted on one shaft at one hundred eighty degree to each other. Resembles to 6 piston cylinder mounded on one crank shaft. When the peak is reached in each step the material is transferred to successive piston that is at its bottom most position. To maneuver the material up, piston height is exaggerated in each step by bound calculated value.

PRINCIPLES OF MATERIAL HANDLING

Although there are not any definite "rules" that may be followed while designing a good MHS, the subsequent "Principles of Material Handling,"3 as compiled by the College-Industry Council on Material Handling Education (CIC-MHE) in cooperation with the Material Handling Institute (MHI), represent the distillation of the many years of accumulated expertise and data of the many practitioners and students of material handling.

1. Principle Planning.

All MH ought to be the results of a deliberate set up wherever the requirements, performance objectives, and practical specification of the planned strategies are fully outlined at the point in time.

2. Principle of Standardization.

MH methods, equipment, controls and software system ought to be standardized among the boundaries of achieving overall performance objectives and while not sacrificing required flexibility, modularity, and output.

3. Work Principle.

MH work (defined as material multiplied by the distance moved) ought to be decreased while not sacrificing productivity or the amount of service needed of the operation.

4. Ergonomic Principle.

Human capabilities and limitations should be recognized and revered within the style of MH tasks and instrumentality to confirm safe and effective operations.

5. Unit Load Principle.

Unit loads shall be befittingly sized and organized during a manner that achieves the material flow and inventory objectives at every stage within the provide chain.

6. Area Utilization Principle.

Effective and economical use should be product of all accessible (cubic) area.

7. System Principle.

Material movement and storage activities ought to be absolutely integrated to create a coordinated, operational system that spans receiving, inspection, storage, production, assembly, packaging, unitizing, order choice, shipping, and transportation, and also the handling of returns.

8. Automation Principle.

MH operations ought to be mechanized and/or machine-driven wherever possible to boost operational efficiency, increase responsiveness, improve consistency and predictability, decrease operative prices, and to eliminate repetitive or probably unsafe labor.

SLIDER CRANK MECHANISM

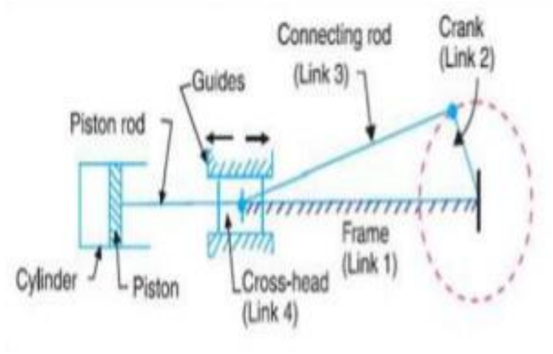


Figure 1 Single Slider Crank Chain

As shown in figure one, once one turning pair of a four bar chain mechanism is replaced by sliding pair, it becomes single slider crank chain or just slider crank chain. It's one in all the most affordable mechanisms.

Crankshaft

When the piston is at BDC the bending moment on the rotating shaft are going to be max. During this position the radial force is max. and tangential force is zero. A 3D model of rotating shaft is shown in figure four. We've got thought of the rotating shaft as a merely supported beam. The utmost bending moment are going to be at center.

Figure 2: Crankshaft

Bending stress,σ (Sigma) b = $\frac{m}{z}$---------------- 1
Where M = Maximum Turning moment, Te $=\frac{\pi}{16}$ dc$^3\tau$ (tou) ---------- 2
Z = section modulus = (lIE / 32) x D3
Considering the crank at a position where tangential force is max. From the figure five once, zero + = ninety tangential force are going to be max. Due to this most tangential force, torsional shear stress are going to be developed in rotating shaft.

APPLICATION

- Small scale and light industries
- Hospitals ,Banks, Hotels
- •Reciprocating engine
- Rotary engine
- Oscillating cylinder engine
- Hand pump, Scotch yoke
- Oldham coupling
- Elliptical Trammel

About the square cam mechanism

In this system the motor rotation is to be stopped once each shaft revolution sure as time period in order that the material gets transferred. Then motor ought to begin and complete consequent handle revolution and again stop. To attain this sq. cam mechanism is employed.

Figure 3 - Conveyor Layout

Fig.3 shows conveyor Layout. Consider about the staff are functioning on ground and 1st floor. The scope of our system is to transfer the material from the conveyor on ground floor to the conveyor on floor mechanically and unceasingly. A storage and retrieval system is shown in figure three. Our system is accustomed transfer the material to those multi-level racks. The system is created mobile so it is moved.

The invention of the crank and connecting rod system is taken into account by historians of technology to be the foremost vital mechanical device of the first 15thin Europe. Bertrand Gille says that this method was unknown before that date and this had significantly restricted the applications of mechanization.

CONVEYOR SYSTEM

A conveyor system could be a common piece of equipment of mechanical handling that moves materials from one location to another. Conveyors are particularly helpful in applications involving the transportation of bulk or heavy materials. Conveyor systems permit fast and economical transportation for a large style of materials that create them extremely popular within the material handling and packaging industries. Several forms of conveyance systems are offered and are utilized consistent with the assorted requirements of various industries. There are chain conveyors (floor and overhead) similarly. Chain conveyors encompass closed tracks, I-Beam, towline, power & free, and hand pushed trolleys.

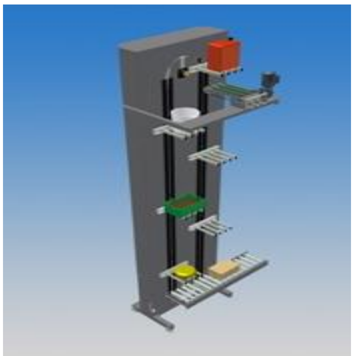


Fig 4 – Lift system conveyor

Our Vertical Shaft design minimizes required space for inter-level transport.Additionally, Kleenline's Integral Feed Conveyors move product as a pass-through or position cases for lifting to a different level. There, a Pneumatic Pusher discharges product as needed.Dynamic Braking controls stop/start whereas extending motor life. Integral automation controls product movement and Programmable Settings guarantee careful handling of delicate merchandise. Lexan covers enable safe observation of raise operation.As with all Klee line systems, custom styles resolve distinctive or difficult applications whereas meeting USDA conveyor standards.

Standard Specifications

- Speeds up to 60 cases per minute
- Capacity up to 100 pounds per case
- Elevation up to 15 feet
- Designs to suit box size

AdvantagesBelt Options

- Plastic Modular ,Wire
- Timing Belts ,Chain
- Urethane Strand, Gravity Rollers
- Synthetic Fabric, Table-top Chain

Compliance Standards

- BISC,USDA ,FDA, ISN
- National Sanitation Foundation

Customization

- Robotics ,Automation Controls
- PLC Programming
- Drive Type — Brand
- and Variable Speed
- Mounting and ,Support Side Rails

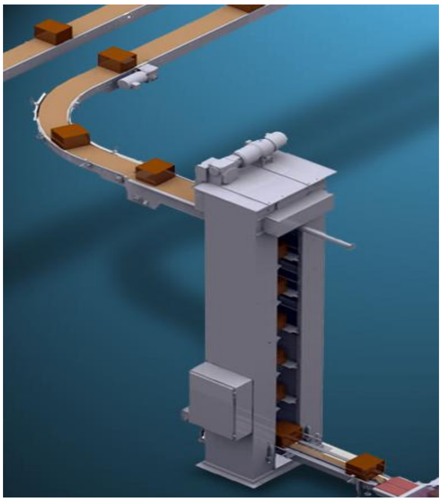


Fig 5: Hydraulic Vertical Material Handling System

LITERATURE SURVEY

In the paper by GargUttam[1] thus effective area usage is given utmost importance in industrial design. Numerous producing processes are administered on multiple floors. As an example whereas producing wafers, soaps, biscuits and different cookies and conjointly on numerous assembly lines totally different processes are administered at multiple stations.. Organizations are attempting to utilize each in. of area typically take into account vertical carousels and vertical elevator modules attributable to high storage density they supply. The paper involves the design of an efficient system which is able to transfer the material from lower level to higher level.

In the paper by Manan Mehta, [2] the author was inspired By The Merry Go Around in the Easel World, Mumbai and that we Finally set to Implicate concept of they have selected solely Chain and Sprocket Arrangement. In this project as a result of chain is solely single arrangement which provides zero Error within the Synchronization. The power needed for moving the Chain and Sprocket Arrangement are provided by twelve volt DC supply victimization the DC motor.

In the paper by Shrinivas .B.Patil, ShenaviSourabh R, [3] Material handling involves short-distance movement inside the compass of a building or between a building and a transportation vehicle. as distinct from producing, that creates type utility by dynamic the form, form, and makeup of material.

In the paper by Kumbhar P.M., Ballal Y.P,[4]Material handling has very old and vast history. During this paper the revive of principles of material handling systems and varied material handling systems utilized in manufactory is taken.

In the paper by Dr. TauseefAized [5]The issues for material system style embrace the dimensions, weight, condition and stack ability of materials; the specified throughput; and building constraints like floor loading, floor condition, column spacing etc. Physical management is that the orientation of sequence and house between material movements. Standing management is that the real time awareness of the placement, amount, destination, origin, possession and schedule of fabric.

In the paper by Sivabalan.KS[6] the system transfers the material vertically in n variety of steps. Every step consists of crank, rod and piston arrangement. Because the cam rotates piston reciprocates within the guides provided. Height of piston is inflated in each step.

Here eight cams are mounted on one shaft at one hundred eighty degree to every alternative..

In the paper byGhazi Abu Taher [7] Belt conveyor & Bucket elevator are the media of transportation of material from one location to a different during a business house.. On the opposite hand Bucket elevator may be of nice use throughout bulk material handling. This paper is principally supported the mix of Belt & Bucket Conveyers to perform advanced task among a brief time and with success during a price effective manner. On account of this, a machine and its physical description is roofed here with some basic calculation.

In the paper by A. P. Bahale, [8] material handling has become a replacement, complex, and quickly evolving science. Material handling can't be avoided in supplying, however will actually be reduced to minimum levels. The aim of the work is to find and establish the wasteful activities concerning the material handling, and to contour the activities to achieve a minimum of material handling.

OBJECTIVE OF THE PROJECT

In this thesis, the present design of vertical material handling system using slider crank mechanism is modified with Hydraulic Vertical Material Handling System and analyzed for their deformations, stresses, frequencies, directional deformations and shear stresses. The 3D models of both the designs are done in Creo 2.0.Structural; Modal and Random Vibration analysis are done on all the designs by varying materials at a particular speed and load.

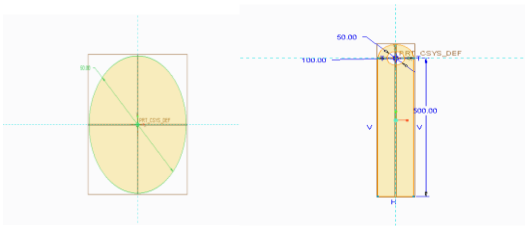


Fig6 : Sketch 1

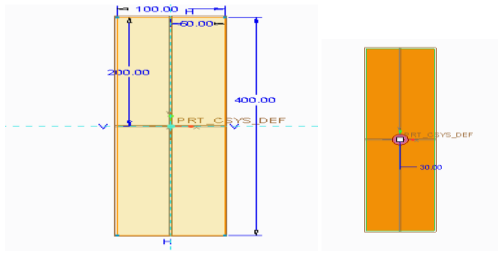


Fig 7: Extrude 1

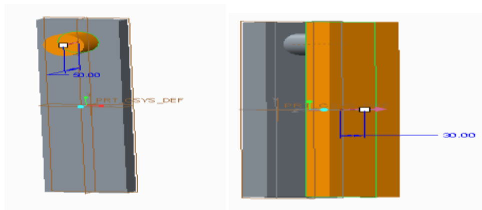


Fig 8: Extrude 2

Fig9 : Final assembly of slider crank mechanism

ANALYSIS OF VERTICALHANDLING SYSTEMS

The reference paper for analysis is taken from the journal paper, "Vertical material handling system" by GargUttam, BhowadRugved, Rahul Chorghe, YadavSachin, International Journal of Mechanical Engineering and Technology (IJMET), ISSN 0976 – 6340(Print), ISSN 0976 – 6359(Online), Volume 6, Issue 2, February (2015), pp. 19-29, specified as [1] in References chapter.

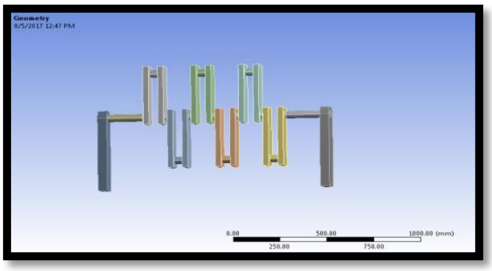


Fig10: Imported Geometry of Slider Crank Mechanism

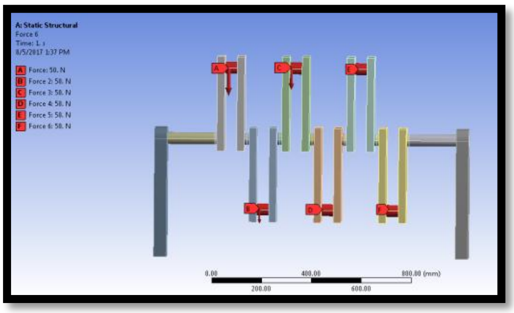


Fig11: Forces applied on cranks

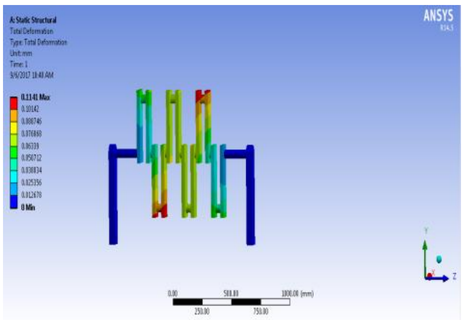


Fig 12: Total Deformation using stainless Steel for Slider Crank Mechanism

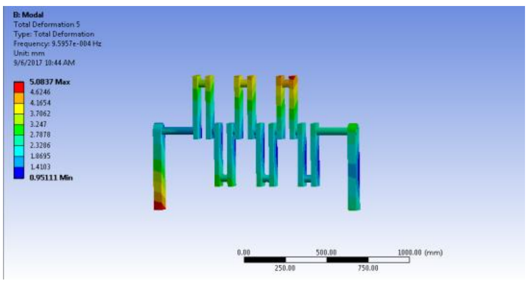


Fig13: Total Deformation at Mode 1 using stainless Steel for Slider Crank Mechanism

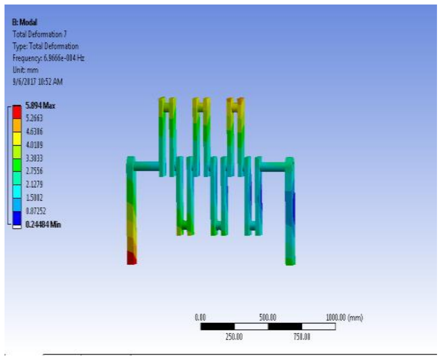
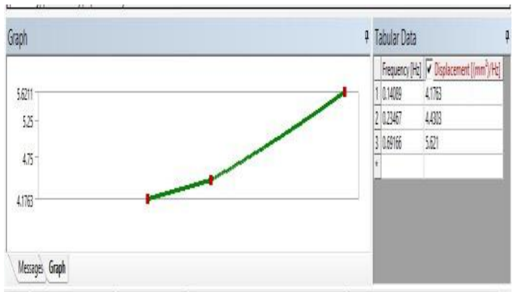
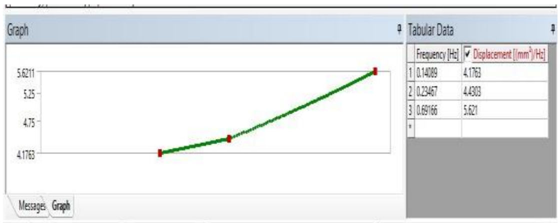


Fig14: Total Deformation at Mode using grey cast iron for Slider Crank Mechanism



Graph1: Specifying frequencies and displacements obtained in Grey cast iron



Graph 2: Specifying frequencies and displacements obtained in Stainless steel

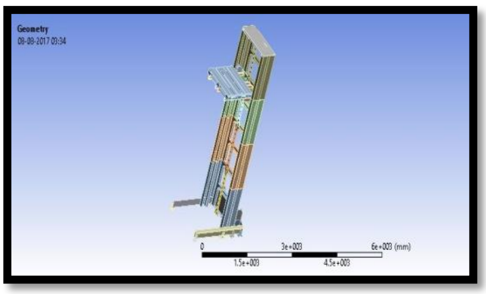


Fig15: Geometry of Lift System Conveyor

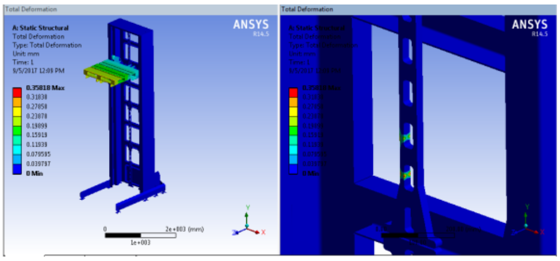


Fig16:Total Deformation using grey cast iron for Lift System Conveyor

	Frequency (Hz)		
	Mode-1	**Mode-2**	**Mode-3**
Stainless Steel	0.00021466	0.00095957	0.0017784
Grey cast iron	0.00069666	0.001377	0.0006956

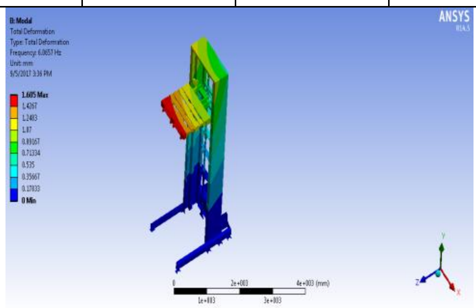


Fig17: Total Deformation using Stainless Steel for Lift System Conveyor

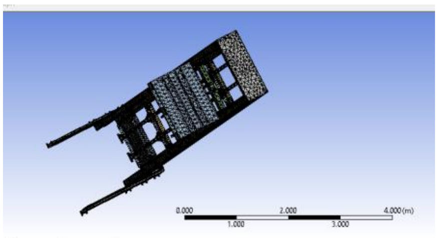


Fig 18:Random vibration analysis

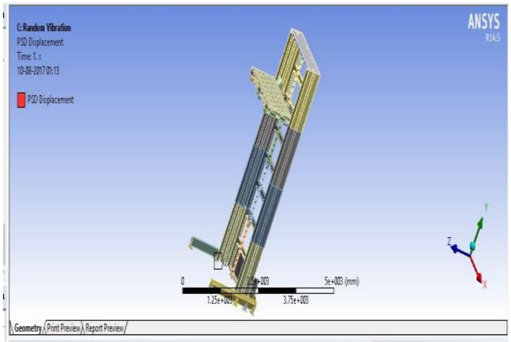
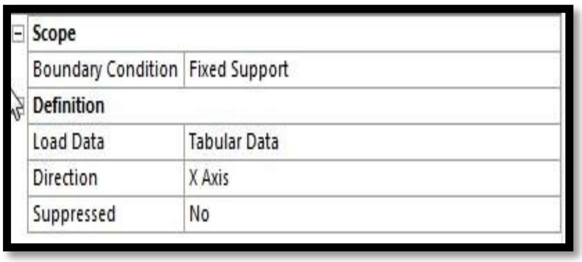
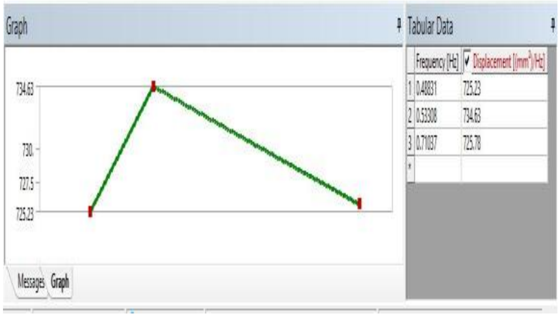


Fig19: PSD Displacement



Scope	
Boundary Condition	Fixed Support
Definition	
Load Data	Tabular Data
Direction	X Axis
Suppressed	No



Graph3 – Frequency and displacement values taken from Modal analysis

RESULTS

Slider Crank Mechanism

	Total Deformation(mm)	**Stress (MPa)**	**Strain**
Stainless Steel	0.1141	4.5476	0.000023648
Grey cast iron	0.20097	4.5556	0.000041551

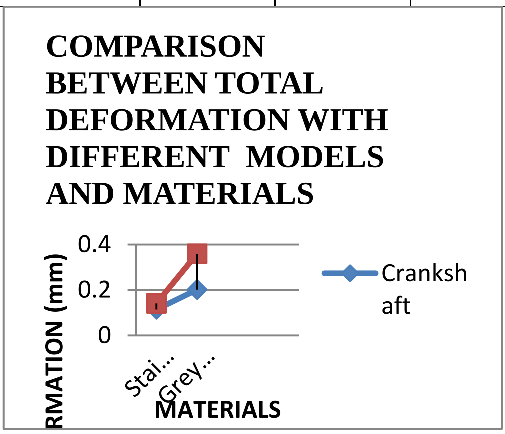
Lift System Conveyor

	Total Deformation (mm)	Stress (MPa)	Strain
Stainless Steel	0.140277	5.5751	0.000032272
Grey cast iron	0.35818	5.6013	0.00005741

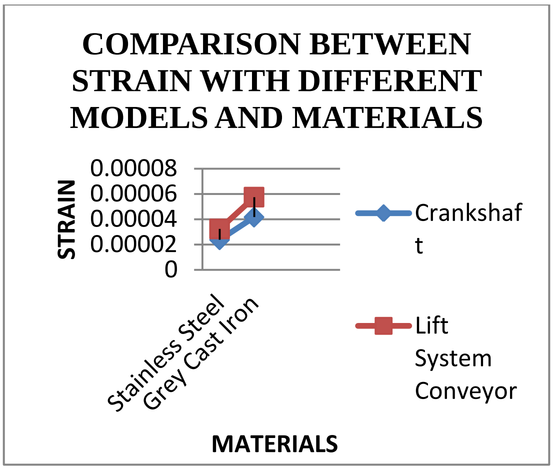
Slider Crank

Lift System Conveyor

	Frequency (Hz)		
	Mode-1	**Mode-2**	**Mode-3**
Stainless Steel	6.0657	6.1199	7.5358
Grey cast iron	4.7518	4.7968	5.5074



Graph 4: Comparison between Total Deformation with Different Models and Materials



Graph5 : comparison between strain with different models and materials

CONCLUSION

In this thesis, the design of material handling system using slider crank mechanism is compared with Lift System Conveyor and analyzed for their deformations, stresses, frequencies, directional deformations and shear stresses. The 3D models of both the designs are done in Creo 2.0.

Static Structural, Modal and Random Vibration analysis are done on both the designs by varying materials Stainless Steel and Grey Cast Iron. The load applied on the Lift System Conveyor is 4 times more than that applied on the Slider Crank Mechanism.

By observing Static Structural analysis results, the stresses for both the models are less than their respective yield stress values for both materials. The stresses are increasing Lift System Conveyor model by 18% for both materials even though load applied on that model is more by 75% than Slider Crank model.

By observing Modal analysis results, the frequencies are increasing Lift System Conveyor model by 99% when both materials are used when compared with that of Slider crank model. The frequencies are more for Stainless Steel due to their less density.

By observing Random Vibration analysis results, the shear stresses are negligible for Lift System Conveyor model due to the frequencies. The shear stresses are more for Slider crank model using Grey Cast Iron.

REFERENCES

1]*"Vertical material handling system" by GargUttam, BhowadRugved, Rahul Chorghe, YadavSachin, International Journal of Mechanical Engineering and Technology (IJMET), ISSN 0976 – 6340(Print), ISSN 0976 – 6359(Online), Volume 6, Issue 2, February (2015), pp. 19-29.*

2]Manan Mehta, Roshan Patel, Vishal Patel, Smit Patel, "Fabrication Of Vertical Material Handling Equipment.

3]Shrinivas .B.Patil, ShenaviSourabh R., Shaikh Rahim B. , Khan MhamudhusenN., ShindePrafull S., Design And Development Of Vertical Material Handling Lift For Reduce Cycle Time And Cost Optimization.

4]Kumbhar P.M., Ballal Y.P and Pawar G.B. Various Material Handling Systems in Foundry.

5]Dr. TauseefAized,Materials handling in flexible manufacturing systems.

6]Sivabalan.Ks, Mathews M, Vertical Material Handling System.

7]Ghazi Abu Taher , YousufHowlader , Md. Ash eke Rabbi, FahimAhmedTouqir, Automation of Material Handling with Bucket Elevator and Belt Conveyor.

8] A. P. Bahale, Dr.S.S.Deshmukh, Improving Material Handling Efficiency in a Ginning Machine Manufacturing Company.

9]A. Dania, Ado Equity, Equity State, Nigeria, Design of a Material Handling Equipment: Belt Conveyor System for Crushed Limestone Using 3 roll Idlers.

[10]KulkarniPrabhanjan P, Goshute Sarah S, Design and Analysis of Material HandlingSystem.