GROUP ASSIGNMENT STATICS

by Mohammad Ridhwan Suriansah

Submission date: 12-Jan-2025 08:40PM (UTC+0800)
Submission ID: 2562492885
File name: GROUP_ASSIGNMENT_STATICS.docx (248.81K)
Word count: 2442
Character count: 15278

GROUP ASSIGNMENT

SEMESTER 1

SESI 2024/2025

TITLE

GROUP ASSIGNMENT

COURSE CODE	**BDA10203**
COURSE NAME	**STATICS**
STUDENT NAME AND MATRIX NUMBER	**1. YOGENDREN A/L R RAVINDRAN CD240383** **2. SYAZRIE FIQRY BIN SUMANDI CD240368** **3. MOHD DANISH HAZIQ BIN SAUFIAN CD240362** **4. MARCELLINUS DIGAT ANAK SUKI CD240335** **5. MUHAMAD SYAHMIE AZRY BIN SYADERI CD240365**
SEKSYEN	**6**
GROUP	**GROUP 7**
LECTURER NAME	**PROF MADYA IR. DR. MOHD KHIR MOHD**

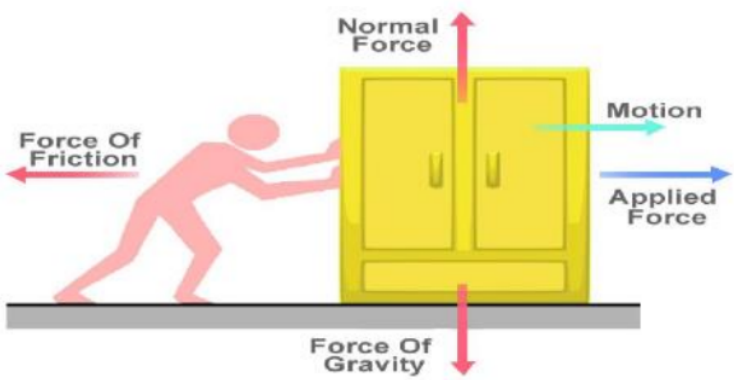
SUBMISSION DUE DATE	**5 JANUARY 2025**

TABLE OF CONTENT

INTRODUCTION

Statics is a fascinating branch of physics that delves into the study of forces, moments, and torques in systems that either remain stationary or move at a constant velocity. This field forms a cornerstone of mechanics, focusing on bodies that do not experience any acceleration. One of the core principles of statics is that the sum of all forces and the sum of all moments acting on an object must be zero. This equilibrium condition is crucial for ensuring the stability and balance of various structures, from bridges and buildings to machinery and furniture.

Newton's First Law of Motion, also known as the law of inertia, is deeply connected to the principles of statics. This law states that an object will remain at rest, or in uniform motion in a straight line unless acted upon by an external force. In the context of statics, this means that if an object is not accelerating, the forces acting on it are balanced, and it is in a state of equilibrium. This equilibrium condition is essential for the analysis and design of structures that must remain stable and secure under various loads and conditions.



One of the key topics in statics is the analysis of structures, particularly simple trusses. Simple trusses are widely used in various engineering applications due to their efficiency in supporting loads. They consist of straight members arranged in triangular shapes, connected at their ends by joints. The triangular arrangement provides geometric stability, making trusses highly effective in distributing forces.

Trusses are commonly used in bridges, roofs, aircraft, space stations, and cranes due to their ability to efficiently bear loads. Understanding the forces within these truss members is essential for their design and analysis. Trusses not only provide structural support but also ensure that forces are evenly distributed, preventing any single member from bearing too much load.

- **Method of Joints:** This technique involves analysing each joint in the truss individually. Since the entire truss is in equilibrium, each joint must also be balanced. By examining the forces acting on each joint, we can determine the forces within the connected members. This method requires solving a system of equations based on the equilibrium of each joint, making it a systematic approach to understanding the distribution of forces in the truss.

- **Method of Sections:** This method is used to analyse the forces in specific members of the truss. It involves cutting through the truss and analysing a segment of it. If the truss is in equilibrium, any segment of the truss will also be in equilibrium. This method is particularly useful for determining the forces in a few members without analysing the entire truss. By isolating a section of the truss, we can apply the principles of equilibrium to solve for the forces within that section.

In our assignment, we will investigate the practical applications of simple truss systems by demonstrating their importance in real-world engineering scenarios. The primary aim is to analyse the forces within a simple truss by developing a mathematical model and uncovering the relationships between the system's forces. This activity not only reinforces our understanding of statics but also underscores its crucial role in engineering practice.

As part of our assignment, we will explore how simple trusses are utilized in various structures and how their design ensures stability and efficiency. We will also learn to apply the principles of statics, such as the method of joints and the method of sections, to determine the forces in truss members. [19] This knowledge is essential for designing safe and efficient structures that can withstand different loads and conditions.

Through this assignment, we will deepen our grasp of statics principles and appreciate their practical significance in engineering. By developing a mathematical model and analysing the forces within a simple truss, we will gain valuable insights into the design and analysis of structural systems. This experience will equip us with the skills needed to tackle future engineering challenges and create stable and efficient structures.

LITERATURE REVIEW

The analysis of simple trusses is a fundamental topic in statics, which is provides essential knowledge for mechanical and manufacturing engineering.

This literature review synthesizes relevant research, textbook, lecture's slide, and technical resources to present a comprehensive overview of the analysis methods, assumptions, and application of simple trusses.

The development of trusses analysis dates back to early 19^{th} century, with contributions from Augustin-Louis Cauchy and James Clerk Maxwell. These pioneers formalized methods for analysing structure under various loading condition, which laid the groundwork for modern structural analysis. The simplicity and efficiency of trusses have made a staple in the design of bridges, roofs, and another framework.

Standard assumptions in truss analysis are pretty well discussed in the literature.

23

1. Truss members are connected by frictionless pins.
2. Loads and reactions can be applied only at joints.
3. Members are subjected to purely axial forces either in tension or compression.
4. The weight of members shall be neglected unless otherwise stated.

These assumptions simplify the mathematical modeling of trusses and thus allow for straight-forward applications of equilibrium equation. The two major techniques for simple trusses analysis include the method of joint and method of sections. Each of these is well discussed in various statics' class, textbook, and research.

I) Method of Joints

In this technique, each joint is considered individually and then using the equilibrium equations, it seeks to determine forces in connected members. The method of joint is used basically for smaller trusses or finding the forces in all its members.

7

II) Method of Sections.

This approach involves cutting the truss into sections and applying equilibrium equations to analyze specific members directly. It is efficient for analyzing large trusses or determining forces in a few members of interest.

Trusses, due to the high strength-to- weight ratio, find wide application in mechanical and manufacturing engineering. Applications include:

1) Bridges: Pratt truss and Warren truss are simple trusses commonly used.

2) Manufacturing frameworks: The trusses that are lightweight and modular find usage in machine structures and robotic frameworks.

3) Building Roofs: Trusses are structural elements that provide support to roofs with minimal material usage.

Even though trusses are efficient, they have some limitations, including sensitivity to buckling in compression members and the assumption of perfect pin connections. In conclusion, analysis of simple trusses is a cornerstone in the education and practice of statics. Computation techniques are at the forefront of development method of solution, including the method of joint and method of section. Future research will continue to be aimed at making trusses structures even more efficient, reliable, and materially sustainable.

PROBLEM DEFINITION

In the realm of structural engineering, the stability and efficiency of constructions like bridges, roofs, and frameworks are paramount. Simple trusses, which are composed of straight members arranged in triangular configurations, play a crucial role in these applications due to their ability to effectively distribute loads. However, determining the precise forces within each member of a truss system poses a significant challenge for engineers. Addressing this challenge requires a thorough understanding of force interactions within the truss to ensure structural integrity and safety.

The primary aim of this assignment is to develop a mathematical model that analyses the forces acting on a simple truss. By utilizing the method of joints and the method of sections, we aim to uncover the relationships between various forces within the system.

The method of joints is a technique used to analyse the forces at each joint within a truss. Given that the entire truss is in equilibrium, each joint must also be in equilibrium. By examining the forces acting on each joint, we can determine the forces within the connected members. This method involves solving a set of equations based on the equilibrium conditions of each joint, providing a systematic approach to understanding the distribution of forces in the truss.

Key steps in the method of joints include:

1. **Identifying Joints:** Select a joint where the forces are unknown.
2. **Equilibrium Equations:** Apply the equilibrium equations to the joint:

- Sum of forces in the x-direction: $\Sigma F_x = 0$
- Sum of forces in the y-direction: $\Sigma F_y = 0$

3. **Solving for Forces:** Solve the system of equations to find the unknown forces in the connected members.

These components ensure equilibrium at each joint, where the summation of forces in both the horizontal and vertical directions must equal zero.

The method of sections is a technique used to analyse the forces in specific truss members. This method involves cutting through the truss and analysing a segment of it. If the truss is in equilibrium, any segment of the truss will also be in equilibrium. This method is particularly useful for determining the forces in a few members without analysing the entire truss.

Key steps in the method of sections include:

1. **Isolating a Section:** Cut through the truss to isolate the section containing the members of interest.
2. **Equilibrium Equations:** Apply the equilibrium equations to the section:

- Sum of forces in the x-direction: $\Sigma F_x = 0$
- Sum of forces in the y-direction: $\Sigma F_y = 0$
- Sum of moments about a point: $\Sigma M = 0$

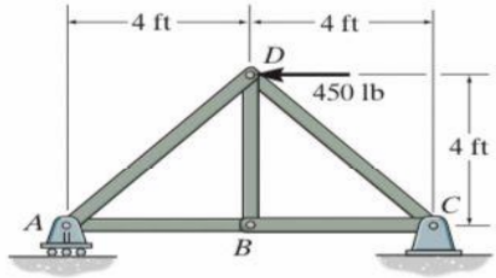
3. **Solving for Forces:** Solve the system of equations to find the unknown forces in the selected members.

The method assumes that each member is subjected to either tension or compression, and this assumption is validated through calculations. By systematically applying these equilibrium conditions at each joint, the internal forces within the individual members can be determined. If the calculated force is positive, the member is in tension; conversely, if the force is negative, the member is in compression.

MATH MODELLING

3.3 Calculation

F6–1. Determine the force in each member of the truss. State if the members are in tension or compression.



Prob. F6–1

Figure : Shows Free Body diagram of trusses

$Dx = -450\ lb$ (external force)

Horizontally

$AB = BC = 8\ ft$

Vertically

$AD = DC = 4\ ft$

$$(\rightarrow +\sum F_x = 0 ,\uparrow +\sum F_y = 0, \circlearrowleft +\sum M_A = 0)$$

1. Reaction Forces at Supports (A and C)

Horizontal Equilibrium ($\rightarrow +\sum F_x = 0$)

$$A_x + C_x - 450 = 0$$

$$A_x + C_x = 450$$

$$A_x = C_x = \frac{450}{2} = 225\ lb$$

Vertical Equilibrium ($\uparrow +\sum F_y = 0$)

Since there are no vertical external forces acting on the truss:

$$A_y + C_y = 0$$

Since the truss is symmetrical and no vertical load is applied:

$$A_y = C_y = 0$$

Joint A:

Analyzing the truss using joints to determine forces in each members or points. By using slope ratio 1 : 2 (since height is 4 ft and base is 8 ft) for inclined members.

$$A_x = 225\,lbs\ (to\ the\ right)$$

$$A_y = 0$$

$$\rightarrow + \sum F_x = 0$$

$$F_{AB} - A_x = 0$$

$$F_{AB} - 225\,lbs = 0$$

$$F_{AB} = 225\,lbs\ (tension)$$

Since F_{AD} is inclined (1 : 2), we can determine it as:

$$F_{AD} = 0\,lb$$

Joint B:

At B , members AB, BC, and BD are connected.

$$F_{AB} = 225\,lbs\ (tension)$$

$$\rightarrow + \sum F_x = 0$$

$$F_{BC} - F_{AB} = 0$$

$$F_{BC} - 225\,lbs = 0$$

$$F_{BC} = 225\,lbs\ (tension)$$

$$\uparrow + \sum F_y = 0$$

$$F_{BD_y} = 0$$

Thus, ?? Siapa kacau tu?

$$F_{BD} \quad = 0\,lb$$

Joint D:

At D, members or trusses AD, BD, and DC are connected.
The external force $450\,lbs$ acts on the left.

$$\rightarrow + \sum F_x = 0$$

$$-450 \; + F_{DC} = 0$$

$$F_{DC} = 450\,lbs\,(compression)$$

Member	Force (lb)	Type
$\boldsymbol{AB}$	225	**Tension**
$\boldsymbol{BC}$	225	**Tension**
$\boldsymbol{AD}$	0	**Zero-force**
$\boldsymbol{BD}$	0	**Zero-force**
$\boldsymbol{DC}$	450	**Compression**

CONCLUSION

Ultimately, the fundamental techniques for analysing truss structures, which are crucial for many engineering applications, are investigated. Two primary methods are dealt with in detail: the method of joints and the method of sections. The method of joints consists of the direct analysis of the individual components (or "joints") in the truss structure in order to ascertain the acting forces and to verify that the structure as a whole is in a state of equilibrium. This method is used not only for simple trusses but also when the internal members, sans joints, can be analysed with the aid of some straightforward geometric considerations. The method of sections, on the other hand, uses a more cunning approach: it cuts the truss into two "halves" and analyses the forces acting on one half (or the other half). The method of sections is particularly useful when one part of an enormous truss is under so much stress that its members are giving way, while the other part remains perfectly safe. Engineers can use it to figure out just where the truss is failing and just where it is holding up. By mastering these two techniques, they can design and troubleshoot truss structures. Both techniques ensure that the structure meets efficiency, safety and load-bearing criteria.

REFERENCE

Baker, D. W., & Haynes, W. (2024). *Engineering statics: Open and interactive*. Retrieved from https://engineeringstatics.org/pdf/statics.pdf

Libre Texts. (n.d.). *Methods of truss analysis*. In *Introduction to aerospace structures and materials*. Retrieved January 10, 2025, from https://eng.libretexts.org/Bookshelves/Mechanical_Engineering/Introduction_to_Aerospace_Structures_and_Materials_%28Alderliesten%29/02%3A_Analysis_of_Statically_Determinate_Structures/05%3A_Internal_Forces_in_Plane_Trusses/5.06%3A_Methods_of_Truss_Analysis

Libre Texts. (n.d.). *Statically determinate structures*. In *Introduction to aerospace structures and materials*. Retrieved January 10, 2025, from https://eng.libretexts.org/Bookshelves/Mechanical_Engineering/Introduction_to_Aerospace_Structures_and_Materials_%28Alderliesten%29/02%3A_Analysis_of_Statically_Determinate_Structures/05%3A_Internal_Forces_in_Plane_Trusses

Baker, D. W., & Haynes, W. (2024). *Engineering statics: Open and interactive*. Retrieved from https://engineeringstatics.org/pdf/statics.pdf

Libre Texts. (n.d.). *Trusses*. In *Engineering statics*. Retrieved January 10, 2025, from https://engineeringstatics.org/Chapter_06-trusses.html

Hoong, N., & Chen, D. (2020). Building mechanical intuition through hands-on learning with truss components. In *Creative Collaborations Undergraduate Research Conference*. Retrieved from https://digital.sandiego.edu/cgi/viewcontent.cgi?article=1161&context=osp-researchweek

Cooper band, Z., Ghrist, R., & Hansen, J. (2023). A cosheaf theory of reciprocal figures: Planar and higher genus graphic statics. *arXiv preprint arXiv:2311.12946*. Retrieved from https://arxiv.org/abs/2311.12946

Cooper band, Z., McRobie, A., Millar, C., & Schulze, B. (2024). Homology of moment frames. *arXiv preprint arXiv:2404.07184*. Retrieved from https://arxiv.org/abs/2404.07184

Libre Texts. (n.d.). *Methods of truss analysis*. In *Introduction to aerospace structures and materials*. Retrieved January 10, 2025, from https://eng.libretexts.org/Bookshelves/Mechanical_Engineering/Introduction_to_Aerospace_Structures_and_Materials_(Alderliesten)/02%3A_Analysis_of_Statically_Determinate_Structures/05%3A_Internal_Forces_in_Plane_Trusses/5.06%3A_Methods_of_Truss_Analysis

Libre Texts. (n.d.). *Statically determinate structures*. In *Introduction to aerospace structures and materials*. Retrieved January 10, 2025, from https://eng.libretexts.org/Bookshelves/Mechanical_Engineering/Introduction_to_Aerospace_Structures_and_Materials_(Alderliesten)/02%3A_Analysis_of_Statically_Determinate_Structures/05%3A_Internal_Forces_in_Plane_Trusses

Proietti, S. (2022). Review of *Engineering mechanics: Statics*. *Open Textbook Library*. Retrieved from https://open.umn.edu/opentextbooks/textbooks/1283

Purdue University. (n.d.). *Chapter 6: Analysis of structures*. Retrieved January 10, 2025, from https://engineering.purdue.edu/~aprakas/CE297/CE297-Ch6.pdf

Amazon.com. (n.d.). *12 truss problems (Statics Series - Module #2 Book 1)*. Retrieved January 10, 2025, from https://www.amazon.com/12-Truss-Problems-Statics-Module-ebook/dp/B01N4CMBGX

McNally Jackson Books. (n.d.). *The design of simple roof trusses in wood and steel*. Retrieved January 10, 2025, from https://www.mcnallyjackson.com/book/9781446064450

YouTube. (n.d.). *Statics: Lesson 48 - Trusses, method of joints*. Retrieved January 10, 2025, from https://www.youtube.com/watch?v=BVCIQfFzguk

YouTube. (n.d.). *Statics: Lesson 47 - Intro to trusses, frames, and machines*. Retrieved January 10, 2025, from https://www.youtube.com/watch?v=PftThd8ev0o

University of Minnesota. (n.d.). *Engineering statics: Open and interactive*. Retrieved January 10, 2025, from https://open.umn.edu/opentextbooks/textbooks/1047

MDPI. (2021). Learning statics by visualizing forces on the example of a physical model. *Buildings, 11*(9), 395. Retrieved from https://www.mdpi.com/article/10.3390/buildings11090395

Amazon.com. (n.d.). *A text-book on roofs and bridges: Stresses in simple trusses. 3rd ed.* Retrieved January 10, 2025, from https://www.amazon.com/Text-Book-Roofs-Bridges-Stresses-Trusses/dp/1018497986

LibreTexts. (n.d.). *Engineering mechanics: Statics*. Retrieved January 10, 2025, from https://eng.libretexts.org/Bookshelves/Mechanical_Engineering/Book%3A_Engineering_Mechanics_Stat

Cooperband, Z., Ghrist, R., & Hansen, J. (2023). *A cosheaf theory of reciprocal figures: Planar and higher genus graphic statics. arXiv preprint arXiv:2311.12946*. Retrieved from https://arxiv.org/abs/2311.12946

GROUP ASSIGNMENT STATICS

ORIGINALITY REPORT

27%	13%	14%	19%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Higher College of Technology Student Paper	3%
2	Submitted to Queensland University of Technology Student Paper	2%
3	Submitted to University of Technology, Sydney Student Paper	2%
4	www.o2learning.org Internet Source	2%
5	Submitted to Brunel University Student Paper	2%
6	Submitted to Engineering Institute of Technology Student Paper	2%
7	Tanvir Mustafy. "Fundamentals of Structural Engineering - A Problem-Based Approach", CRC Press, 2024 Publication	1%

Submitted to University of Wales, Lampeter

8	Student Paper	1 %
9	Submitted to Australian Christian College - Master Account Student Paper	1 %
10	Cooperband, Zoe. "Cellular Cosheaves, Graphic Statics, and Mechanics", University of Pennsylvania, 2024 Publication	1 %
11	Submitted to University of Bolton Student Paper	1 %
12	www.coursehero.com Internet Source	1 %
13	Dietmar Gross. "Trusses", Engineering Mechanics 1, 2009 Publication	1 %
14	Nicholas Vandewetering, Joshua M. Pearce. "Streamlining structural engineering compliance of rooftop solar photovoltaic installations using an open-source approach", Solar Energy, 2024 Publication	1 %
15	Submitted to University College London Student Paper	1 %
16	Submitted to University of Auckland Student Paper	1 %

17	Submitted to Technological Institute of the Philippines Student Paper	1 %
18	Submitted to University of Salford Student Paper	1 %
19	Submitted to University of Sydney Student Paper	1 %
20	Submitted to Kingston University Student Paper	1 %
21	Renfu Lu, Nathan Dickinson, Kyle Lammers, Kaixiang Zhang, Pengyu Chu, Zhaojian Li. "Design and Evaluation of End Effectors for a Vacuum-Based Robotic Apple Harvester", Journal of the ASABE, 2022 Publication	1 %
22	www.youtube.com Internet Source	1 %
23	documents.mx Internet Source	<1 %
24	Submitted to East Carolina University Student Paper	<1 %
25	Submitted to CSU Northridge Student Paper	<1 %
26	www.researchgate.net Internet Source	<1 %

27	journal.uinjkt.ac.id Internet Source	<1 %
28	repositorio.iestpffaa.edu.pe Internet Source	<1 %
29	scholarworks.boisestate.edu Internet Source	<1 %
30	www.amazon.com Internet Source	<1 %
31	www.inspirasitimur.com Internet Source	<1 %

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		