A PROJECT REPORT

ON

"MECHANICAL WALKING SIMULATOR"

Submitted by

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IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

Prof. ZAKIR ANSARI

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL,

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This is to certify that the project entitled

"MECHANICAL WALKING SIMULATOR"

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

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APPROVAL OF DISSERTATION

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PROF. ZAKIR ANSARI ___________________

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ABSTRACT

This report aims to model, stimulate, and perform the static and dynamic analysis and fabrication of walking stimulator that help the person who doesn't know how to walk. Modeling simulation are performed using modeling software i.e. SOLIDWORKS and analysis on SOLIDWORKS/ANSYS. The deflection is determined by performing static analysis and dynamic analysis.

As we have to customize this walking stimulator so it can use for those people who not able to walk. Strength and light weight is our basic consideration throughout the design of walking stimulator. Hence the proper material is selected for the design.

All the impact and stress were calculated by considering the walking condition and then design was analyses in the software. Step by step the modification in design we made as found necessary and analyses in software. After the complete analysis and the approval of design by inspecting it in the modes of failure the design was finalized and was selected to fabricate which will not fail in any extreme criteria of stresses or load induced.

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Introduction

1. Introduction:

Several studies have shown that both children and adults benefit substantially from access to a means of independent mobility, including power wheelchairs, manual wheelchairs, scooters, and walkers. Independent mobility increases vocational and educational opportunities, reduces dependence on caregivers and family members, and promotes feelings of self-reliance. For young children, independent mobility serves as the foundation for much early learning. Nonambulatory children lack access to the wealth of stimuli afforded self-ambulating children. This lack of exploration and control often produces a cycle of deprivation and reduced motivation that leads to learned helplessness.

For adults, independent mobility is an important aspect of self-esteem and plays a pivotal role in “aging in place.” If they become unable to walk or wheel themselves to the commode and help is not routinely available in the home when needed, a move to a more enabling environment (e.g., assisted living) may be necessary. Mobility limitations are the leading cause of functional limitations among adults, with an estimated prevalence of 40 per 1,000 persons age 18 to 44 and 188 per 1,000 at age 85 and older. Mobility difficulties are also strong predictors of activities of daily living (ADL) and instrumental ADL disabilities because of the need to move to accomplish many of these activities. In addition, impaired mobility often results in decreased opportunities to socialize, which leads to social isolation, anxiety, and depression. For example, 31 percent of persons with major mobility difficulties reported being frequently depressed or anxious, compared with only 4 percent of persons without mobility difficulties.

While the needs of many individuals with disabilities can be satisfied with traditional manual or powered wheelchairs, a segment of the disabled community finds it difficult or impossible to use wheelchairs independently. This population includes, but is not limited to, individuals with low vision, visual field reduction, spasticity, tremors, or cognitive deficits. These individuals often lack independent mobility and rely on a caregiver to push them in a manual wheelchair. To accommodate this population, several researchers have used technologies originally developed for mobile robots to create wheelchairs.

Using a multibody passive-legged class of vehicle as a solution to the all-terrain mobility problem a vast design space of particular implementations. Specifically, there is a multitude of possible crawling vehicle configurations, and for each of these different robot design, there is a virtually limitless number of possible motion program that could be used. Note that a motion program or gait that works well with one robot design often does not work well with another design. Solving all-terrain mobility problem requires the compatible operation of both a good robot design and good motion program designs.

Sifting through such vast design possibilities for the best solution is not a job for pocket calculators and drawing boards more powerful tools are required to obtain good, timely results. As with other complex engineering design efforts, simulation is often the tool of choice because it enables the testing of design alternatives without having to physically construct them.

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Chapter 2

Literature survey

2. Literature review:

2.1 Wheelchair for physically disable person:

There were many attempts to connect furniture to wheels dating back to the time of Christ. But perhaps the first wheelchair was invented for king phillip of spain. A drawing of the king dated 1595 shows him in a chair with wheels, armrests and footrests. However, he needed assistance to propel it and the chair resembled more a modern baby's highchair than a wheelchair of today. In 1665 one of the first self-propelled vehicles was invented by Stephan Farfler. But it looked more like a present day hand-bike than a wheelchair as it was propelled by hand cranks attached to the front wheel. The modern wheelchair begin to take shape in the late 19th century to early 20th century with the advent of push rims for self-propulsion and slings for seat and backrests. The 20th century saw a rapid development in wheelchairs, from the first motorized wheelchair, to the first folding wheelchair, to light weight and sports wheelchairs. The most recent two decades have seen the progress in the modern wheelchair accelerate. They are lighter and perform better than the ever before. There are many different types of wheelchair that are used for various reasons. It is important to understand the limitation and safe operation of whatever wheelchair we choose.

2.1.1 Types of Wheelchairs:-

A. Manual Wheelchairs:

Manual wheelchairs are the type that requires people to move them; there are three types of manual wheelchairs namely self-propelled, attendant propelled, and wheelbase. Many manual chairs can be folded wheelchairs for storage or movement into a vehicle. A single-arm drive enables the user to turn either left or right while the two-armed drive enables user to move forward or backward on a straight line. Another type of wheelchair commonly used is a lever-drive wheelchair. This type of chair enables the user to move forward by pumping the lever back and forth.

Fig 2.1 Manual wheelchair

B. Electric Wheelchairs:

The electric powered wheelchair was said to be invented by George Klein who worked for the National Research Council of Canada, to assist injured veterans during World War II.A power chair can be used by someone who hasn't got the dexterity or mobility, perhaps, to drive a mobility scooter due to arm, hand, shoulder or more general disabling conditions, and do not have the leg strength to propel a manual chair with their feet. EPWs can offer various powered functions such as tilt, recline, leg elevation, seat elevation, and others useful or necessary to health and function. A power chair user might also have special seating or arm and leg rest requirements that are better served by a power chair than a mobility scooter. The technology involved in electric wheelchairs is similar to that of mobility scooters and some power chair manufacturers are offering models that look more like a mobility scooter than a traditional wheelchair. Today you will find three general styles of electric powered chairs (EPWs) rear, Centre, front wheel driven or four wheel driven. Each style wheelchair has particular handling characteristics. EPWs are also divided by seat type; some models resemble manual chairs, with a sling-style seat and frame, whereas others have 'captain's chair' seating like that of an automobile. EPWs run the gamut from small and portable models, which can be folded or disassembled, to very large and heavy full-featured chairs (these are often called 'rehab' chairs). The user typically controls speed and direction by operating a joystick on a controller. Many other input devices can be used if the user lacks coordination or the use of the hands or fingers, such as chin controls and puff/sip scanners Power chairs are usually controlled by a joystick on the armrest which can be fitted on either armrest to suit left or right handed use. The arm rest can usually be swung out of the way so that the user can get closer to a desk or table for example. If a joystick control isn't appropriate for the user's needs, there are other methods of operating the power chair, including a head controller, a sip and puff tube, fingertip control or foot control for those with spinal cord lesions or head injuries (the user blows into a tube located near the mouth, which controls the movement of the chair).A power chair or electric wheelchair can bring independence and freedom to those currently reliant on others. Once you have decided on a power chair rather than a mobility scooter or wheelchair, there are still plenty of other choices to be made. Including the price, the style and size of the power chair, how portable the power chair is, and how far it goes between charges.

Fig 2.2 Electric wheelchair

C. Pediatric Wheelchairs:

Most pediatric wheelchairs fall under the following categories: Standard Wheelchairs – These are the so-called traditional styles, Small Child Wheelchairs – This variety is designed for kids under the age of six, Sports/Lightweight Wheelchairs – These are popular for everyday use because of their sporty appearance, lightweight frames, and independent movement. Junior/Child/Growing Pediatric Wheelchairs – They are intended for children who are six years old and over, Specialty Wheelchair – These models require various alterations to a basic chair such as a tilting or reclining option.

Fig 2.3 Pediatric wheelchair

D. Types of Wheelchairs for Kids:

Like adult wheelchairs, the pediatric models are available in different shapes, sizes, colors, and designs. You can even have one especially designed and custom-made based on the child's needs. You can also choose between a manually propelled and a motorized wheelchair.

Fig 2.4 wheelchair for kids

E. Manual Pediatric Wheelchair:

Manual pediatric wheelchairs are the most popular type used by kids of all ages. Motors do not propel this type of wheelchair, so either the occupant or caregiver must push the chair around. In addition, children with severe disabilities are not advised to use such kind of mobility aid since they don't have the capacity to move without assistance.

Fig 2.5 manual pediatric wheelchair

2.1.2 Principles of Seating and Positioning:

The prescription of appropriate seating equipment for children and young people with physical disabilities is important, in order to provide an optimal seated position from which they may engage in functional activities. Research has evidenced the benefits of adaptive seating to include improved postural alignment, development of motor skills, helping the prevention of fixed deformity and facilitation of upper extremity function. It is imperative that health professionals prescribing and engineers designing seating equipment are well informed regarding the fundamental seating principles that dictate the sitting postures of children and young people and the impact they have on long term health and function. Traditional emphasis regarding positioning is placed on achieving an upright symmetrical posture utilizing the 90-90-90 flexion at the hips, knees and ankles position. Although an important posture to achieve, this upright position is suggested as non-functional and difficult to maintain over time, resulting in adoption of compensatory postures which may lead to long term deformity and further deterioration when appropriate external support is unavailable. Seating solutions may require reaching a balance between an upright anatomical symmetrical posture and ability to function. The focus of this research was to review and critically appraise the literature regarding the fundamental principles of seating and positioning used with children and young people with physical disabilities. The report uses evidence from published studies, and expert opinion to identify seating and positioning principles used with children and young people with disabilities, the benefits of optimal positioning and problems which may incur as a result of incorrect positioning. An overview of normal and abnormal postures is discussed from biomechanical and neurophysiological viewpoints. Common childhood neuromotor and neuromuscular conditions are considered with respect to clinical manifestations and resultant positioning problems which health professionals and engineers must consider when prescribing / designing seating interventions to promote long term health and functional independence.

2.1.3 The relationship between posture, movement, stability and function:

Posture may be defined as, “the position of one or many body segments in relation to one another and their orientation in space”. Body ‘segments’ are referred to as the head, thorax, pelvis, lower limbs and feet, whilst the body ‘linkages’ are considered as the spinal joints, hips, knees, ankle and shoulder joints. When considering posture, one should not consider it as static, but as an active and dynamic process which underpins movement and function . Normally, our postures continuously shift and change position to facilitate movement to engage in functional activities. Pope identifies that posture is a prerequisite for movement. Howe and Oldham also highlight that posture and movement are inextricably linked, referring to posture as a temporary arrested movement, which is in a constant state of change. From a neurodevelopmental perspective Nichols suggests that the development of postural control and acquisition of motor milestones are intrinsically linked. Ham et al support this assumption highlighting that there is constant neuromotor activity being used to maintain body balance and posture. Engström further suggests that biological and physiological influences affect body position and posture. This is also in addition to the somatosensory, vestibular and musculoskeletal systems.

For functional movement to occur in sitting, literature suggests that stability of proximal body parts (pelvis, spine and shoulders) is a prerequisite for distal control. For example, pelvic stability is required for the spine so that the neck is free to move; shoulder girdle stability is required to stabilise the arm for fine motor and hand control. Washington et al however suggests that there is limited published research to support this hypothesis 5 suggesting that the relationship between proximal stability and distal control is not necessarily one of cause and effect. This is supported by Case-Smith et al who identified weak correlations between proximal control and hand function in typically developing children as assessed by the Posture and Fine Motor Assessment of Infants. However evidence suggests that clinicians and therapeutic seating do utilise the principle of achieving pelvic stabilization to maximize distal control for function in children with neuromotor dysfunction. This is illustrated in the literature by the use of anterior pelvic stabilization devices in seating interventions and by promoting anterior pelvic tilt via the use of the functional sitting position in children with cerebral palsy. Children with neuromotor and neuromuscular dysfunction will require external support from seating systems to accommodate for compromised postural control and postural deficits. Based on

Clinical and empirical evidence, it is accepted that the general goals of seating and positioning include the following, and will be considered in the context of this review:

1) Normalise tone or decrease abnormal influence on the body.
2) Maintain skeletal alignment.
3) Prevent, accommodate or correct skeletal deformity.
4) Provide stable base of support to promote function.
5) Promote increased tolerance of desired position

6) Promote comfort and relaxation.

7) Facilitate normal movement patterns or control abnormal movement patterns.

8) Manage pressure or prevent the development of pressure sores.

9) Enhance autonomic nervous system function (cardiac, digestive and respiratory function)

10) Facilitate maximum function with minimum pathology.

Seating and Positioning: Principles and Practice:

Normal Posture:

Following a review of the literature, it is difficult to define what constitutes ‘normal’ posture. This is because each person is unique regarding their physiological profile and continually engages in a number of postural variations which may be attributed to fatigue and emotional state From a biomechanical viewpoint, good posture is dependent on the balance of the skeleton and symmetrical alignment of body segments. Engström states that those who balance their body in accordance with mechanical rules for human body systems tend to be more erect. From a neurophysiological and developmental perspective, normal posture is also dependent on the development of normal postural control which is described as the control of the body’s position in space in order to obtain stability and orientation and is influenced by the neuromotor, somatosensory, vestibular and musculoskeletal systems. Postural control requires achieving normal developmental milestones and includes the development of postural reactions (righting, protective and equilibrium reactions), developmental integration of primitive reflexes (asymmetrical tonic neck reflex, symmetrical tonic neck reflex, tonic labyrinthe reflex), normal muscle tone, normal postural tone and intentional voluntary movements.

The action of sitting:

It is also useful to understand the interface between the standing and seated posture. Turner suggests the ‘action of sitting’ results in flexion of the thoracic spine, flexion of the lower extremities, and backwards rotation of the pelvis towards the rear of the seat. Pelvic rotation in turn dictates the compensatory curves of the spine, which in turn dictates the position of the remaining body segments. The pelvis is then placed on the seat against the backrest. The trunk extends, moving towards the backrest. The upper part of the pelvis is in contact with the lower part of the backrest, thus achieving pelvic stability, with the person now sitting in an upright neutral position.

Neutral sitting posture:

Sitting skills emerge in a normally developing child approximately between 7 and 9 months and requires the child to maintain postural control of the head, trunk and extremities against the pull of gravitational forces. The majority of the literature refers to the 90-90-90 position as the normal upright neutral seated posture and considers the head, trunk and extremity positions in relation to each other. Assuming that one is sitting on a flat, right angled chair in a static or neutral position, the upright symmetrical position is characterised by extension of the trunk, the pelvis in anterior tilt, thighs slightly abducted, parallel and horizontal and the iliac crests aligned and level in the lateral plane. The hips, knees and ankles are placed at ninety degrees of flexion, the feet are in plantar grade or 0° degrees flexion and the head is positioned in midline and maintained in the vertical plane. The head position in relation to the spine is important as it has a direct effect on posture. Loss of head control can therefore affect body position. When the pelvis is in anterior tilt, the centre of gravity falls anterior to the ischial tuberosities hence the base of support is provided through the ischial tuberosities and the upper thighs. Depending on the chair design, weight will be transferred through the back rest, and the arm rests to the floor through the feet. The goal of upright positioning is therefore to promote symmetry and alignment of the body segments and linkages. The sitting position is more relaxing than the standing posture, provides a greater support surface and allows relaxation of the muscles of the lower extremities. However, there is greater potential for pelvic instability in sitting compared to standing due to the hip joint position, the anatomical shape of the ischial tuberosities and the tendency for the pelvis to rotate backwards. In the seated posture, it is desirable that as much contact is made with the chair's support surface in order to provide maximum stability to facilitate function, with the goal of seating being able to achieve a stable base of support surface to allow function. However in right angled seating, it is difficult to achieve and often results in a person acquiring a 'slumped' posture to compensate for fatigue and discomfort. Combined with the effects of constant activation of the erector spinae muscles, a person will gain relief from excessive muscle activity by sacral sitting

The 90-90-90 Position:

The 90-90-90 position may be regarded as an ideal seated position from an ergonomic perspective (Engström 2001). From an anatomical view point the goal is to achieve maximum orthopaedic symmetry between left and right sides of the body via a neutral pelvis to avoid obliquity, rotation and posterior pelvic tilt (Lange 2001). Advantages of this position depicted in the literature include minimisation of orthopaedic deformity (Ham et al 1998) and promotion of proximal stability which in turn promotes distal control (Lange 2001). One of the goals of seating is to promoted relaxation and comfort (Jones and Gray 2005). Kangas (2002) suggests the 90-90-90 position can passively and temporarily reduce tone when considered as a resting position.

Functional Sitting Position:

A major goal in seating is to provide and stable base of support to promote function and to enhance autonomic nervous system function. Pain et al suggests that alternative sitting positions to 90-90-90 are being proposed and include forward inclination to permit engagement in functional tasks and backwards recline for relaxation. Findings from studies regarding the effects of seat inclination on function and/or postural control are conflicting. Studies identified for review, focus on the cerebral palsy population and/or typically developing children. Several authors suggest that forward inclination promotes improved upper 10 extremity function; trunk extension and improved postural efficiency. Other research studies report no effects of anterior tipped seating on respiratory function; upper extremity function and postural stability. An investigation regarding the development of postural adjustments during reaching in twenty-nine typically developing children, and ten adults suggested that forward tilted seating (15° seat surface inclined) was a more efficient position for postural efficiency compared to horizontal (0°) and backwards tilted (15° seat surface reclined) sitting positions. Findings were contrary to the original hypothesis postulated by the authors, who hypothesised that backward sitting would have been the most efficient position as it would passively counterbalance the forward body sway induced by reaching movements. Sitting positions were studied via surface Electromyograms (EMG) and kinematics, therefore quantifying results.

2.2 Self-Excited Walking of a Biped Mechanism:

Biped locomotion is regarded as a combined motion of an inverted pendulum and a 2 DOF pendulum. Here the inverted pendulum represents motion of a support leg and body, while the 2-DOF pendulum represents motion of swing leg. Only when those movements are synchronized, biped locomotion can be stabilized. Over the past few decades, a large number of studies have been made on bipedal walking. Among many researchers, McGeer studied passive dynamic walking mechanisms on a downhill slope without actuating and controlling. In connection with his research, a close study on stability and complexity of simple walking model was done by Garcia. Goswami investigated the passive gait of a compass-like biped robot especially about symmetry and chaos. Spong studied on the switching control applied to passive gait. One of the purposes of their researches is to enlarge the basin of the limit cycles. The remarkable feature of these passive gaits is its anthropomorphic motion and energy efficiency because those passive mechanisms utilize its inherent natural motion. Based on the similar idea of utilizing natural mode, one of the authors has already proposed self-excitation control which can efficiently and robustly drive natural mode of the mechanical system. Ono and Okada applied the Van der Pole type self-excitation to drive an insect wing model and the asymmetric stiffness-matrix type to drive a rolling biped mechanism. Further, Ono and Imadu showed a possibility that a human like planar 3-DOF biped mechanism can be driven by the latter method. In this paper, we show this self-excitation control strategy enables 3-DOF planar biped mechanism to walk. Then we verify the numerical simulation experimentally by using a manufactured biped robot.

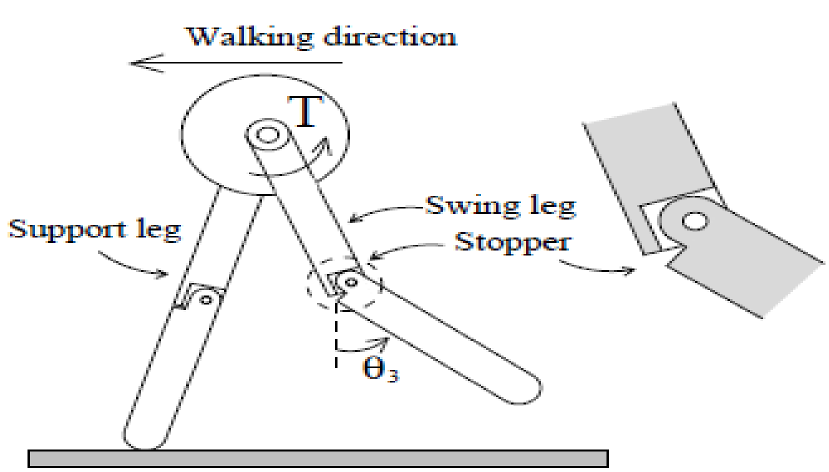


Figure 1: 3-DOF walking mechanism

Fig 2.6: 3 DOF walking mechanism

Control Method of Biped Walking

2.2.1 Conditions for stable walking

Figure 1 shows a planar biped walking mechanism which has no ankle and trunk. This mechanism consists of two legs which are connected in series at hip joint by an actuator. Each leg consists of a thigh and a shank connected at a passive knee joint which has a rotary damper and a knee stopper. By this knee stopper, an angle of knee rotation is restricted like a human knee so that it cannot rotate forward. Five conditions are required to realize a stable biped walking on a sagittal plane by this simple mechanism.

1. The period of the mechanism as a inverted pendulum should synchronize with half period of swing leg as a 2-DOF pendulum.
2. Kinematic energy loss which is consumed during swing leg's foot collision and each knee stopper collision should be actively supplied by the actuator.
3. Synchronized motion of inverted pendulum and 2-DOF swing leg pendulum, and energy supply and consumption have a stable characteristics against deviations from the synchronized motion.
4. At the support leg's knee joint, knee stopper have to be locked (support leg condition).
5. The swing leg should bend to keep the clearance (swing leg condition).

2.2.2 Algorithm of self-excitation control

In order to derive basic equation of motion to simulate the walking gait of the 4-link biped mechanism, we divide one step walking motion into three phases from view point of difference of freedom and governing equation. Figure 2 shows three different phases of one step walking.

1. From start of swinging leg to collision of knee stopper (First phase).
2. From collision of knee stopper to touchdown of swing leg (Second phase).
3. Double support phase and exchange between support leg and swing leg (Third phase).

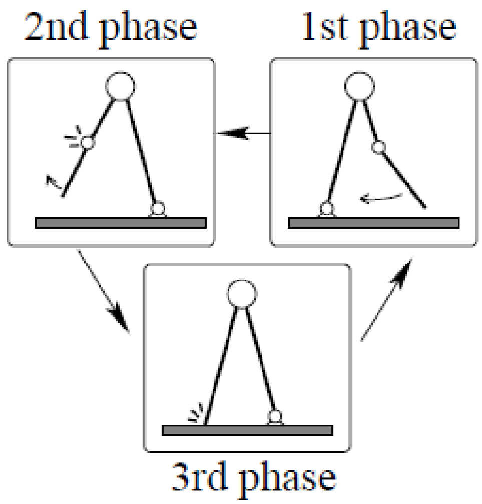


Fig 2.7 Different phases of biped walking

Stance Phase: The stance phase is that part of a gait cycle during which the foot remains in contact with the ground. For analyzing gait cycle one foot is taken as reference and the movements of the reference foot are studied. It constitutes 60 percent of the gait cycle. In stance phase the reference foot undergoes five movements:

1. Initial Contact (Heel Strike): In initial contact, the heel is the first bone of the reference foot to touch the ground.
2. Loading Response (Foot Flat): In loading response phase, the weight is transferred onto the referenced leg. It is important for weight-bearing, shock-absorption and forward progression.
3. Mid Stance: It involves alignment and balancing of body weight on the reference foot.
4. Terminal Stance: In this phase the heel of reference foot rises while its toes are still in contact with the ground.
5. Toe Off (Pre Swing): In this phase, the toe of reference foot rises and swings in air. This is the beginning of the swing phase of the gait cycle.

Swing Phase: The swing phase is that part of the gait cycle during which the reference foot is not in contact with the ground and swings in the air. It constitutes about 40% of gait cycle. It has three parts:

1. Initial Swing
2. Mid Swing
3. Terminal Swing

Support:

- Single Support: In single support only one foot is in contact with the ground. Double Support: In double support both feet are in contact with the ground.

Terminology:

- Step Length: It is defined as the distance between corresponding successive points of heel contact of the opposite feet. In a normal gait, the right step length is equal to left step length.
- Stride Length: It is defined as the distance between any two successive points of heel contact of the same foot. In a normal gait, the stride length is double the step length.
- Walking Base or Stride Width: It is defined as the side-to-side distance between the line of step of the two feet.
- Cadence: It is defined as the number of steps per unit time. In normal gait, cadence is about 100–115 steps per minute. Cadence of a person is subject to various factors.
- Comfortable Walking Speed: It is a characteristic speed at which there is least energy consumption per unit distance. It is about 80 meters per minute in a normal gait.

In the following analysis, we assumed that during the first and second phases, the knee stopper of support leg can be locked by negative internal force. The validity of this assumption is discussed in the next chapter. From this assumption we can regard the biped mechanism as 3-DOF which consists of 1-DOF support leg and 2-DOF swing leg.

In the first phase, the feedback torque is applied at hip joint. By this feedback torque, swing leg is naturally bent at knee joint. Then it can swing forward without hitting the ground. In the second phase, the feedback torque is not supplied. Therefore it moves freely until

it collides with a ground. We considered these foot collision and knee stopper collision as perfect inelastic one. Hence we calculate angular velocity of each links just after the collisions by the law of conservation of angular momentum.

2.2.3 Methodology:

2.2.3.1 Literature review:

- Make review on other model, mechanism and focusing on how to make it simple and relevance to the project title.

2.2.3.2 Conceptual Design:

- Sketching several type of design based on concept that being choose.

- State the dimension for all part.
- Draw the rough diagram on sheet.

2.2.3.3 3-D CAD Modeling:

- Draw the sketching model using SOLIDWORK OR INVENTOR software.

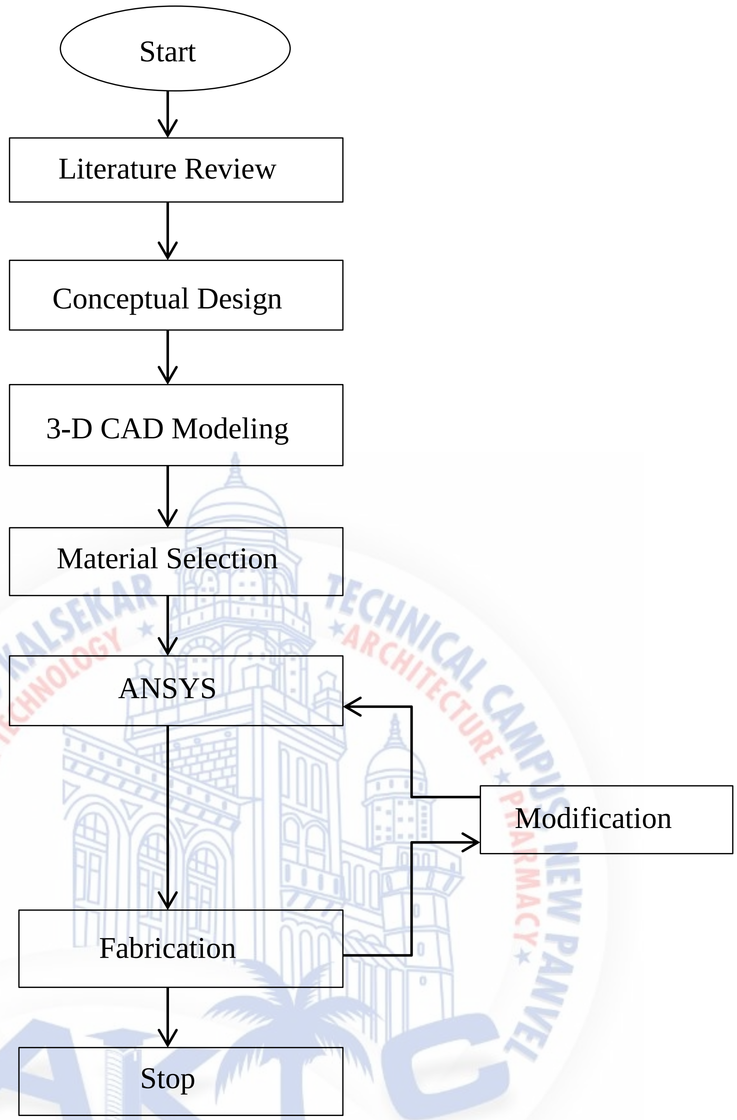
2.2.3.4 Material Selection:

- Selected the true material based on model design and criteria.

2.2.3.5 ANSYS:

- Analysis the design for strain stress structure by using ANSYS.

2.2.3.6 Fabrication:



Project Flow Chart

Chapter 3

Project Overview

3 Project Overview

3.1 Methodology

- Here we are dedicated in designing a customised chair for the need of person suffering from cerbral palsy
- Basic structure designing taking into consideration the actual need of the person.
- Taking ideas from several other chairs and modifying it incorporating several design consideration.
- CAD modelling is to be done followed by the actual fabrication taking into consideration the cost which is to be minimal.
- The basic design and idea is taken from the below images which will be incorporated with wheelchair design.

Fig 3.1 walker

LEG MECHANISM:

• A leg mechanism (walking mechanism) is an assembly of links and joints (a linkage) intended to simulate the walking motion of humans.

• For leg walking motion :

1) Oscillating cylinder and 4 bar mechanism

2) dual leg mechanism

• This will help those people who don't know the natural motion of walking to learn it and imitate it.

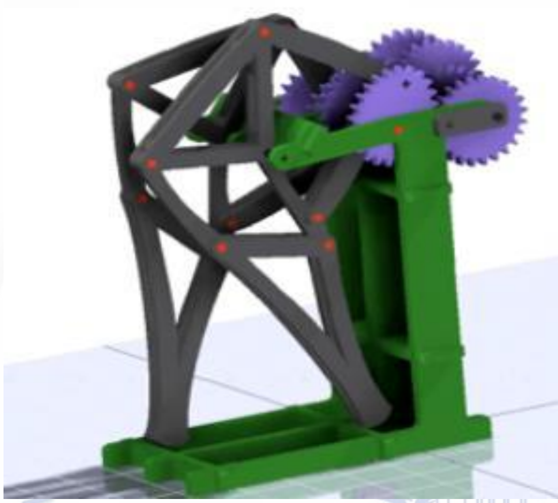
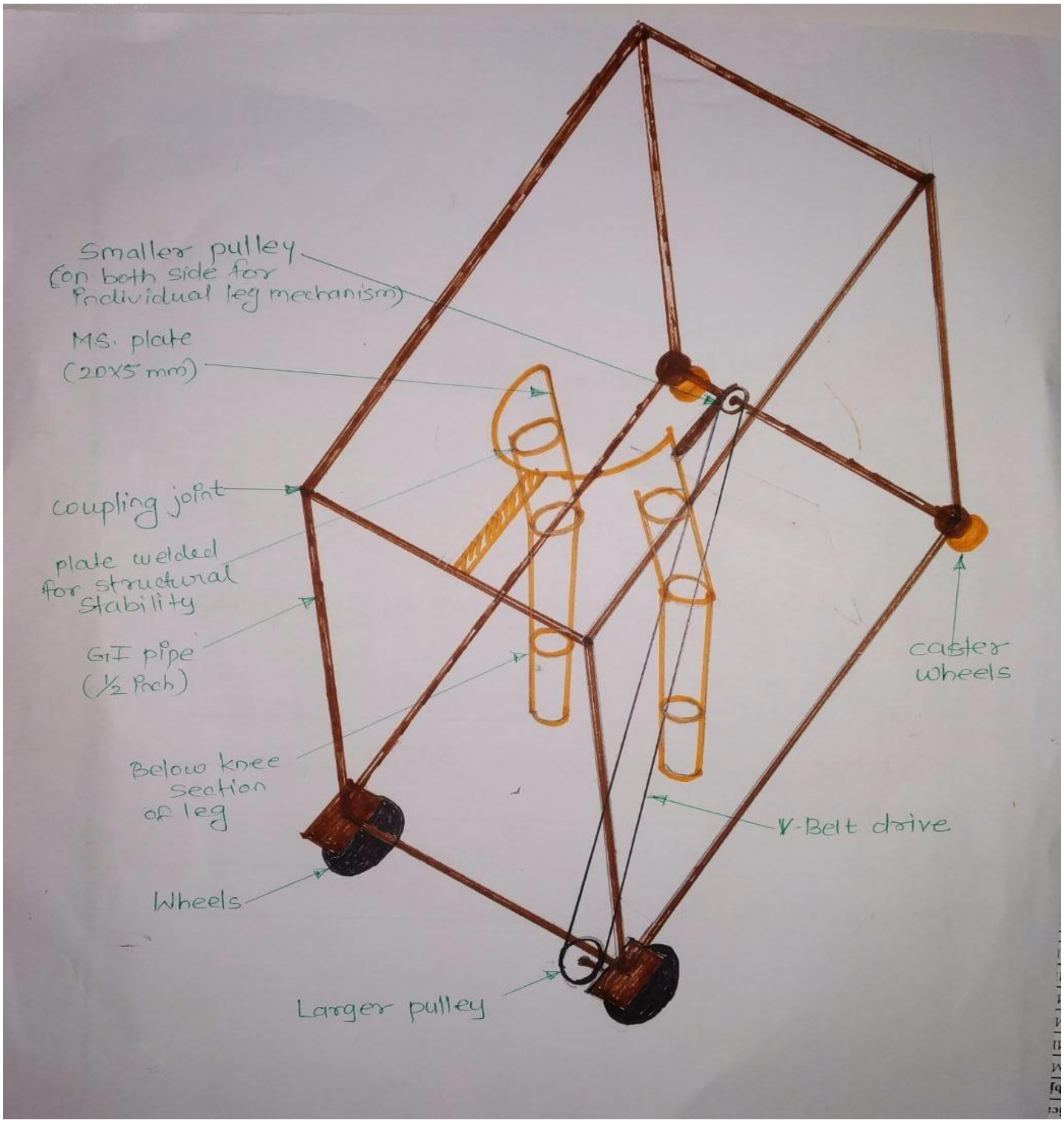


Figure **3.2** Leg mechanism

3.2 Design layout:

To perform sequence of events or movements during locomotion in which one foot contacts the ground to when that same foot again contacts the ground, and involves forward propulsion of the centre of gravity. We make a walking stimulator to guide the person during walking. The mechanism we used that help to move him forward. It help its leg to perform the walking motion. It moves its leg with the linkages that are attached to both the leg. That mechanism helps him to walk.



3.3 Design details:

a) Material selection:

The machine elements should be made of such a material which has properties suitable for the conditions of operations. In designing the various part of the machine it is necessary to know how the material will function in service.

Thus, the material and its form is selected after thoroughly analyzing each and every component in terms of bending stresses and tensile stresses during its operation. Also mechanical properties are considered to achieve cost effective and reliable design.

Thus the Choice of material for serving the purpose depends upon the following factors:

- Availability of the materials.
- Suitability of materials for the working condition in service.
- The cost of materials.
- Physical and chemical properties of material.
- Mechanical properties of material.

b) Components:

1) Cast iron pulley
   - I. Smaller pulley
   - II. Larger pulley
2) Fibre Wheels
3) Rotating caster trolley wheel
4) PIPES
   - a) GI PIPE
   - b) Mild steel pipe
5) Mild steel brackets
6) Mild steel strips
7) V-Belt

1) Cast iron pulley

A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable or belt, or transfer of power between the shaft and cable or belt. In the case of a pulley supported by a frame or shell that does not transfer power to a shaft, but is used to guide the cable or exert a force, the supporting shell is called a block, and the pulley may be called a sheave.

A pulley may have a groove or grooves between flanges around its circumference to locate the cable or belt. The drive element of a pulley system can be a rope, cable, belt, or chain.

Fig 3.4 pulleys

2) Fibre wheels:

A **wheel** is a circular component that is intended to rotate on an axle bearing. The wheel is one of the key components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel and flywheel.

Common examples are found in transport applications. A wheel greatly reduces friction by facilitating motion by rolling together with the use of axles. In order for wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity or by the application of another external force or torque.

Fig 3.5 wheel

Rotating caster trolley wheel

A **caster** is a wheeled device typically mounted to a larger object that enables relatively easy rolling movement of the object. Casters are essentially special housings that include a wheel, facilitating the installation of wheels on objects. Casters are found virtually everywhere, from office desk chairs to shipyards, from hospital beds to automotive factories. They range in size from the very small furniture casters to massive industrial casters, and individual load capacities span 100 pounds (45 kg).

Types of caster:

A) Swivel caster

This type of caster allows for movement in multiple directions. They can have one or two sets of raceways that allow the caster to swivel 360 degrees under a load. The different types of swivel casters include the following:

- Locking casters: There are several devices that can be added to casters to prevent the wheel from rotating or the swivel assembly from turning.
- Kingpin-less casters: This caster does not have a bolt and nut kingpin. The raceways are a one piece construction forged together. This design is extremely durable and can be used in abusive applications and shock load applications where kingpin type casters may fail.
- Hollow Kingpin casters: This type of caster has a tubular rivet that holds the caster together. The hole in the rivet can accept a bolt or a customized stem for any type of mounting requirement.
- Plate casters: This is the most common type of means to mount a caster to a unit and is sometimes called the top plate. Most mounting plates contain four holes used to bolt the caster to the unit. Top plates are offered with various hole patterns to match numerous types of mounting requirements.
- Stem casters: This type caster can have various stem styles to be used to mount the caster to a unit. Some common types of stems are threaded, round or square with mounting holes, friction ring & expandable stems.

B Rigid caster:

This style of caster only allows forward and backward movement. Rigid casters tend to be stronger than swivel casters. They are rated at the same capacity as the swivel casters for safety reasons. They can be a one piece construction or a two piece construction that is riveted or welded.

Fig 3.6 Caster wheel

3) PIPES:

The pipe is used to make a frame. The pipe holds the whole mechanism and also it for a person to stand. There two types of pipe is used GI pipe and mild steel pipe.

Fig 3.7   GI pipe

Fig 3.8 Mild steel pipe

Mild steel brackets:

- A bracket is an architectural element "a structural or decorative member". It can be made of wood, stone, plaster, metal, or other mediums. It projects from a wall, usually to carry weight and sometimes to "...strengthen an angle"
- In mechanical engineering a bracket is any intermediate component for fixing one part to another, usually larger, part. What makes a bracket a bracket is that it is intermediate between the two and fixes the one to the other.
- Brackets vary widely in shape, but a prototypical bracket is the L-shaped metal piece that attaches a shelf (the smaller component) to a wall (the larger component): its vertical arm is fixed to one (usually large) element, and its horizontal arm protrudes outwards and holds another (usually small) element.
- Brackets can support many architectural items, including a wall, balcony, parapets, eaves, the spring of an arch, beams, pergola roof, window box, or a shelf. The term is also used to describe a shelf designed to hold a statue.
- In adjustable shelving systems, the bracket may be in two parts, with the load-bearing horizontal support fitting into a wall-mounted slotted vertical metal strip. Brackets also are an element in the systems used to mount modern facade cladding systems onto the outside of contemporary buildings, as well as interior panels.


Fig 3.9 Bracket

5) Mild steel strip:

The mild steel strip is used for the making a joints. The all joint is connected to a mechanism. The strips hold the leg and also it perform the walking motion.

Fig 3.10 Mild steel strips

6) V-belt:

A **belt** is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel.

In a two pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts). As a source of motion, a conveyor belt is one application where the belt is adapted to carry a load continuously between two points.

- V-belts solved the slippage and alignment problem. It is now the basic belt for power transmission. They provide the best combination of traction, speed of movement, load of the bearings, and long service life. They are generally endless and their general cross-section shape is roughly trapezoidal (hence the name "V").

- The "V" shape of the belt tracks in a mating groove in the pulley (or sheave), with the result that the belt cannot slip off. The belt also tends to wedge into the groove as the load increases the greater the load, the greater the wedging action improving torque transmission and making the V-belt an effective solution, needing less width and tension than flat belts.

- V-belts trump flat belts with their small center distances and high reduction ratios. The preferred center distance is larger than the largest pulley diameter, but less than three times the sum of both pulleys. Optimal speed range is 1,000–7,000 ft/min (300–2,130 m/min). V-belts need larger pulleys for their thicker cross-section than flat belts.

- For high-power requirements, two or more V-belts can be joined side-by-side in an arrangement called a multi-V, running on matching multi-groove sheaves. This is known as a multiple-V-belt drive (or sometimes a "classical V-belt drive").

- V-belts may be homogeneously rubber or polymer throughout, or there may be fibers embedded in the rubber or polymer for strength and reinforcement. The fibers may be of textile materials such as cotton, polyamide (such as Nylon) or polyester or, for greatest strength, of steel or aramid (such as Twaron or Kevlar).

- When an endless belt does not fit the need, jointed and link V-belts may be employed. Most models offer the same power and speed ratings as equivalently-sized endless belts and do not require special pulleys to operate. It's provide easy installation and superior environmental resistance compared to rubber belts and are length-adjustable by disassembling and removing links when needed.

Power transmitted between a belt and a pulley is expressed as the product of difference of tension and belt velocity:

$$P = (T_1 - T_2)v,$$

where, T_1 and T_2 are tensions in the tight side and slack side of the belt respectively. They are related as

$$\frac{T_1}{T_2} = e^{\mu\alpha},$$

where, μ is the coefficient of friction, and α is the angle (in radians) subtended by contact surface at the centre of the pulley.

Fig 3.11 V belt

CHAPTER 4

STRUCTURAL ANALYSIS

Simulation of strucrure

Date: 25 April 2018
Designer: Solidworks
Study name: Static 2
Analysis type: Static

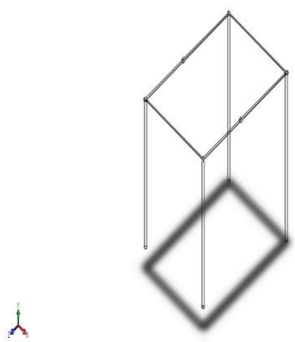


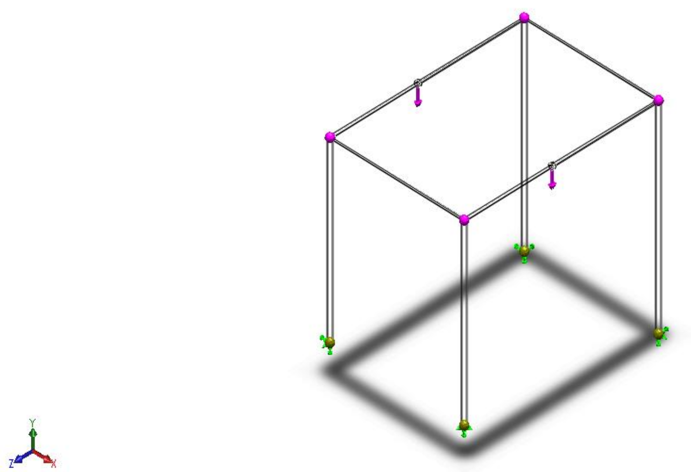
Table of Contents

Description

No Data

Assumptions

Model Information



Model name: strucrure
Current Configuration: Default<As Machined>

Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Split Line3[1]	Solid Body	Mass:1.04129 kg Volume:0.000135233 m^3 Density:7700 kg/m^3 Weight:10.2047 N	D:\Users\ALI\Desktop\project\strucrure.SLDPRT Apr 24 16:45:30 2018
Split Line3[2]	Solid Body	Mass:1.04134 kg Volume:0.000135239 m^3 Density:7700 kg/m^3 Weight:10.2051 N	D:\Users\ALI\Desktop\project\strucrure.SLDPRT Apr 24 16:45:30 2018

Beam Bodies:

Document Name and Reference	Formulation	Properties	Document Path/Date Modified
Beam-1(Pipe 0.5 SCH 40(2)[1])	Beam – Uniform C/S	Section Standard-ansi inch/pipe/0.5 sch 40 Section Area: 0.000161496m^2 Length:720mm Volume:0.000116277m^3 Mass Density:7700kg/m^3 Mass:0.895333kg Weight:8.77426N	D:\Users\ALI\Desktop\project\strucrure.SLDPRT Apr 24 16:45:30 2018
Beam-2(Pipe 0.5 SCH 40(2)[2])	Beam – Uniform C/S	Section Standard-ansi inch/pipe/0.5 sch 40 Section Area: 0.000161496m^2 Length:720mm Volume:0.000116277m^3 Mass Density:7700kg/m^3 Mass:0.895333kg Weight:8.77426N	D:\Users\ALI\Desktop\project\strucrure.SLDPRT Apr 24 16:45:30 2018
Beam-3(Pipe 0.5 SCH 40(2)[3])	Beam – Uniform C/S	Section Standard-ansi inch/pipe/0.5 sch 40 Section Area: 0.000161496m^2 Length:820mm Volume:0.000132427m^3 Mass Density:7700kg/m^3 Mass:1.01968kg Weight:9.99291N	D:\Users\ALI\Desktop\project\strucrure.SLDPRT Apr 24 16:45:30 2018
Beam-4(Pipe 0.5 SCH 40(1)[3])	Beam – Uniform C/S	Section Standard-ansi inch/pipe/0.5 sch 40 Section Area: 0.000161496m^2 Length:581.511mm Volume:9.36968e-005m^3 Mass Density:7700kg/m^3 Mass:0.721465kg Weight:7.07036N	D:\Users\ALI\Desktop\project\strucrure.SLDPRT Apr 24 16:45:30 2018

Beam - 5(Pipe 0.5 SCH 40(2)[4])	Beam – Uniform C/S	Section Standard-ansi inch/pipe/0.5 sch 40 Section Area: 0.000161496m^2 Length:820mm Volume:0.000132427m^3 Mass Density:7700kg/m^3 Mass:1.01968kg Weight:9.99291N	D:\Users\ALI\Desktop\project \strucrure.SLDPRT Apr 24 16:45:30 2018
Beam - 6(Pipe 0.5 SCH 40(1)[1])	Beam – Uniform C/S	Section Standard-ansi inch/pipe/0.5 sch 40 Section Area: 0.000161496m^2 Length:581.511mm Volume:9.36968e-005m^3 Mass Density:7700kg/m^3 Mass:0.721465kg Weight:7.07036N	D:\Users\ALI\Desktop\project \strucrure.SLDPRT Apr 24 16:45:30 2018

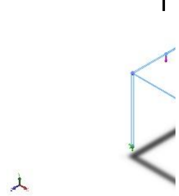
Study Properties

Study name	Static 2
Analysis type	Static
Mesh type	Mixed Mesh
Thermal Effect:	On
Thermal option	Include temperature loads
Zero strain temperature	298 Kelvin
Include fluid pressure effects from SOLIDWORKS Flow Simulation	Off
Solver type	Direct sparse solver
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off
Incompatible bonding options	Automatic
Large displacement	Off
Compute free body forces	On
Friction	Off
Use Adaptive Method:	Off
Result folder	SOLIDWORKS document (D:\Users\ALI\Desktop\project)

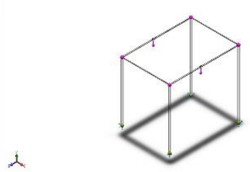
Units

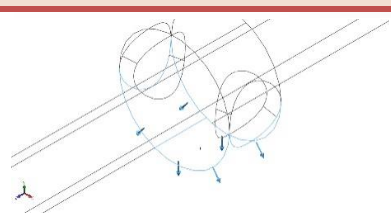
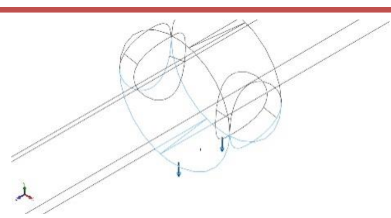
Unit system:	SI (MKS)
Length/Displacement	mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/m^2

Material Properties

Model Reference	Properties	Components
	Name: **Alloy Steel** Model type: **Linear Elastic Isotropic** Default failure criterion: **Max von Mises Stress** Yield strength: **6.20422e+008 N/m^2** Tensile strength: **7.23826e+008 N/m^2** Elastic modulus: **2.1e+011 N/m^2** Poisson's ratio: **0.28** Mass density: **7700 kg/m^3** Shear modulus: **7.9e+010 N/m^2** Thermal expansion coefficient: **1.3e-005 /Kelvin**	**SolidBody 1(Pipe 0.5 SCH 40(2)[1])(strucrure), SolidBody 2(Split Line3[1])(strucrure), SolidBody 3(Pipe 0.5 SCH 40(2)[2])(strucrure), SolidBody 4(Pipe 0.5 SCH 40(2)[3])(strucrure), SolidBody 5(Pipe 0.5 SCH 40(1)[3])(strucrure), SolidBody 6(Split Line3[2])(strucrure), SolidBody 7(Pipe 0.5 SCH 40(2)[4])(strucrure), SolidBody 8(Pipe 0.5 SCH 40(1)[1])(strucrure)**
Curve Data:N/A		

Loads and Fixtures

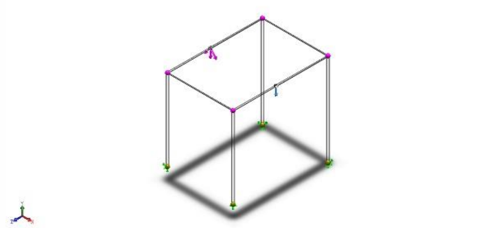
Fixture name	Fixture Image	Fixture Details
Fixed-1		Type: **Fixed Geometry**

Load name	Load Image	Load Details
Force-1		Entities: **1 face(s)** Type: **Apply normal force** Value: **-250 N**
Force-2		Entities: **1 face(s)** Type: **Apply normal force** Value: **-250 N**

Connector Definitions

No Data

Contact Information

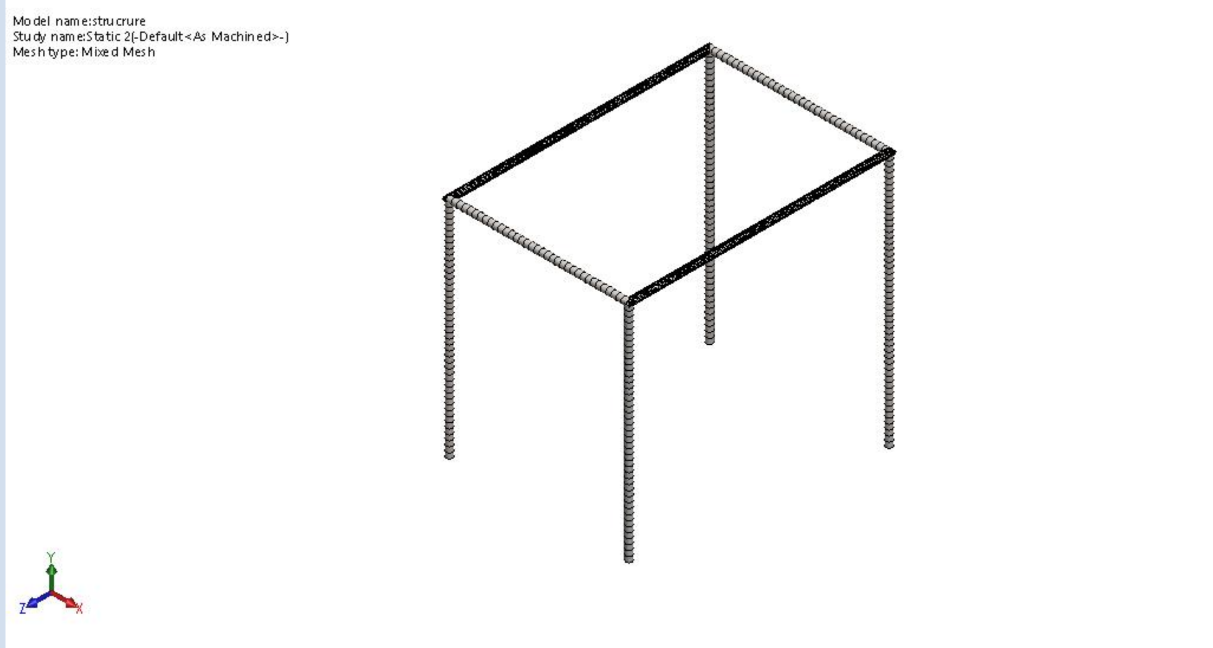
Contact	Contact Image	Contact Properties
Global Contact		**Type:** **Bonded** **Components:** **1 component(s)** **Options:** **Incompatible mesh**

Mesh information

Mesh type	Mixed Mesh
Mesher Used:	Curvature-based mesh
Jacobian points	4 Points
Jacobian check for shell	On
Maximum element size	0.698514 in
Minimum element size	0.0349257 in
Mesh Quality Plot	High

Mesh information - Details

Total Nodes	33289
Total Elements	16707
Time to complete mesh(hh;mm;ss):	00:00:10
Computer name:	



Sensor Details

No Data

Resultant Forces

Reaction forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	-0.130124	389.464	0.127058	389.464

Reaction Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N.m	2.03562	0.3483	0.135701	2.06965

Beams

Beam Forces

Beam Name	Joints	Axial(N)	Shear1(N)	Shear2(N)	Moment1(N.m)	Moment2(N.m)	Torque(N.m)
Beam-1(Pipe 0.5 SCH 40(2)[1])	1	108.209	-24.5975	0.583589	-0.239031	-5.39293	0.0966595
	2	-108.209	24.5975	-0.583589	-0.181154	-12.3173	-0.0966595
Beam-2(Pipe 0.5 SCH 40(2)[2])	1	104.179	1.69956	0.850019	-0.302792	0.611885	0.0845087
	2	-104.179	-1.69956	-0.850019	-0.309222	0.611796	-0.0845087
Beam-3(Pipe 0.5 SCH 40(2)[3])	1	90.5798	1.1533	-0.893901	0.369325	0.47265	0.0742024
	2	-90.5798	-1.15298	0.893901	0.363674	0.472924	-0.0742024
Beam-4(Pipe 0.5 SCH 40(1)[3])	1	0.0494871	-1.27272	0.51501	0.106391	0.405147	-2.78321
	2	-0.0494871	1.27272	-0.51501	0.193093	0.334954	2.78321
Beam-5(Pipe 0.5 SCH 40(2)[4])	1	86.4969	21.872	-0.669831	0.308199	6.34401	0.0929286
	2	-86.497	-21.8717	0.669831	0.241063	11.5909	-0.0929287
Beam-6(Pipe 0.5 SCH 40(1)[1])	1	0.142011	-1.50658	0.317424	0.132103	0.41805	3.22519
	2	-0.142011	1.50658	-0.317424	0.0524828	0.458042	-3.22519

Beam Stresses

Beam Name	Joints	Axial(N/m^2)	Bending Dir1(N/m^2)	Bending Dir2(N/m^2)	Torsional (N/m^2)	Upper bound axial and bending(N/m^2)
Beam-1(Pipe 0.5 SCH 40(2)[1])	1	-670042	358437	-8.08694e+006	72472.6	8.76492e+006
	2	-670042	-271648	1.84703e+007	-72472.6	1.91423e+007
Beam-2(Pipe 0.5 SCH 40(2)[2])	1	-645085	454050	917549	63362.3	1.66883e+006
	2	-645085	-463692	-917415	-63362.3	1.67302e+006
Beam-	1	-560880	-553820	708760	55634.9	1.46036e+006

3(Pipe 0.5 SCH 40(2)[3])	2	-560880	545345	-709170	-55634.9	1.45549e+006
Beam-4(Pipe 0.5 SCH 40(1)[3])	1	306.43	159538	-607536	-2.08677e+006	628441
	2	306.43	-289551	502278	2.08677e+006	580068
Beam-5(Pipe 0.5 SCH 40(2)[4])	1	-535599	-462158	9.51312e+006	69675.3	1.00599e+007
	2	-535599	361484	-1.73811e+007	-69675.4	1.79205e+007
Beam-6(Pipe 0.5 SCH 40(1)[1])	1	879.35	198094	-626885	2.41816e+006	658319
	2	879.35	-78700.2	686855	-2.41816e+006	692228

CHAPTER 5

PROJECT COSTING

Total cost of the project:-

Components	**PRICE**
1. Mild steel strip	**Rs.450**
2. MS pipe	**Rs.320**
3. Bolts	**Rs.140**
4. Fibre +caster wheel	**Rs.200**
5. Cast iron pulley	**Rs.440**
6. MS bracket	**Rs.500**
7. GI pipe for frame	**Rs.650**
8. Labour	**Rs.220**
9. V belt	**Rs.200**
10. Miscellaneous	**Rs.75**
11. Bolts	**Rs.100**
TOTAL	**Rs.3295**

Future Scope:

Research is the unending activity after every research some issues will definitely come out and these issues are available for coming researchers. These issues provide the wide scope for the future design making that machine more and more efficient. In this oil expeller machine also there is a lot scope for future development such as improvement in design, safety, utility.

- These walking simulator mechanism can be applied in wheelchair also by some modification.
- These walking simulator can work automatically by using electrical control system.
- These walking simulator can make modular where area can be major concern.
- Chain sprocket can also be used for power transmission.

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