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Design and Analysis of Wheelchair Ramp in Government Buses

Sankarlal R. L
Assistant Professor, Dept. of Mechanical Engineering, R.M.K. Engineering College

Duraimurugan P
Assistant Professor, Dept. of Mechanical Engineering, R.M.K. Engineering College

Karthikeyan. G
UG Scholar, Dept. of Mechanical Engineering, R.M.K. Engineering College

Kollipara Seshubabu
UG Scholar, Dept. of Mechanical Engineering, R.M.K. Engineering College

Abstract - **Waste disposal is one of the lifecycle phases that influence the environmental sustainability of waste management. At present door-to-door collection, recycling and land-filling disposal system was being followed. To overcome the drawbacks in the existing system an automated waste disposal system was developed. This system has sludge vacuum pump placed in garbage truck and the inlet of sludge vacuum pump is connected to the waste collection tank of garbage truck. When the truck parks on the parking lane, waste get sucked from the waste bin through sludge vacuum pump and deliver this waste to waste collection tank of garbage truck. This system speeds up the whole collection and disposal process. As this system reduce the man power, improve overall safety, rectifies the hygiene issues and efficiency shortfalls in waste collection A large portion of the physically disabled community of the world is currently using wheel chair which is not universally accessible. In many countries, public transport system depends on high floor bus and a wheel chair user fails to access to that comfortably. This research aims to demolish that problem of inaccessibility through a modification of the high floor bus door. This will encourage the integration of disabled people in the community and will also consist a technical challenge for the design. The basic methodology here consists of movable Ramp system which allows the wheel chair users to board the bus. Chain and Sprocket mechanism is involved in this system. In this research, through explicit analysis the feasibility of the ramp is tested. Eventually, the cost is discussed for performing this type of modification in a public bus in Tamil Nadu. So, this work will help people to find an effective mean to make public buses accessible for disabled persons. This study deals with the design and development of Ramp mechanism for wheel chair Users. In this project we will be creating CAD model of the Ramp and performing FEA on Ramp it will assist us to know the stresses and displacement.**

Keywords - Wheelchair Ramp, chain and sprocket mechanism, universally accessible, Explicit Analysis.

1. INTRODUCTION

A wheelchair ramp is an inclined plane installed in addition to or instead of stairs. Ramps permit wheelchair users, as well as people pushing strollers, carts, or other wheeled objects, to more easily access a building, or navigate between areas of different height. Ramps for accessibility may predate the wheelchair and are found in ancient Greece. When designing a wheelchair ramp an important factor to keep in the mind is that design and concept are proposed so as to meet the strict requirements of The Americans with Disabilities Act (ADA), all ramps must be as follows: A minimum of a 5x5 flat space at the top of the ramp. This is to ensure safe maneuverability once wheelchair users have reached the top of the ramp. A 1:12 slope ratio. This means that for every inch of vertical rise, there have to be 12 inches (or one foot) of the ramp. This is to ensure the ramp itself is not too steep and is the most complex measurement to get right. No ramp is allowed to be longer than 30 feet without a rest or a turning platform. This is to ensure that ramps aren't too long which could cause fatigue and accidents. Minimum width of 36 inches of clear space across the ramp is ideal. Some states such as California require as much as 48 inches, so be sure to check the specific legislation of your state. If using a turning platform, it should be a minimum size of 5x5 just like the flat space at the top of the ramp.

Globally, persons with disabilities are often referred to as the largest minority, accounting for a total of over 1 billion or 15 percent of the world's population**.** Too often, they experience challenging poverty, marginalization and exclusion in society.

The existence of cultural and physical barriers among other factors are major contributors to the obstacles for persons with disabilities, their families and communities face. Lack of inclusive environments often lead to deprivation of opportunities such as education, skill training, work or income-generating business, access to health care or leisure activities etc. As a result, many persons with disabilities are unable to get out of their own homes and lead independent, productive and fulfilling lives. Member States are making efforts to remove environmental barriers in compliance with international and domestic legal requirements.

Accessibility is well-established by the United Nations Convention on the Rights of Persons with Disabilities as an obligation for States Parties to ensure equality and non-discrimination. This commitment is further reinforced by the2030 Agenda for Sustainable Development, and its 17 goals (SDGs) that pledges to leave no country and no one behind. Therefore, accessibility should be promoted as a collective good. States and development agencies must better quantify and capture the socio-economic added value that benefits not merely a particular group of people, namely persons with disabilities, but the population at large.

II. METHODOLOGY

Persons with disabilities are often referred to as the largest minority. Too often, they experience challenging poverty, marginalization and exclusion in society. The existence of cultural and physical barriers among other factors are major contributors to the obstacles persons with disabilities, their families and communities face. As a result, many persons with disabilities are unable to get out of their own homes and lead independent, productive and fulfilling lives. So to encourage the integration of disabled people in the community, it was decided to create a facility for Wheel Chair Users for boarding public transports like normal people, so that they won't get left behind. In many countries, public transport system depends on high floor bus and a wheel chair user fails to access to that comfortably. This research aims to demolish that problem of inaccessibility through a modification of the high floor bus door.

So we have decided to use a ramp facility using Chain and Sprocket Mechanisms. Since accidents are minimized while using Ramp facility.

We are going to create a CAD Model of the Ramp using **SOLID WORKS** CAD Software and we are going to analyze the Ramp using **ANSYS** Software.

Modulus of Elasticity	190-210GPa
Poisson's Ratio	0.27-0.3
Density	7.7-8.03g/cm^3
Ultimate Tensile Strength	615.4MPa
Yield Strength	375.8MPa

Table 1:
Physical Properties of Mild Steel

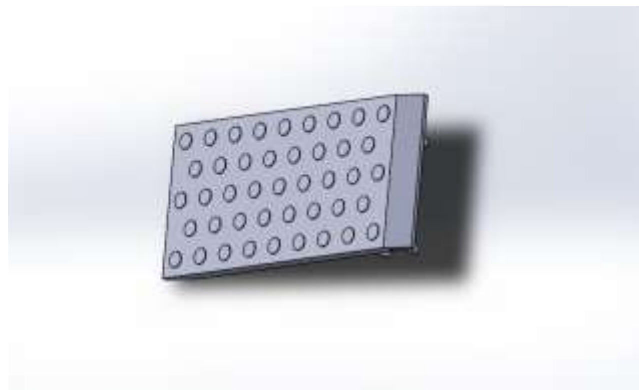

Fig.1
Top View of Ramp

Fig. 2
Isometric View of Ramp

CHAIN AND SPROCKET MECHANISM

A **sprocket** is a toothed wheel that fits on to a shaft. It is prevented from rotating on the shaft by a key that fits into key ways in the sprocket and shaft. A **chain** is used to connect two sprockets. One sprocket is the driver sprocket. The other sprocket is the driven sprocket. Motion and force can be transmitted via the chain from one sprocket to another, therefore from one shaft to another. Chains that are used to transmit motion and force from one sprocket to another are called **power transmission chains.**

III. EXPLICIT ANALYSIS:

For the production of Ramp, we have decided to use sandwich type of Materials consisting of Mild Steel at the bottom, Wood at the middle and Aluminum at the top.
ANSYS explicit dynamics analysis software solutions are capable of solving short-duration, large-strain, large-deformation, fracture, complete material failure, and structural problems with complex contact interactions. A time integration method used in Explicit Dynamics analysis system. It is so named because the method calculates the response at the current time using explicit information. Once the body is meshed properly, the next step is to define initial conditions or boundary conditions. At least one initial condition is required to complete the setup.

After defining the initial conditions (initial velocity, Angular velocity), the analysis setting has to be maintained as per the problem requirement. In the analysis setting, time steps have to be defined explicitly. The solution time depends on the time steps. Time steps include:

Table.2
Physical Properties of Aluminium

Modulus of Elasticity	68.9 GPa
Poisson's Ratio	0.33
Density	2.70g/cc
Ultimate Tensile Strength	310MPa
Yield Strength	276 Mpa

Initial time step, Minimum time step, Maximum time step, Time step safety factor etc. For the Finite Element Analysis of Wheel Chair Ramp, 3D model is created in SOLIDWORKS 2020 and saved in IGS format and imported in ANSYS Workbench14.5. At first, the plate was divided into meshes and then Von-mises stress, Equivalent Strain, Total displacement, Force Reaction, Moment Reaction and factor of safety of the wheel chair lifting plate were studied.

IV. EXPLICIT ANALYSIS OUTPUTS:

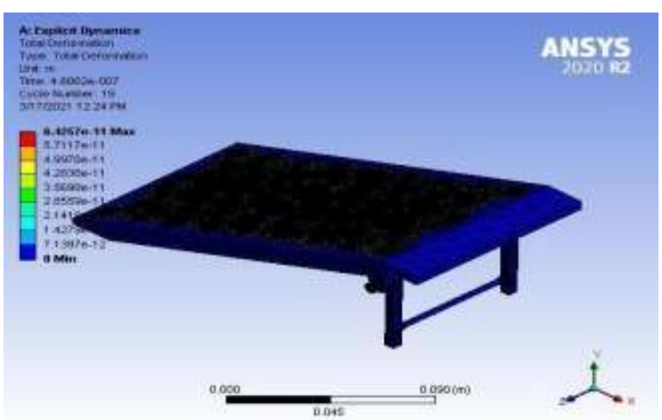

Fig.3
Total Deformation

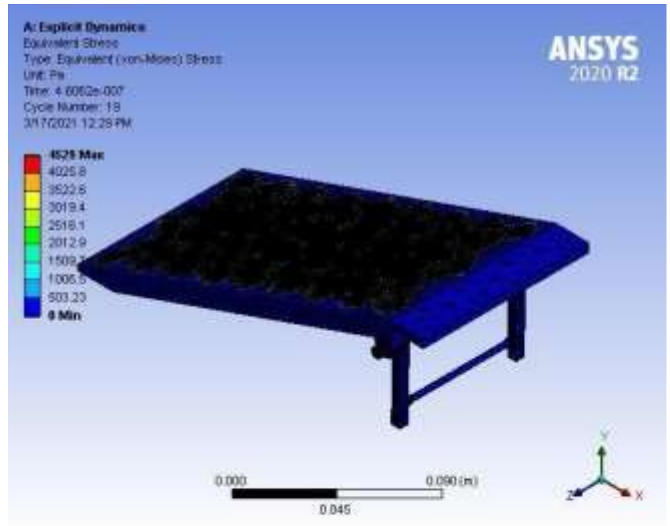

Fig.4.
Equivalent Stress

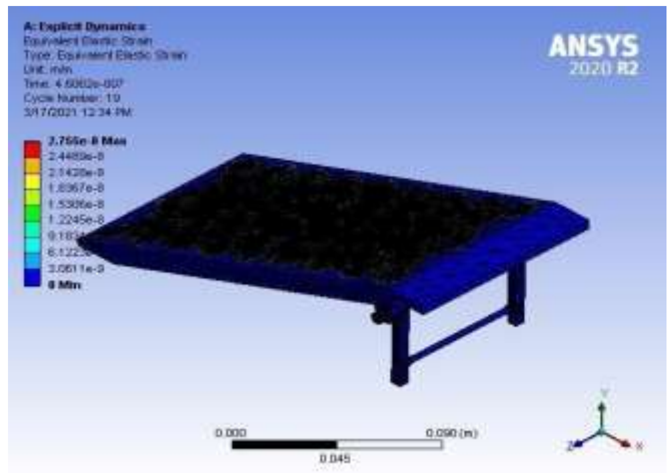

Fig.5
Equivalent Elastic Strain

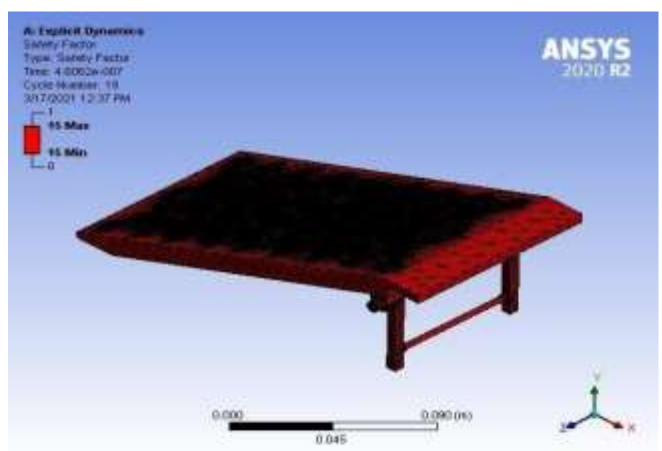

Fig.6
Safety Factor

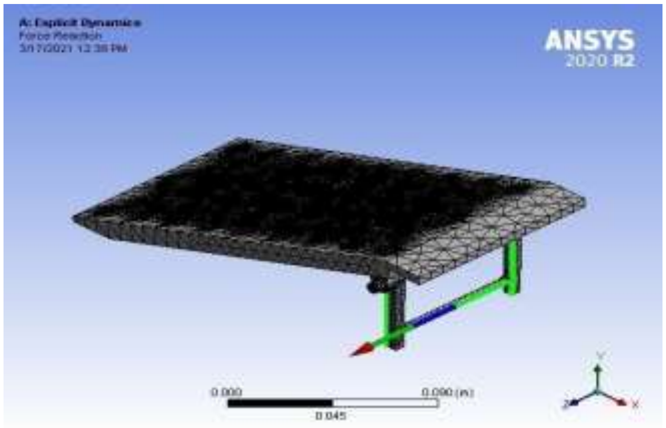

Fig.7
Force Reaction

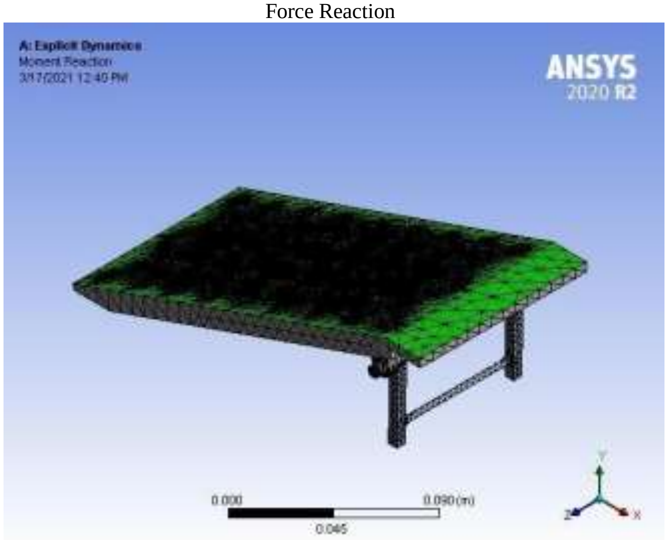

Fig.8
Moment Reaction

IV. CONCLUSION

Mobility is the prime requirement for a person to communicate and to keep pace with the world. But in some of the states in India, due to having no provision to accommodate a wheel-chair user in public buses, the movement of a physically challenged person remains impracticable. This research work has depicted the current situation of bus system in countries like India, Bangladesh, etc., and has suggested an economical way to overcome this situation by modifying the conventional door system. It has also created scope for further research for developing such a system for the noble sake of the wheel chair users.

In the present work, the CAD model of the ramp design has been done using SOLIDWORKS software. Then the finite element analysis was carried out by using ANSYS Software to validate the designed CAD model. In this analysis the Equivalent Stress, Total Deformation, Equivalent Elastic Strain, Factor of Safety, Force Reaction and Moment Reaction etc were determined. The Equivalent stress obtained from the analysis of the Ramp was found to be 4269 Pa and the total deformation for the ramp as 6.4257e-11m and equivalent elastic strain for the ramp as 2.755e-08 m/m. The Force and Moment Reaction for the ramp are 1.26e-002 N and 0.

The Explicit Dynamics analysis results proved that the stresses were well within the safe limits, and concluded that, the design is safe for using in real environment.

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