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Design & analysis of seat tilting of a wheelchair by using hydraulic system

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Abstract---- In presently world there are lot of Disable people living, it is very difficult to face day to day life in a computation world. Mainly they are depend on Wheelchair to survive in a society. In present wheelchair it is very difficult while moving on a slope. If chair moving up the slope there is possibility that the person will fall backward and if chair is moving down the slope then the person will fall front side of chair. In this project we are providing solution for this problem. And we are using hydraulic system for tilting a seat. This will provide comfortable while moving on a slope, like if moving in a downward we can tilt the seat backward with some inclination similarly in moving in upward we can tilt the seat downward with some inclination. This will provide smooth movement for a user with good economy.

Key words---- Wheelchair, Seat Tilting, Hydraulic System

I. Introduction

Wheelchair is a chair with wheels that is used by people who cannot walk because they are disabled, sick or injured. This is the device comes in variation allowing either manual propulsion by the seated people turning the rear wheels by hand or electric propulsion by motors. There are often handles behind the seat to allow it to push by another person. People who have difficulty sitting and walking often make use of wheelchairs.

In this fast moving materialistic world people need to modernize and progress themselves. The world's population increasing faster and also the people with disabilities. They face barriers in their daily works and they need some helpers. So, they need a device which will help them to improve their daily life. The device which is helping them is wheelchair. The wheelchair acts a boon for them. The most widespread assistive device is the wheelchair. All over the world the usage rate of the people with wheelchair is nearly 3.3 million.

In 1887 wheelchairs (rolling chairs) were introduced to ATALANTIC city so tourists to rent them to enjoy bored walk. Many healthy tourists also rented the decorated rolling chairs and the servants to push them.

HARRY JENNINGS and his disabled friend HERBERT EVEREST, both Mechanical Engineering invented the first light weight steel, collapsible wheelchair in 1933. EVEREST had

broken his back in mining accident. The two saw the business potential of the invention and went on to become the first mass manufactories of wheelchairs. Their "X-BRACE" design is still in common use along with updated materials and other improvements.

Wheelchairs currently the only available solution to the mobility problem of disabled people. For disabled persons equal opportunities need focused on accessibility and independent mobility. The most obvious needs of employment and education have now been addressed by legislation governing. But, other opportunities of less obvious nature have remained neglected and inaccessible. They represent not only physiological needs but opportunity to meet with others, even to compete, is also dependent on the ability to move around independently. To produce, to create, to recreate each of these effects all depends to some degree of mobility. For nondisabled (normal person) these environmental behaviors are small matters easily taken care Advances in wheelchairs designed have provided increased easy and range of mobility but they have not significantly reduce the limitations to the use of wheels. Our concept of "Tilting mechanism" predicted on the desired to expand the capabilities of mobility device such as wheelchairs opportunities for independent and healthy living beyond the capacity of guidelines for the development of this project.

In our work we tried to provide comfort and safe mobility to wheelchair while moving in slopes using seat tilting mechanism.

II. Objective of our work:

The objective of this project is to analysis and a motorized wheelchair based in extensive fast findings & research on existing models, technology used market scenario and customer requirements. The course of work begins with the planning phase involving initial research, literature review and background study.

It is followed by concept generation phase that includes evaluating customer requirement, outlining specifications & generating concept designs. Next comes the system level design in which product architecture is defined and parts are modelled in CATIA V5. The wheelchair components were designed, modelled using CATIA V5 and analysis using ansys 14.5, we compare the results analytical and experimental solution (FEM).

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III. Introduction to CAD/CAE

Computer Aided Design-(CAD):

From the inception, it has been human nature innovate, discover, invent new things and so has been his creation. Design may be pronounced as the synonym for creation so there is no end to man's creation, design and hence CAD. By passage of time it will be even smarter, quicker & sophisticated.

CAD involves creating computer models defined by geometrical parameters. These models typically appear on a computer monitor as a three dimension representation of part or system of parts, which can be readily altered by changing relevant parameters. CAD systems enable designers to view objects under a wide variety of representations and to test their objects by simulating real world conditions.

Based on the concept of CAD technology many
CAD software's have been developed by software giants like Autodesk Inc, Bentley, Dassault systems, some of the leading software in industry are

1) AUTOCAD
2) MICROSTATION
3) CATIA
4) UNIGRAPHICS
5) SOLID EDGE etc.

In our work we used CATIA V5 software to model the component,

CATIA-computer aided three dimensional Interactive application

It is a multiplatform computer aided design, software suit developed by the French company Dassault System. CATIA enables creation of 3D parts, 3d sketches, sheet metal, composites, and assembly. The software provides advanced Technologies for Mechanical Surfacing of BIW CATIA Provides a Wide Range of Tooling Design for both generic tooling, mould and Die. CATIA offers a solution to shapes design, styling, Surfacing workflow and Visualization to create, modify and validate complete innovative Shapes from Industrial design to class-A Surfacing with the ICEM Surfacing Technologies.

IV. Working Methodology:

We can see there are variety of wheelchairs available in market for serving disabled people, with a wide range of specifications and applications. We have many designs of wheelchairs but still they have lot of drawbacks. We undergone survey as a part of our work with doctors and disabled people and we understood different problem from feedback of them. Some of these problems are present in current wheelchairs and they are

1. No proper footstep design for person whose knee is hurt
2. Problems for person at the time of urination and toilet
3. No proper seating arrangement if wheelchair is moving on slopes
4. There must be one person always needed to push the wheelchair

The objective of our work is on providing proper seat arrangement for wheelchairs when it will move on slopes. For fulfilling this objective we designed some of the parts of wheelchair. Those parts will improve the quality and applications of present wheelchair.

V. Design of Wheelchair

Guidelines on the design and selection of wheelchairs and how to produce. The focus here is to increase the quality and range of manual wheelchairs available in less-resourced settings. Health and safety, strength and durability, suitability for use, and effective production methods are the main design criteria. The design of a wheelchair determines its functional performance in matters of stability, maneuverability, pushing and transferring efficiency, transport and reliability.Weight should be considered when designing a wheelchair. Reducing weight not only makes the chair easier to use, it also lowers the material cost. One weight reducing strategy is to design your frame so all the features add strength. Try to avoid features that add weight but do not add strength. Another strategy is to maximize the strength and minimize the weight of the frame tubing. In this phase of our work, we mainly focus on three parts of wheelchair. Those
Parts are

1) Design of $shaft_1$
2) Design of main frame
3) Design of hinges
4) Hydraulic system

Shaft: It is a machine element used to transmit motion, in the wheelchair it is main part which drives the wheelchair. It is the part which is connected to the two wheels of wheelchair. And it will give the stability to the chair.All parts have a certain amount of stiffness. The stiffness of a part depends on the material and the geometry. Notice that the stiffness of each part has the modulus of elasticity (*E)* in the equation. This means the part can be made stiffer if it is made from a material with a higher modulus of elasticity. In the beam examples, stiffness also increases with the moment of inertia.

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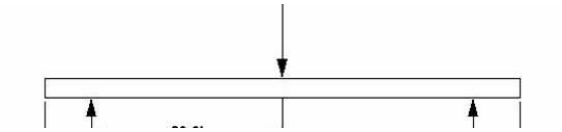

Fig: Shaft with load

Main frame: It is a main part which carry all other parts and gives seating arrangement in it. It is fabricated by using steel pipe using suitable welding process. As comparing with other materials used in frame design we considered steel pipe in order to maintain weight to strength ratio.If you want a frame or any kind of structure to be stiff you should design the components of the structure to be close together. A structural loop is a visual way of representing how forces travel through a structure. If the path the forces take is narrow, the structure will be stiff. For example, picture the forces that travel through the caster frame. The forces start at the ground and move up through the caster barrel. At the top of the barrel they travel into the frame, loop around the frame, and come back to the bottom of the barrel. Now imagine if the caster frame was very long – the structural loop would be larger and the frame would be less stiff.

Hinges: In our work, we design two hinge parts as upper and lower hinge, one of this part will be fixed with frame and another part of hinge is connected to seat in order to achieve the tilting movement of seat. The hinges are rigid, it carries total load of person from seat. As per our desired objective it gives a angular tilting movement of seat.

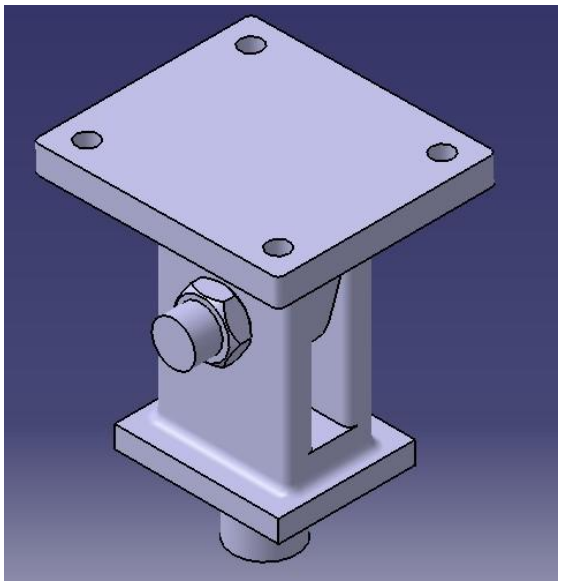

Fig: Assembly of hinge

Hydraulic system: Hydraulic system is used to lift the load. Hydraulic will lift load in slow and steady way. In our work we used this mainly to achieve tilting movement of seat with constant speed and smooth operation. This system is arranged such a way that it can work without giving any problems to the person seating on wheelchair.

Vi. Modeling of Wheelchair

We design all required parts of wheelchair using CATIA V5 software. CATIA is a multiplatform computer aided design software suite developed by the French company DASSAULT SYSTEMS. The parts which we have designed are as per our work aspects. Each of these parts are assembled as per the required positioning and consideration of design which will fulfill the objective of our work.

Fig: Final assembly of wheelchair

Calculation for Shaft

1) Maximum bending moment

$$M^{max} = \frac{pl}{4}$$

2) Maximum deflection

$$\Delta_{max} = \frac{pl\text{^}3}{48EI}$$

3) Shear stress at yield

$$\tau_{ed} = \frac{\tau}{fos}$$

4) Diameter of shaft

$$_{D} = \left(\frac{16}{\pi \tau ed} \ (k\ m) \right)^{1/3}$$

The calculation part as mentioned above will satisfy the required conditions.

Hydraulic system used

Working Principle of Hydraulic system: A Hydraulic Jack uses a fluid, which is incompressible, that is forced into a cylinder by a pump plunger. Oil is used since it is self-lubricating and stable. When the plunger pulls back, it

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draws oil out of the reservoir through a suction check valve into the cylinder. The suction valve ball is within the chamber and opens with each draw of the plunger. The discharge valve ball is outside the chamber and opens when the oil is pushed into the cylinder. At this point the suction ball within the chamber is forced shut and oil pressure builds in the cylinder.

Hydraulic system are mechanical devices used to lift heavy loads, vehicles, weight equipment or apply great forces using hydraulic fluid as the main source of power. These are widely used in automotive, industrial and construction industries. These are sturdy in construction, compact in size, portable and capable of exerting great forces. It consists of two cylinders of different sizes which are connected together by a pipe and a hydraulic fluid or oil. And it is this pressure which leads to the working of the hydraulic jack. It also finds usage in workshops and also lifts elevators in low and medium rise buildings.

Hydraulic system with varied sizes and specifications are used to lift different types of heavy equipment and vehicles such as bulldozers, forklifts, elevators, trolleys & trailers and excavators. These can also be found in household equipment as well like door stoppers, cars, bikes etc. Hydraulic System are high in demand across the globe owing to their sturdy construction, reliable& hassle free operation, unparalleled performance, user-friendly design and less maintenance.

Analysis

In this we are using ANYSIS 14.5 for the Analysis

Analysis of frame:

The wheelchair frame is rigid, tubular structure that supports the seat and the wheels. In this we are applying 150kg (1470N) of load with a factor of safety 1.5 according to International wheelchair organization. According to below properties of Stainless steel.

Properties:

DENSITY:- 7.75Kg/m3

YOUNG'S MODULUS:- 208GPa

POISSIONS RATIO:- 0.3

TENSILE STRESS:- 515-827MPa

YIELD STRESS:- 207-552MPa

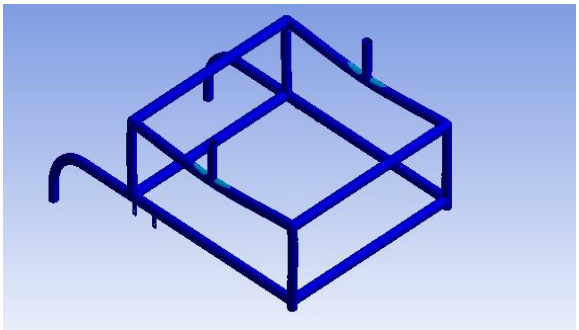

Fig: Frame of the wheelchair

After the analysis we get the result of stress is with in the range. Hence design is Safe.

Analysis of Hinge:

Hinge can be defined as moveable part or mechanism which it lies.

In this mainly we are using two hinge for both the sides hence the total load is distribute equally for both the hinge.

This is divided mainly in two parts as Upper and lower hinge. Analysis is done separately for upper hinge and lower hinge.

The material used for hinge is STAINLESS STEEL and the mechanical properties of it, as follows.

DENSITY:- 7.75Kg/m3

YOUNG'S MODULUS:- 208GPa

POISSIONS RATIO:- 0.3

TENSILE STRESS:- 515-827MPa

YIELD STRESS:- 207-552MPa

Upper Hinge:

It is very important part of our work, which will enable the seat tilting mechanism. This is connected to the seat.

The analysis of upper hinge is performed by applying load(Pressure) on the half circular surface of hinge which will be shown below.

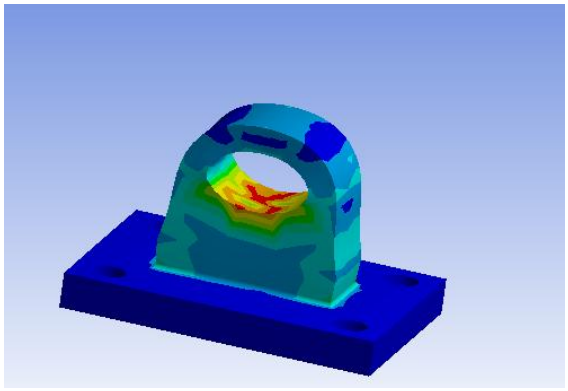

Fig: Upper Part of Hinge

Lower Hinge-

It is very important part of our work, which will enable the seat tilting mechanism. This is connected to the main body which is rigidly fixed.

The analysis of upper hinge is performed by applying load (Pressure) on the half circular surface of hinge which will be shown below.

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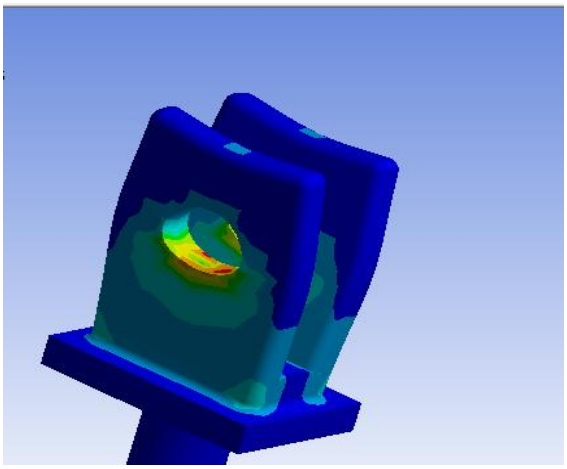

VII. Conclusion

The main concept behind selecting this project is to promote personal mobility and enhance quality of life which is achieved by seat tilting mechanism by using Hydraulic system. Which improves the comfortless of the Disable people.

References

1) Mechanical Principles of Wheelchair Design.
(Challenges for users, financial barriers, physical barriers of wheel chair)

2) Anatomy of a Manual Wheelchair.
(Components & its importance)

3) Guidelines on the provision of Manual wheelchairs.
(Calculation, forces, free body diagram.)

4) Basic Wheelchairs.
(Types, history, present condition)