



Hungarian University of Agriculture and Life Science
Szent István Campus
Master Course

**DESIGN OF A MULTI-HINGED GATE-OPENING
MECHANISM**

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Summary

In the field of mechanical engineering, mechanics is crucial. The study of forces acting on bodies and the motion that results is known as mechanics. Engineering mechanics is the foundation of or strength in several engineering disciplines, including mechanical, civil, aeronautical, industrial, and material engineering. Because of mechanics, this technology century has gotten simpler for humans. Engineering mechanics' main goal is to design and analyze systems that are both stationary and in motion. The support and loading methods used for beams are known as their service conditions.

The widespread use of mechanical systems around the world is an important point to emphasize. The usage of mechanical systems in everything from transportation to production to everyday objects makes them a crucial component of modern society. Mechanical systems have completely changed the way we work and live, and it is crucial to acknowledge their significance in the construction sector as well.

Gates play a significant role in the construction industry since they are both useful and eye-catching components of a building. Bi-folding gates, in particular, offer several benefits that make them a popular choice in both residential and commercial settings. One of the primary advantages of bi-folding gates is their space-saving design, which allows for maximum use of available space. This makes them an excellent choice for areas where space is limited or where there are access restrictions. Bi-folding gates give an aesthetic appeal that can improve a building's overall appearance and feel in addition to its functional advantages. They may match any architectural style or design aesthetic due to the variety of materials, finishes, and colors that are offered.

Furthermore, bi-folding gates are commonly used in various industries and applications. For instance, they are popular in residential settings as a way to improve security and privacy, while also enhancing the curb appeal of the property. In commercial and industrial settings, they are often used as a way to control access to the premises, improve safety and security, and increase efficiency.

For bi-folding gates to be successfully used in construction, the engineering designing procedure is very important. To ensure that the gates are practical, secure, long-lasting, and fulfill the particular needs of the application, proper design is required.

The design process of a bi-folding gate is looked at in this master's thesis to show the different factors that must be taken into consideration when creating such gates. The dimensions, which are essential in determining the size and shape of the gate overall, are the first step in the design process for a bi-folding gate.

Accurate measurements of the opening where the gate will be mounted are necessary before the design process for a bi-folding gate can start. This is due to the fact that the size of the opening will define the gate's maximum size, which will affect the materials utilized, the gate's weight, and the motor type needed to run it. Accurate measurements would help designers avoid mistakes like designing a gate that is either too small or too big for the opening, which can cause instability, safety concerns, and even gate failure.

After determining the dimensions, the choice of materials is another important factor to consider. The materials used in the construction of the gate must be strong enough to withstand the forces acting upon it, while also being lightweight and durable. The selection of materials will depend on

factors such as the application, the environment in which the gate will be used, and the desired level of security.

Once the materials have been chosen, calculations must be performed to determine the mass and weight of the gate. This is essential to ensure that the gate is stable and can be operated safely. Furthermore, calculations must be made to determine the forces acting upon the gate, including torque and angular velocity. These calculations are critical in selecting the appropriate motor for the gate, which must be powerful enough to operate the gate smoothly and efficiently.

For the gate to perform effectively, choosing the right motor is also crucial. This thesis attempts to offer insight into the different elements that must be taken into account in the design of mechanical systems by investigating the design process of a bi-folding gate.

Once all the necessary calculations have been performed, the next step in the design process of a bi-folding gate is to create a 3D model of the gate. This is where 3D CAD (Computer-Aided Design) software comes into play.

Designers may produce accurate, realistic, and detailed models of their concepts using 3D CAD software. It offers an effective toolkit for producing complex mechanical designs, such as the bi-folding gate. Designers can see their creations in three dimensions using 3D CAD software, simulate how they will act in different scenarios, and make quick changes.

In today's world, 3D CAD software has revolutionized the mechanical design industry, making it far easier to create, modify, and test designs than ever before. This has resulted in faster design cycles, more accurate designs, and ultimately, better products.

The 3D CAD program of choice for this master's thesis was Autodesk Inventor. The bi-folding gate is one of the many mechanical designs that can be created with this program. The gate was designed in 3D using Autodesk Inventor, and all the necessary components—including the motor, top pivot joint, bottom pivot joint, leaf joint, column joint, hinges, and panels were integrated.

Once the 3D model of the bi-folding gate has been created, the next step is to simulate its operation using specialized software. In this thesis, Adams View was used for simulation, which is a user-friendly software designed for multi-body dynamics simulations.

The bi-folding gate model is imported into Adams View for the simulation, and the appropriate angular velocity is applied to the gate's motion. Following that, the simulation will forecast how the gate will behave, enabling designers to test the gate's functionality under different situations.

It is crucial to ensure that each part of the gate is connected with proper joints and has the correct motion applied to it during the simulation. This will ensure that the gate operates correctly and that all the necessary components are working as intended.

Adams View allows designers to simulate the operation of the gate, including how it will move, the forces it will encounter, and how it will respond to external loads. This provides designers with valuable insights into how the gate will behave in the real world and helps them to refine the design to make it safer, more efficient, and more reliable.

In the bi-folding gate design, there are four panels that are arranged in pairs, with one pair next to the other. To enable the panels to rotate, pivots are added at the top and bottom of the panel that is

next to the supporting beam, which also supports the rotation movement. The panels are also connected by hinges, which play a critical role in ensuring the gate operates smoothly.

In the simulation process, the panels are shown to rotate when a motor is applied to the gate. As the first panel begins to rotate, the column joint pushes the leaf joint, and the second panel rotates in the opposite direction (-90 degrees). This process continues until all four panels have rotated, and the gate is fully open or closed, depending on the desired configuration.

The simulation process provides designers with valuable insights into how the gate operates, including how the panels rotate and the forces that act on the gate's various components. This allows designers to make necessary adjustments to the design to ensure that the gate operates safely and efficiently. When a motor is supplied to the gate, the bi-folding gate works by using pivots and hinges to allow the panels to revolve. The simulation procedure offers insightful information about the motion of the gate and the forces acting on its various parts, enabling designers to improve the design to make sure the gate runs securely and effectively.

The ability to analyze and assess the outcomes of a design in a virtual environment is one of the key advantages of employing simulation software in the mechanical design process. Prior to performing any physical testing or prototyping, this can assist in identifying potential problems or areas of concern.

Gates are a common design element in mechanical engineering, with uses ranging from simple home gates to complex industrial gates. A thorough understanding of mechanical concepts, materials science, and manufacturing processes is necessary for the design and production of gates.

It is the responsibility of mechanical engineers to design the finest possible mechanisms for each application, taking into account elements like robustness, safety, dependability, and affordability. They must also be skilled at using contemporary and advanced tools like simulation software and 3D CAD modeling to solve issues that develop during the design and building process.

Ultimately, the goal of mechanical engineering is to create functional and efficient mechanisms that improve the quality of life for people and advance various industries. The design and construction of gates are just one example of how mechanical engineering principles and techniques can be applied to solve complex problems and create innovative solutions.