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Address:-Ashok Yakkaldevi 258/34, Raviwar Peth, Solapur - 413 005 Maharashtra, India
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ORIGINAL ARTICLE

MODELLING AND ANALYSIS OF A MULTIFUNCTIONAL CRUTCH

T.S.MOHAN KUMAR AND K.V.MAHENDRA

1Assistant Professor Department of Mechanical Engineering Jyothy Institute of Technology Tataguni Bangalore.
Principal Department of Mechanical Engineering Jyothy Institute of Technology Tataguni Bangalore-

Abstract:

Devices like walking sticks, walkers, crutches, artificial limbs are in use for improving the mobility of orthopedically disabled persons. It is disheartening to note that about twenty million people in India are disabled of which about ten million are orthopedically disabled, Elderly people have the difficulty of walking longer distances without support.. The development of this multipurpose crutch is simple facilitating easy manufacture and assembly. Various concepts were generated to meet the requirement of the problem. These concepts were evaluated based on important criteria using a concept scoring matrix and the modular design concept, which scored high, was selected for development. The detailed design and optimization was carried out for selected concept using the solid modeling software.

KEYWORDS:

Crutch, orthopaedically disabled ,concept scoring matrix .

INTRODUCTION

Assistive devices like walking sticks, walkers, crutches, artificial limbs are in use for improving the mobility of orthopaedically disabled persons. It is disheartening to note that about twenty million people in India are disabled of which about ten million are orthopaedically disabled, having limited mobility and restricted muscular coordination. Orthopaedically disability could be with regard to leg, arms or spinal cord. The cause could be due to polio, cerebral palsy at birth or acquired due to spinal cord injury or paralysis. The disability to walk could be due to the above causes or arthritis, surgery of hip, leg or knee, fibromyalgia, back injury or any other physical condition. Elderly people have the difficulty of walking longer distances without support. There are various types of assistive devices for providing mobility thereby enhancing the quality of life of a disabled person. Efforts should be made to ensure that these are affordable even by the underprivileged section of the society.

Among all the assistive devices used by the orthopaedically disabled and elderly people, a Crutch is most widely used. It is the simplest assistive device for supporting a person during walking. It is universally used by people to provide balance in walking.

With these considerations in view, a new multipurpose crutch which can be converted to a seat to assist people who get tired during walking or standing for a long time has been developed and fabricated. Study of similar equipment elsewhere and market survey to establish the exact requirements has been made before arriving at this concept. This concept was finalized after interviewing and discussing with various people who are using crutches and studying their views.

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which scored high, was selected for development. The detailed design and optimization was carried out for selected concept using the solid modeling software.

It uses the basic principle of four bar mechanism for folding the seat. It consists of minimum number of parts forming the three legs of the tripod, links, pivots and the seat. When the crutch is converted into a seat, a wide base of nearly 250mm to 350mm is created on the ground. The seat is formed at the centre so that the weight of the person sitting on the seat falls well within the triangle and provides stability. The legs are made of tubular steel to provide strength at minimum possible weight. The linkages and pivots are made of steel to provide maximum strength.

The multifunctional crutch was manufactured at MERU Precision Industries, Rajajinagar, Bangalore. The prototype was demonstrated at "MOBILITY INDIA", a centre for

Type of disability	Population in millions
Orthopaedically disabled	10.1
Visual	4.6
Hearing	3.7
Speech	2.2
Total	20.5 (Approx 2%)

Welfare of Disabled Persons. It was well appreciated by the inmates.

It is hoped that this multipurpose crutch would meet the requirement of elderly people and disabled people. It is felt that this device would also be useful for persons who have to be on their feet for long periods during the execution of their duties.

PROBLEM DEFINITION

Based on the analysis of the data collected by administering the questionnaire the problem was defined as "To develop and fabricate a multifunctional Crutch to assist orthopaedically disabled people The crutch should be provided with a foldable seat and a mechanism to convert the stick into a seat to facilitate resting. It should be light weight, easy to carry, easy to manufacture and use, ergonomic and aesthetic in design and cost effective.

CRUTCH WITH SEATING TYPE (FOUR BAR MECHANISM)

FIG1 3D MODEL OF THE CRUTCH

ANALYSIS APPROACH

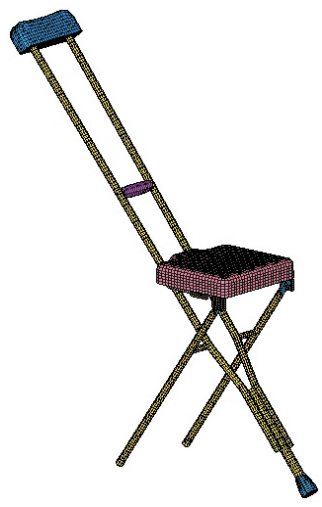
Hypermesh is used as pre-processor
ANSYS is used as Solver and post processor
Static and Eigen Buckling analysis is done for the multifunctional Crutch
Crutch pad, Crutch tip, Hand grip and Wooden seat are modeled with Solid45 elements (Hexa / Penta elements)
Hinge, Links, Seating attachment legs, Crutch main leg,

Tools Used	Hypermesh
Mesh Type	Shell and Solid
Element Size	5 mm
No. of Shell Elements	5738
No. of Solid Elements	7100
No. of nodes	14814

and Spacer are modeled with Shell63 (4 and 3 noded shell elements)
Bolts / Pins are simulated by CERIG elements (Rigid Elements)

Material properties

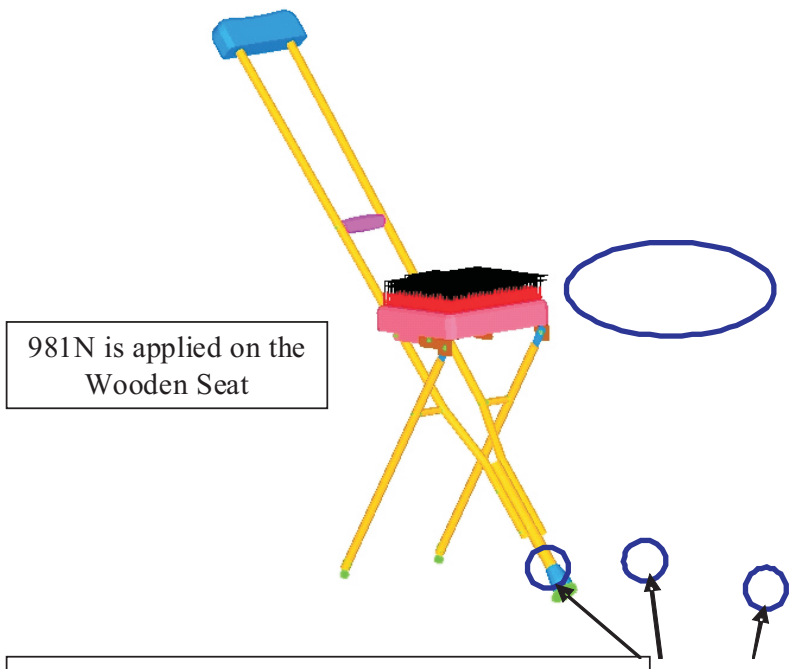
Component	Young's Modulus (N/mm2)	Poisson's Ratio
Aluminium	7.0 E+4	0.33
Wood	1.5 E +4	0.46

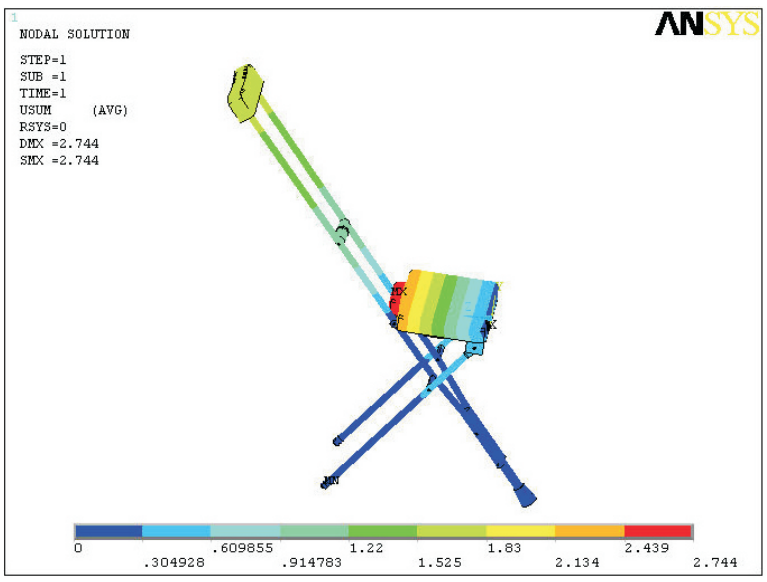


Displacement

Name : Plot 1
Type: Displacement
Min: 0
Max:2.74mm

Static Analysis: Loads and Boundary Conditions





CONCLUSION:

The Design thickness of the link plate taken in the analysis is 3mm. It has been observed that increasing the thickness of the link plate to 5mm the stresses and deformation reduces by 50%.

RESULTS AND DISCUSSIONS

A multifunctional crutch has been successfully designed and developed. It is hoped that this product will be very useful to orthopaedically disabled persons and who find difficulty in walking and who need to rest frequently during walking. The multifunctional seating attachment was analyzed using using Ansys 11 under static analysis for stress and deformation

The displacement was found to be 2.74 mm and the stress at the link is about 154.4Mpa . This can be further reduced by increasing the thickness of the Link plate used .

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