Building Structures [ARC 2522] Project 1

Fettuccine Truss Bridge

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Content

1. Introduction

1.1 General purpose of study

The general purpose of this study is to evaluate, explore and improve attributes of construction. Through constructing a truss bridge out of fettuccine, explore truss members in different arrangement and apply the understanding of load distribution in truss system. Moreover, able to understand and apply the knowledge on calculating the reaction force, internal force and determine the truss. Hence, identify tension and compression members in a truss structure.

1.2 Report preview

In groups of 5, a truss system bridge will be produced by using fettuccine as material, which the bridge should withstand a point load of 5kg .The report will include the precedent studies Kota Bridge which we researched and went for site visit in Klang and the analysis on strength of the material used and truss system. A set of testing results of our truss bridge model will also be carried out. Besides that, calculation on given question and the designated bridge is also included.

2. Methodology

Material Strength Testing

The first task will be the analysis of material attributes, which means its strength will be tested.

Precedent Study & Site Visit

Site visit: studying a real truss bridge’s connections, arrangement of members and orientation of each member. Truss model’s structure will be depended on the information obtained from precedent studies.

Model Making

Each model making will require an autoCAD drawing, as the two side of truss bridge model will be firstly constructed, and they will be connected by the intermediate members.

Structural Analysis

By the methods practiced by truss analysis exercises, the structural analysis of the bridge will be done by the same way.

Requirements:

1. Students are required to construct a fettuccine bridge of 600mm clear span.
2. Only fettuccine and glue are allowed to use as the materials of the bridge.
3. Students are not allowed to laminate the bridge using glue.
4. The loads have to be point load and focus on one specific point of the bridge constructed.
5. The bridge constructed must be able to withstand 5Kg of load for 60 seconds.

Working Schedule:

Date Tested	Tasks
7/9/2013	Testing on the strength of layers and I-beam structure of fettuccine.
19/9/2013	First testing model making and testing.
30/9/2013	Second testing model making.
1/10/2013	Second testing model testing.
2/10/2013	Second testing model testing: tested to its limit
5/10/2013	Third model making and testing.
6/10/2013	Forth testing model making and testing.
7/10/2013	Final fettuccine bridge testing and submission.

Table 1 Working Schedule

Equipments & Materials:

Fettuccine

Fettuccine is the main material to build the bridge. Strengthening the fettuccine by lamination is prohibited.

S hook

The S hook is used to connect the fettuccine bridge and weights together and focus all the force on one point on the bridge.

Weight

The weight is used to determine the strength of the fettuccine bridge by applying it as point load on the bridge.

Water Pile

water pile was used in the material testing process due to the minimum weight of weights that we have are 2.5Kg, which is too heavy for testing small amount of fettuccine.

3-second super glue

Used to hold fettuccine together. The reason we have chosen this glue is because it can adhesive in instant and also its high strength.

240ml Cup

The cup is used to measure the amount of water that serve as weight that poured inside the water pail. Each cup consists of 240ml of water which is equivalent to 240g.

DSLR camera

Camera was used to record all the testing progress and evidences.

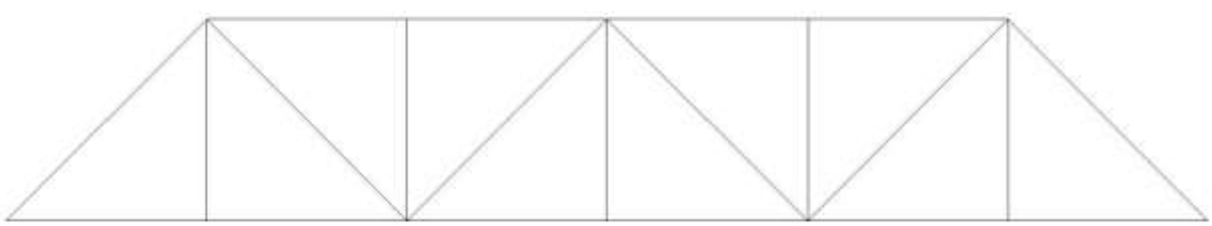
3.Precedent Study

Fig3.1 Exterior view of the bridge

Kota Bridge Klang

Kota Bridge, which is located in Klang, Malaysia was built in May 1957 by British Dorman Long Bridge and Engineering Ltd Company. The bridge's main span over the Klang River is 500 meter.

It is a double decker truss girder bridge which uses Warren truss with verticals as members to distribute load.



WARREN TRUSS

Fig3.2 Site map

It is the first double-decked in Malaysia that features a pedestrian walkway at the lower half.

The Kota Bridge is the main connection of Bandar Klang Utara and Klang Selatan.

However, it was closed for public in 21st January 1992 and the renovation of the bridge completed on July 17, 1997.

The Council then decided to turn this bridge as one of the tourist attraction to Klang.

Fig 3.3 View from one side of Kota Bridge

Interior view of the bridge

Fig 3.4.1 Interior view of the bridge.

Span 500m across Klang river,Kota Bridge used to serve as a connection for vehicle such as car at the upper half.

Fig 3.4.2 Interior view of the bridge.

Kota Bridge uses steel member to form warren truss with verticals.

Fig 3.4.3 Interior view of the bridge.

Nowadays,the only the lower half of the bridge is used as a pedestrian walkway.

Fig 3.4.4 Interior view of bridge

Besides, there is also a road for motorcycle and bicycle to pass by.

Truss connection and members

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Fig 3.5.1 Overall view of truss connection and members from exterior of bridge.

Fig 3.5.2 Rigid joint connections, Warren arrangement

Fig 3.5.3 Planer space frame, Rigid joint with gusset plates.

Fig 3.5.4 Rigid joint close up view.

Fig 3.5.5 Rigid joint with gusset plates close up view.

Fig 3.6.1 Overall view of truss arrangement from interior view of the bridge.

Fig 3.6.2 Double intersection of Warren truss.

Fig 3.6.3 Warren truss, Rigid joint connection.

Fig 3.6.4 Pin joint connection , Warren truss arrangement.

Fig 3.6.5 Space frame truss, Rigid joint connection with gusset plates

4.Analysis

4.1 Strength of Material

As fetucini is used as the only material for the model, its attribute is required to be studied and tested before the model making.Our aims are :

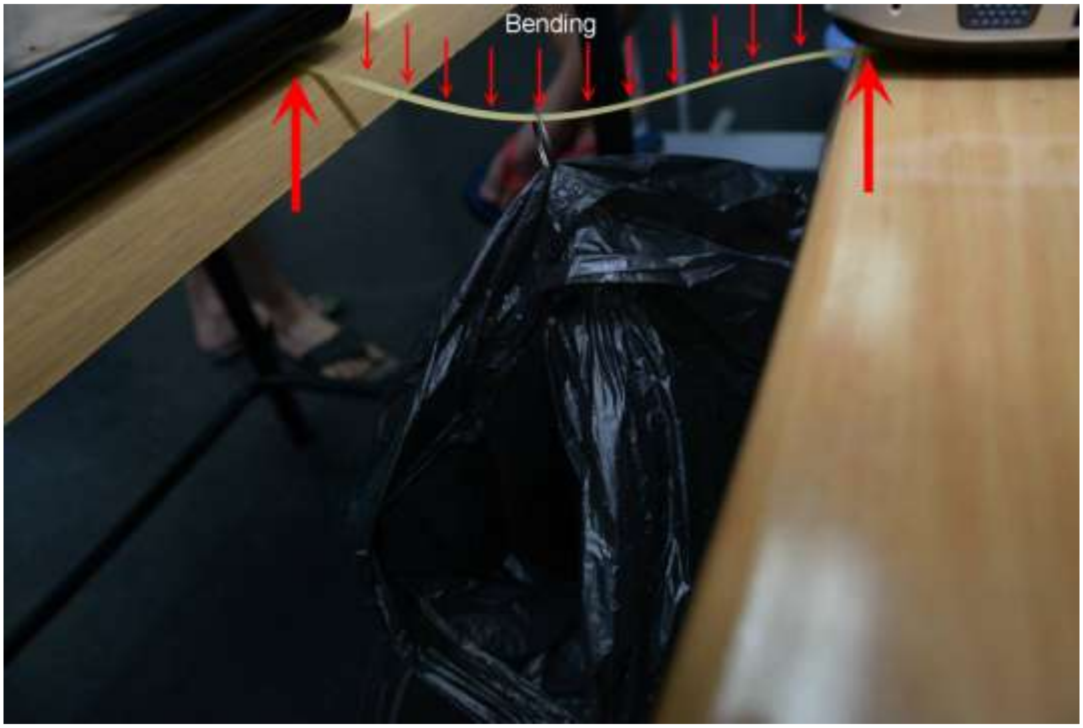
i) to achieve high level of aesthetic value

ii) acquire minimal construction material

Below is a table showing, strength of fetuccini analysis by applying point load(number of cups of water) on middle point of the fettuccine with different number, orientation and arrangement of fettuccine to form the member.

Clear Span	Length of Fettucinne	Perpendicular distance	Weight Sustained (Horizontal facing)	Weight Sustained (Vertical facing)
20cm	26cm	1 stick	2 cup	2.7 cup
20cm	26cm	2 stick	3 cup	3.7 cup
20cm	26cm	3 stick	4 cup	4.8 cup
20cm	26cm	4 stick	5 cup	5.8 cup
20cm	26cm	5 stick	6.8 cup	6 cup

TABLE 4.1. 1 TO DETERMINE THE STRENGTH OF MATERIALUSING DIFFERENT LAYER
1 cup = 240gram



PICTURE 4.1.1 The loads(and reactions) bend the fettuccine and try to shear through it

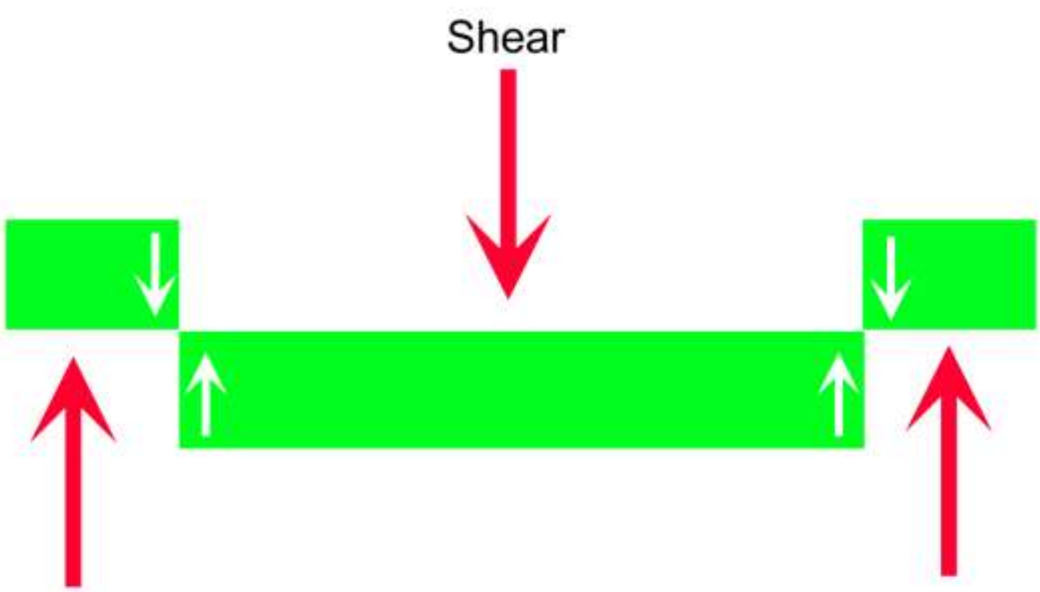


FIGURE 4.1.1 When the fettuccine is loaded by forces, stresses and strains are created throughout the interior of the beam.

The weight that one fettuccine can withstand is lower in horizontal facing when compared to vertical facing from 1 stick to 4 stick. However, the results turn out to be opposite when reaching 5 sticks and onward. This conclude that when the area exposed relative to its volume is bigger as it is sustaining the point load, the weaker is the fettuccine member in resist strains and stresses(the easier is the member to broken apart)

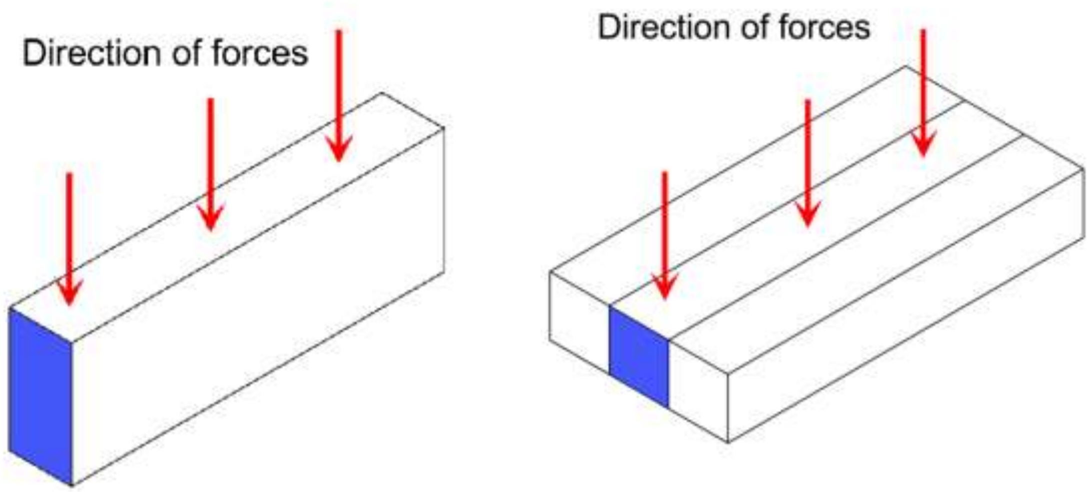
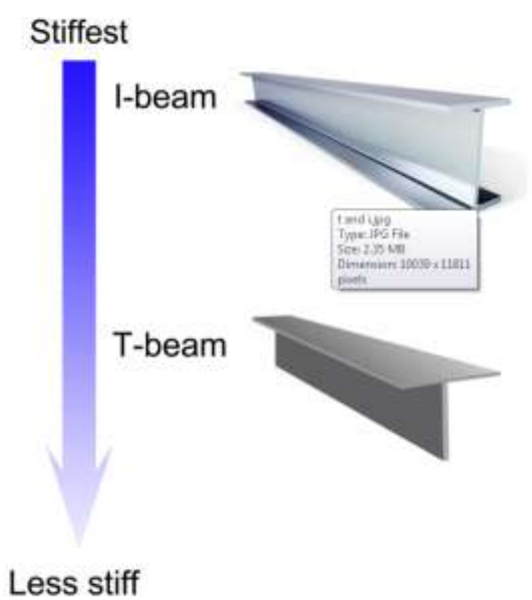


FIGURE 4.1.2 Maximum material in the direction of forces ensure a stronger member

From this result, we concluded to use fettuccine member of 1 to 4 stick with vertical facing on the truss member that required less strength.

Clear Span		Length of Fettucinne	Perpendicular distance	Weight Sustained
I-beam (1 top 4 middle 1 bottom)	Vertical	26cm	5 stick	9 cup
	Horizontal	26cm	5 stick	5.9 cup
T beam (1 top 4 middle)		26cm	4 stick	6.2 cup

TABLE 4.1.2 TO DETERMINE STRENGTH USING DIFFERENT SHAPES



From above, it can be concluded that different shape would have different stiffness and resistance to strains and stresses inside the beam. However, a high efficiency member significantly can increase the weight of the fettuccine.

FIGURE 4.1.3 STIFFNESS OF MEMBER AS REFER TO SHAPE

Hence, **appropriate member of weight and strength** is used according to the need of truss member at different area.

Test on glue are done to get the best result on connection, weight it imposed and the efficiency of the glue itself.

Ranking (according to efficiency)	Type of glue	Description
1	3 second glue (V-tech)	-Highest efficiency. - Fastest solidify time between connection
2	Elephant	-High efficiency. -Longer solidify time.
3	Hot glue	-Low efficiency. -Long solidify time. -Easily create bulky finishing,weight increased significantly

TABLE 4.1.3 TO DETERMINE EFFICIENCY OF GLUE

4.2 Truss Analysis

Warren Bridge

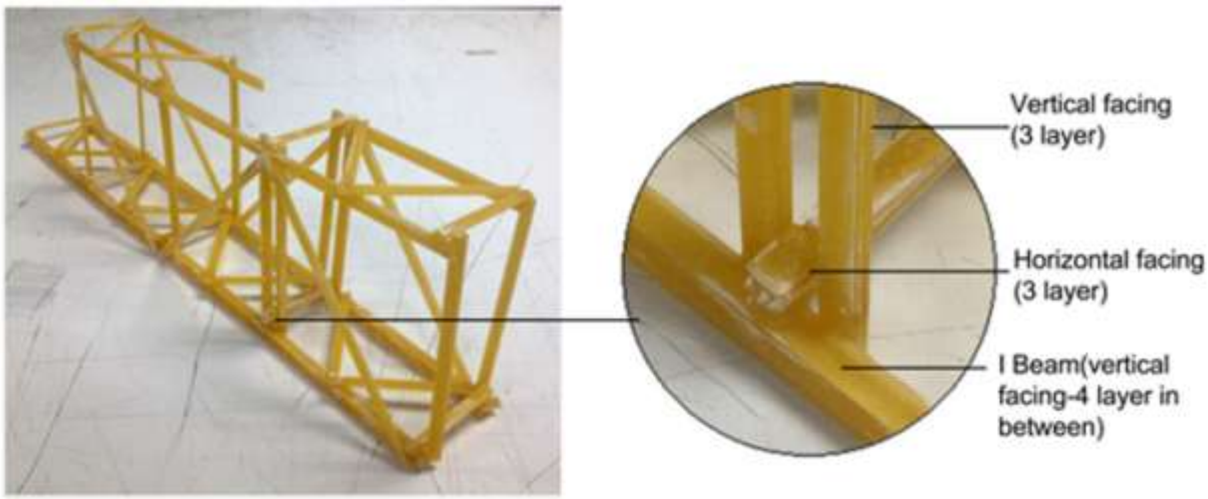


FIGURE 4.2 .1 DETAIL OF WARREN BRIDGE

In proposing our first warren truss bridge, we are chosen the truss member based on the required force to withstand tension and compression after referred to the past material testing as well as precedent study on how to make the connection between the joint.

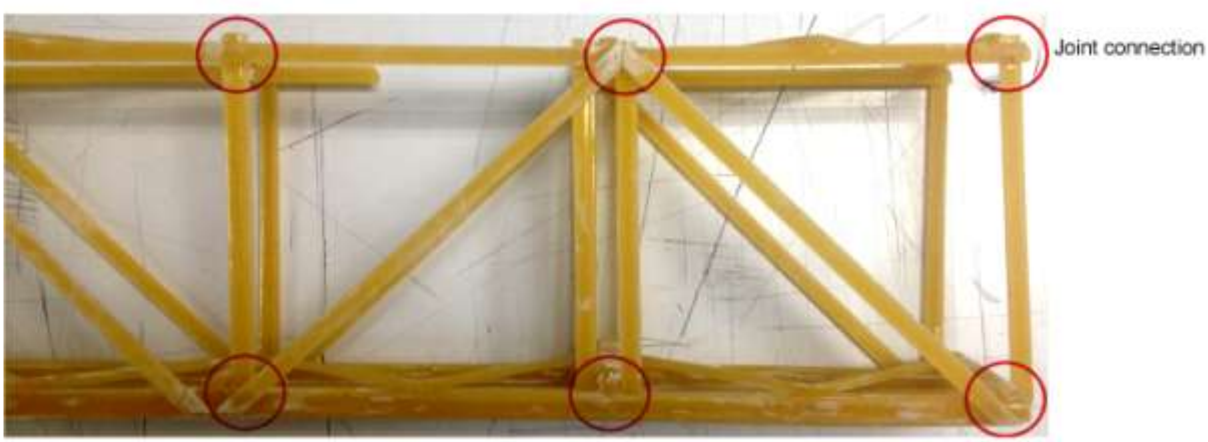


FIGURE 4.2 .2 JOINT CONNECTION OF WARREN BRIDGE

The connection shown doesn't transfer the load as supposed along the member from top to lower part. As compared to precedent study and after weighing it to fail at 5kg,we proved that connection between joint are important to ensure load is able to transfer in between the member.

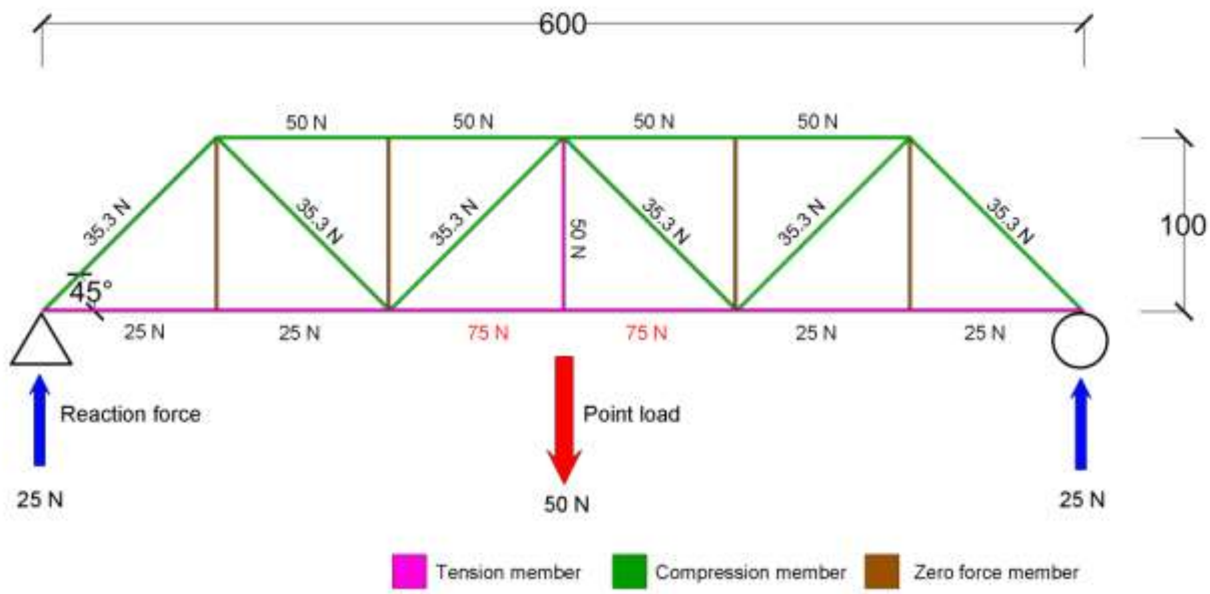


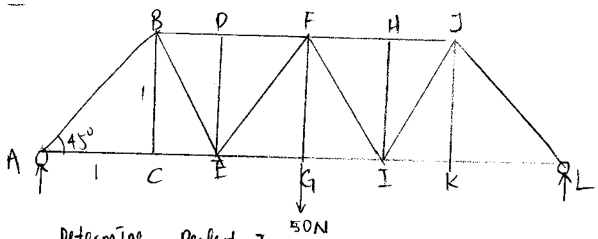
FIGURE 4.2 .3 STRUCTURAL ANALYSIS OF WARREN BRIDGE

As refered to the calculations made, the tension, compression, zero force and critical member(75N) are able to be identified.

From the testing we made, it is determined that the top horizontal member of the part is not enough to resist compression force of 50N. There are also zero force member exist as well.

Hence, in order to improvise this selected warren bridge to sustain maximum 5 kg with minimum material used, the zero force member can be omit while the selection of type of top horizontal member need to be strengthen .The lower horizontal member other than the critical member can be reduced the material used as well to improve the efficiency.

Analysis of Warren Bridge



Determine Perfect Truss

$2J = m + 3$

$2(12) = 21 + 3$

$24 = 24$

$\therefore$ It is a perfect truss

Determine Reaction force

$\Sigma F_x = 0$ $\quad\quad$ $\Sigma F_y = 0$

$R_{Ay} + R_{Ly} - 50 = 0$

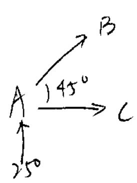
$R_{Ay} + R_{Ly} = 50\,N$

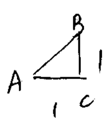
$\therefore R_{Ay} = R_{Ly}$ (equavalence)

$R_{Ay} = R_{Ly} = 25\,N$

Determine Internal Forces and FBD

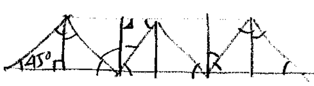
FBD @ A





$\tan A = 1$

$\angle A = 45°$



$\Sigma F_x = 0$

$F_{AC} + F_{AB}\cos 45° = 0$

$F_{AC} = -(-35.36)(\cos 45°)$

$\boxed{F_{AC} = 25\,N}$ (T)

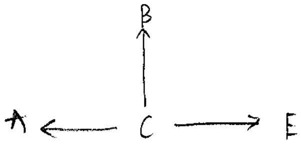
$\Sigma F_y = 0$

$25\,N + F_{AB}\sin 45° = 0$

$F_{AB} = \left(-\frac{25}{\sin 45°}\right)$

$\boxed{F_{AB} = -35.36\,N}$ (C)

FBD @ C



$\Sigma F_x = 0$

$-F_{AC} + F_{CE} = 0$

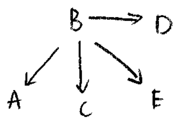
$F_{CE} = F_{AC}$

$\boxed{F_{CE} = 25\,N}$ (T)

$\Sigma F_y = 0$

$\boxed{F_{CB} = 0\,N}$

FBD @ B



$\Sigma F_x = 0$

$F_{BD} - F_{AB}\cos45° + F_{BE}\cos45° = 0$

$F_{BD} - F_{AB}\cos45° + F_{BE}\cos45°$

$F_{BD} = F_{AB}\cos45° - 35.36(\cos45°)$

$\boxed{F_{BD} = -50\text{ N}}$ (C)

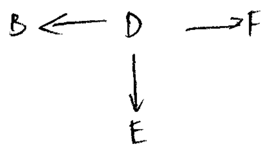
$\Sigma F_y = 0$

$-F_{BC} - F_{BA}\sin45° - F_{BE}\sin45° = 0$

$-F_{BA}\sin45° - F_{BE}\sin45°$

$\boxed{F_{BE} = 35.36\text{ N}}$ (T)

FBD @ D



$\Sigma F_x = 0$

$-F_{DB} + F_{DF} = 0$

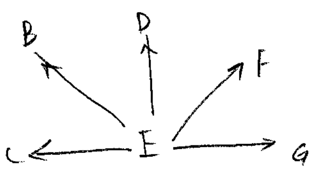
$F_{DF} = F_{DB}$

$\boxed{F_{DF} = -50\text{ N}}$ (C)

$\Sigma F_y = 0$

$\boxed{F_{DE} = 0\text{ N}}$

FBD @ E



$\Sigma F_y = 0$

$F_{EB}\sin45° + F_{ED} + F_{EF}\sin45° = 0$

$(35.36)(\sin45°) + F_{EF}(\sin45°) = 0$

$F_{EF} = -\dfrac{35.36(\sin45°)}{\sin45°}$

$\boxed{F_{EF} = -35.36\text{ N}}$ (C)

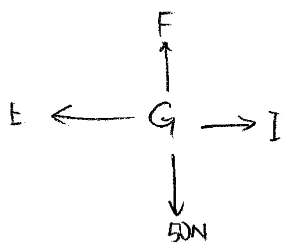
$\Sigma F_x = 0$

$-F_{EC} - F_{EB}\cos45° + (-35.36)(\cos45°) + F_{EG} = 0$

$F_{EG} = 25 + (35.36)(\cos45°) + (35.36)(\cos45°)$

$\boxed{F_{EG} = 75\text{ N}}$ (T)

FBD @ G



$\Sigma F_x = 0$

$-F_{EG} + F_{GI} = 0$

$-75N + F_{GI} = 0$

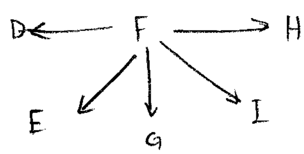
$\boxed{F_{GI} = 75N \ (T)}$

$\Sigma F_y = 0$

$F_{GI} - 50N = 0$

$\boxed{F_{GI} = 50N \ (T)}$

FBD @ F



$\Sigma F_x = 0$

$-F_{FD} + F_{FH} - F_{FE}\cos 45° + F_{FI}\cos 45° = 0$

$50 + F_{FH} - (-35.36)(\cos 45°) - 35.36(\cos 45°) = 0$

$\boxed{F_{FH} = -50 \ N}$ (C)

$\Sigma F_y = 0$

$-F_{FE}\sin 45° - F_{FG} - F_{FI}\sin 45° = 0$

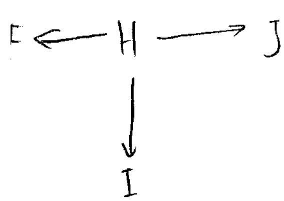
$(35.36)\sin 45° - 50 - F_{FI}\sin 45° = 0$

$-F_{FI}\sin 45° = 25$

$F_{FI} = -\left(\frac{25}{\sin 45°}\right)$

$\boxed{F_{FI} = -35.36 \ N}$ (C)

FBD @ H



$\Sigma F_x = 0$

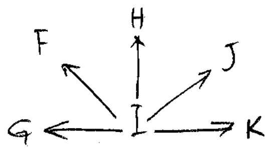
$-F_{HF} + F_{HJ} = 0$

$\boxed{F_{HJ} = -70.72 \ N}$ (C)

$\Sigma F_y = 0$

$\boxed{F_{HI} = 0}$

FBD @ I



$\Sigma F_x = 0$

$-F_{GI} + F_{IK} - F_{FI}\cos 45° + F_{JI}\cos 45° = 0$

$-75 + F_{IK} + 35.36\cos 45° + F_{JI}\cos 45° = 0$

$\boxed{F_{IK} = 25\ N \quad (T)}$

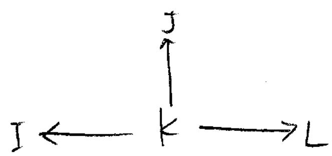
$\Sigma F_y = 0$

$F_{FI}\sin 45° + F_{HI} + F_{JI}\sin 45° = 0$

$-35.36\sin 45° + F_{JI}\sin 45° = 0$

$\boxed{F_{JI} = 35.36\ N}$ (T)

FBD @ K



$\Sigma F_x = 0$

$-F_{IK} + F_{KL} = 0$

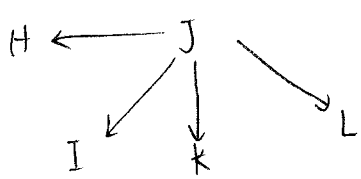
$-25 + F_{KL} = 0$

$\boxed{F_{KL} = 25\ N\ (T)}$

$\Sigma F_y = 0$

$\boxed{F_{JK} = 0}$

FBD @ J



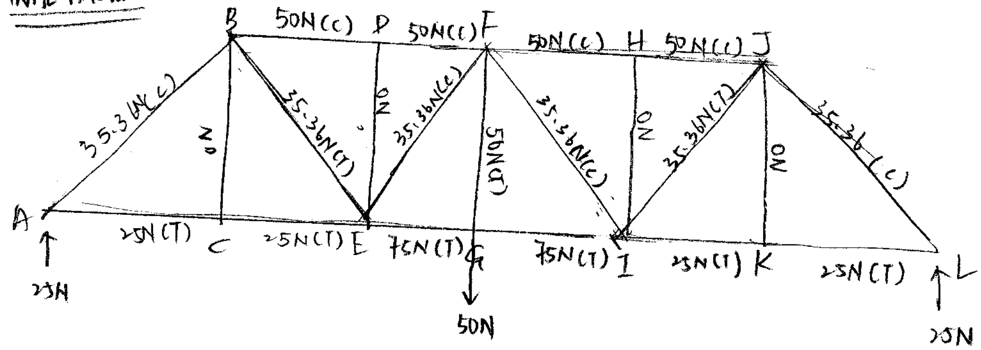
$\Sigma F_y = 0$

$-F_{JI}\sin 45° - F_{JK} - F_{JL}\sin 45° = 0$

$-35.36\sin 45° - F_{JL}\sin 45° = 0$

$\boxed{F_{JL} = -35.36\ N \quad (C)}$

FINAL ANSWER



Pennslyvania bridge

4 model of the same truss structure with different type of member of decreasing weight from material analysis are used to get the minimum material & maximum efficiency can achieve as in 5 kg point load applied.

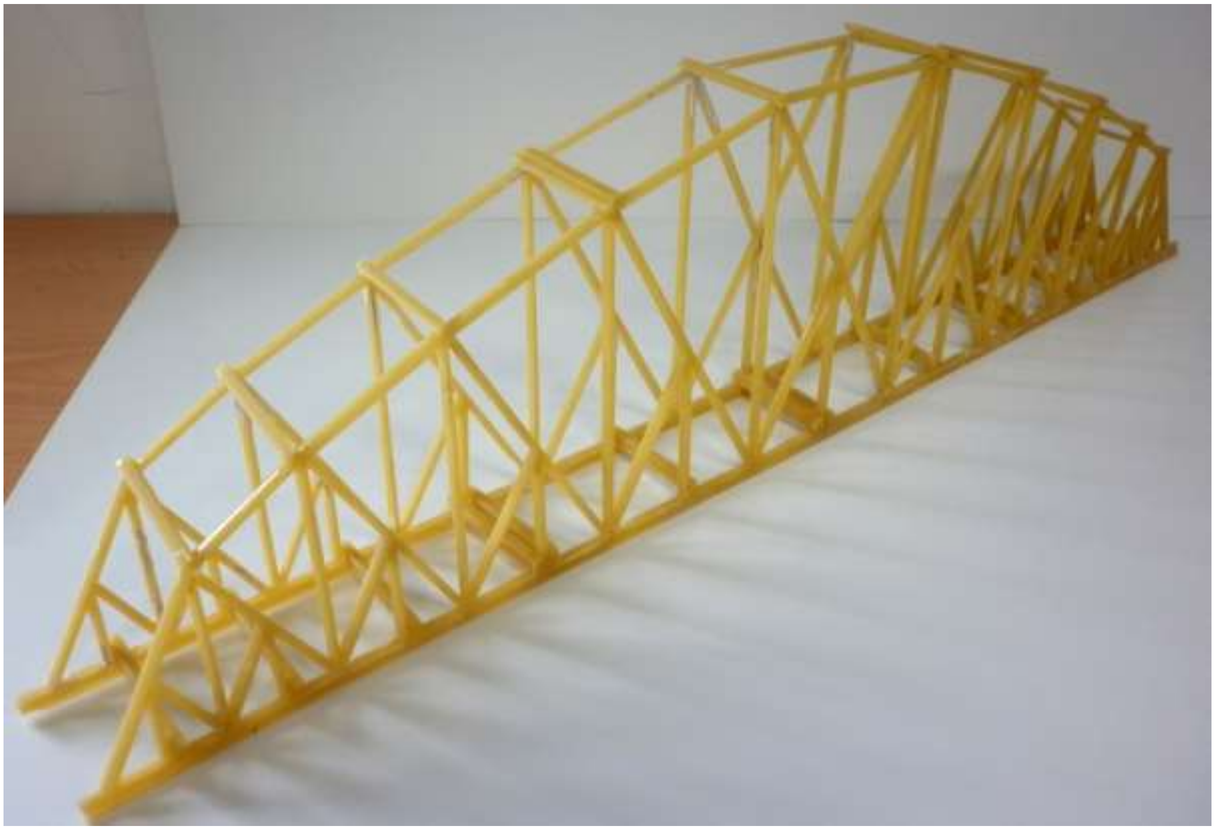


FIGURE 4.2 .4 1ST PROTOTYPE BRIDGE

Efficiency $= (\text{load})^2/\text{mass of bridge}$

$= (5)^2/0.33 = 75.76$

This material needed to sustain 5 kg load in this model is way much overwhelm. From our own testing,the model was able to withstand load of **20 kg** without having any effect on it. From here, we decided to reduce the number of layer for each vertical member by 1 while vertical members connecting both face are reduced

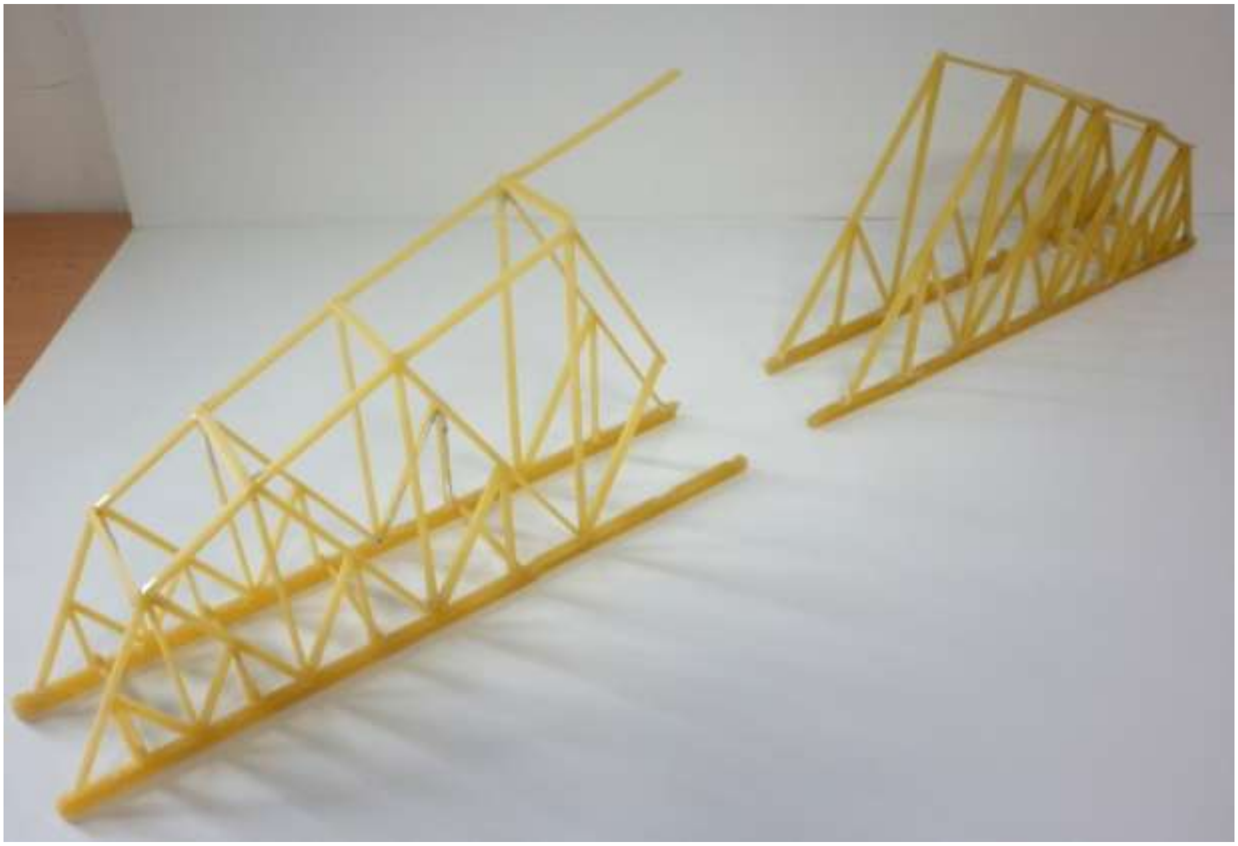


FIGURE 4.2.5 2^{ND} PROTOTYPE BRIDGE

Efficiency $= (\text{load})^2/\text{mass of bridge}$

$= (5)^2/0.24 = 104.17$

This bridge model is able to sustain 10 kg weight before it breaks apart.Since 5 kg is our maximum weight needed to sustain,we reduce again the critical,tension and compression member except the I beam.

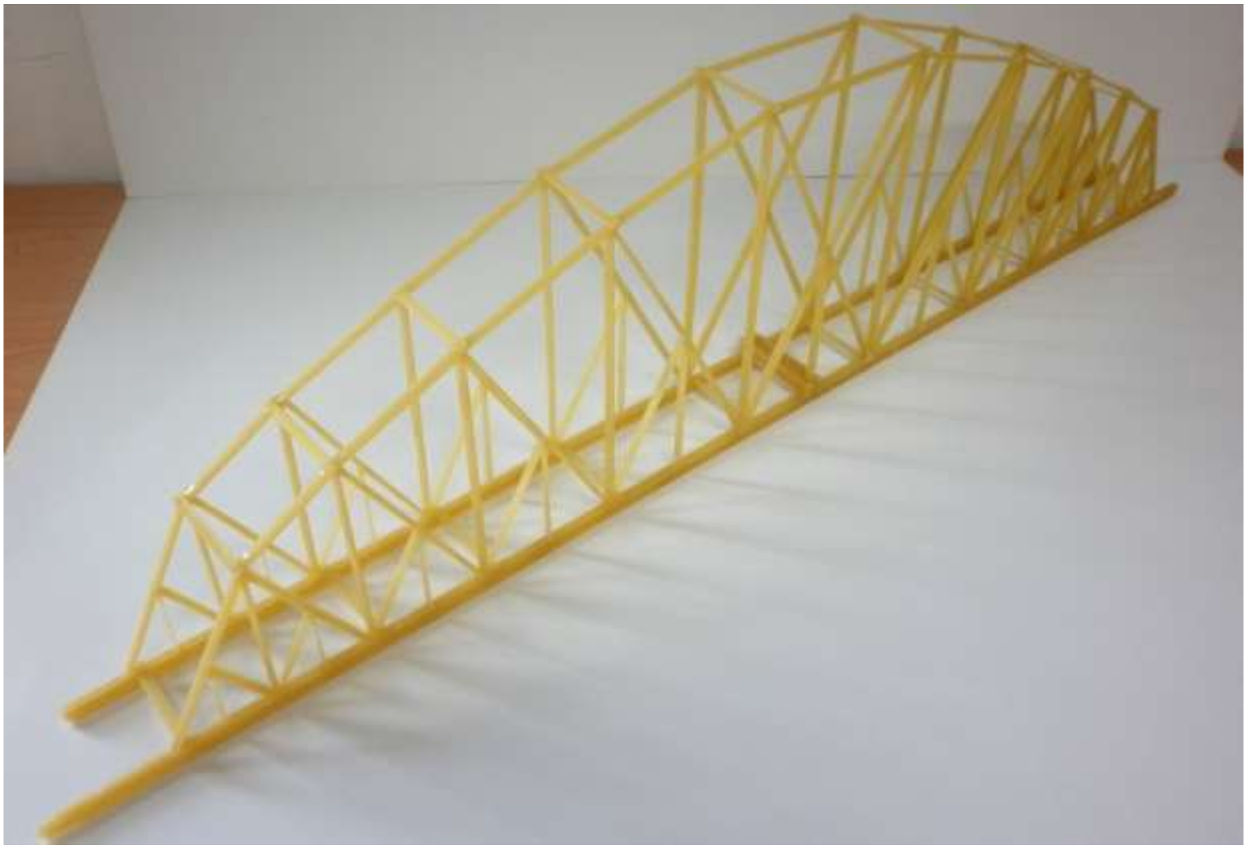


FIGURE 4.2 .6 3RD PROTOTYPE BRIDGE

Efficiency = $(\text{load})^2/\text{mass of bridge}$

$= (5)^2/0.2 = 125$

This bridge is able to sustain a load of 8 kg before it breaks.We reduce the layer of member except critical member.

FIGURE 4.2 .7 FINAL PROTOTYPE BRIDGE

Efficiency $= (\text{load})^2/\text{mass of bridge}$

$= (5)^2/0.175 = 142.86$

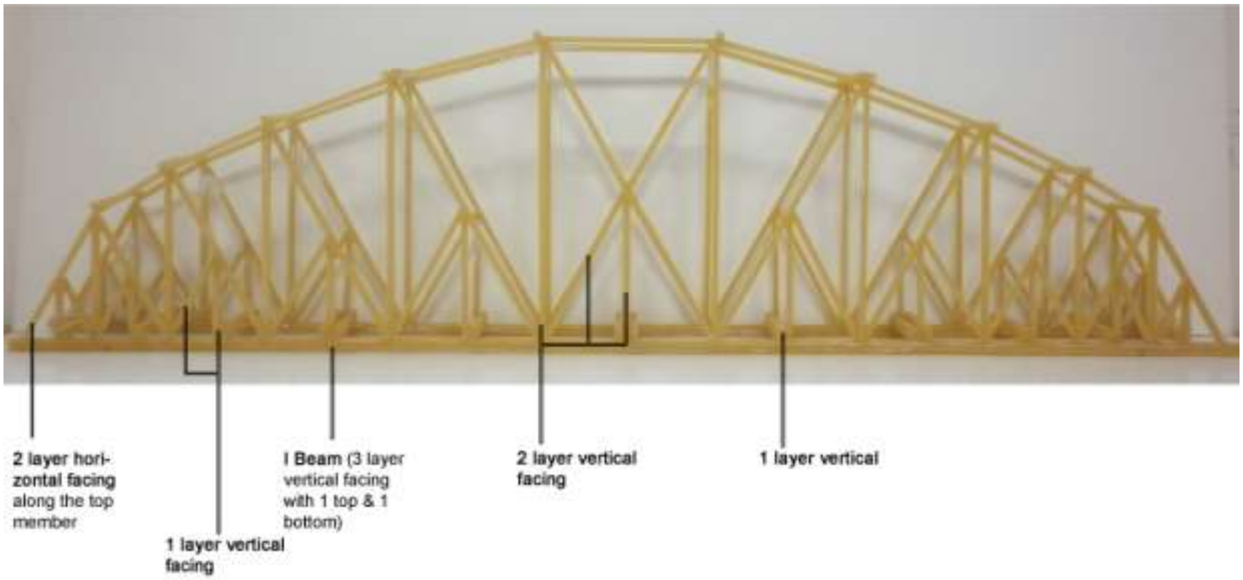


FIGURE 4.2 .8 FINAL MODEL MEMBER COMPONENT

Structural Analysis

In this section, we are performing our analysis mainly in two ways :

1) analysis of the simplified version of the original bridge by using calculation method

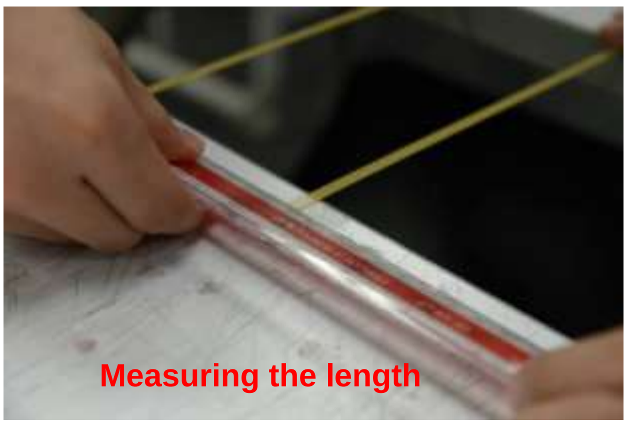
2) analysis of the original bridge by using Staad Pro v8i (engineering structural analysis software) as our bridge component is made up of 5 members in one joint where the calculation for the member is not covered in syllabus.

From the analysis, we are able to determined the tension and compression member of the bridge itself. It is also found that zero force member doesn't exist in the bridge we constructed where it would be good since we didn't waste extra material. Critical member is determined at the middle top and bottom member of the bridge. Hence, if we are going to improve on this bridge efficiency, the material of this member should be less reduced or maintain while the other member's material can be reduced slightly to achieve minimum material high efficiency bridge with the best aesthetic looking.

5 Testing

5.1 Fettuccini Test

We want to find the best way to measure the strength of the fettuccini. In the beginning, we measured the length between the 2 fettuccini (mm) and distance between the tables (mm). The fettuccini at the both end were attached by masking tape so that it will be immovable at the point. We were using point load to test the strength of the fettuccini. Firstly, we were using the fetucini (without broken) to measure the strength of the fettuccini but the result is unsatisfied when the number of fettuccini is increased as



Measuring the length

Overflow with fettuccini

it became a distribution load. So the experiment was no longer preceded. Therefore, a new method has introduced which a bottle with top part removed hangs at the middle of fettucini by using a satey stick filling with fettuccini into the bottle. As we filled the pasta into the bottle, it has become unbalanced and the pasta felt off.

Bottle hold in the middle

Bottle become unbalanced

Further on, we fill fettuccini into a plastic bag. In this experiment, initially we were testing 2 fettuccini instead of a fettuccini. However we decided to use only 1 fettuccini instead of 2 fettuccini. In addition, we were not using the masking tape to hold the fettuccini because it is unstable. So, we used our laptops to serve as weights to hold the fettuccini at the two ends on the tables.

In the further discussion, we were no longer using the weight of fettuccini to measure the strength of the fettuccini because (1) it is not accurate, (2) greater time consumption, (3) needs a lot of fettuccini. Therefore, we used water to measure the strength of the fettuccini.

5.2 Water Testing

Firstly, we prepared a key chain, a paper cup (subway cup), 2 buckets, a plastic bag and a ruler. We were using 2 buckets because as we fill in the plastic with water to test the

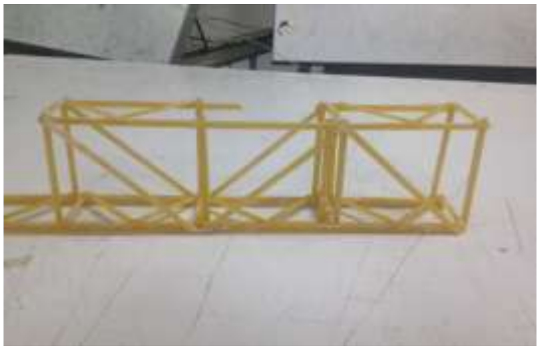
   

strength of the fettuccini, the plastic will drop into the bucket and the water will not spill around. When we poured the water into the plastic bag, ruler is used to lead the water

to flow Into the bucket soft and constantly. The same methods were repeated with different layers of fettuccini, which the analysis showed, and that is the result. This is how we test the strength of the fettuccini one by one, layer by layer.

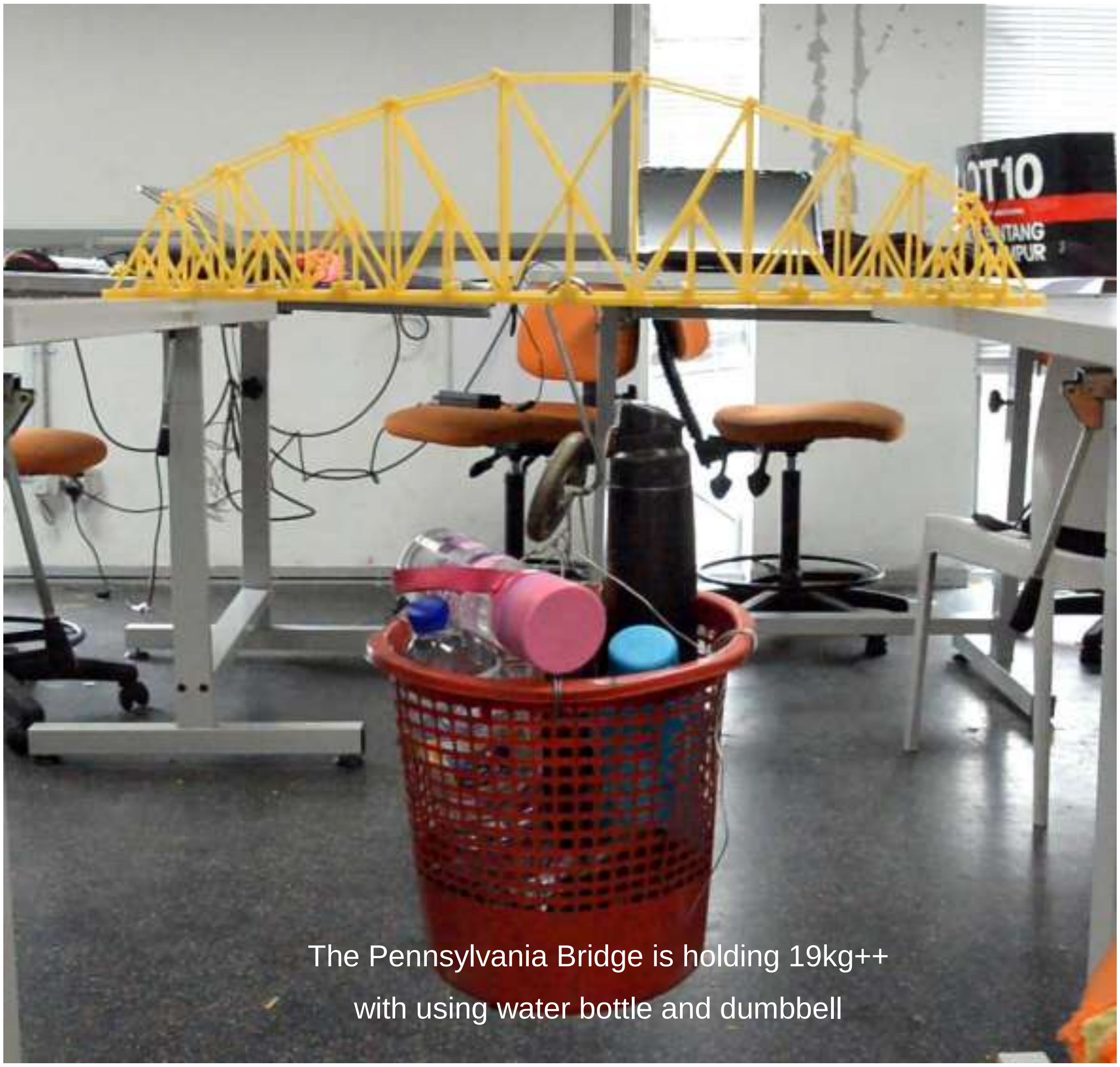
5.3 Bridge Test

We tested two types of truss bridge, Warren (with verticals) and Pennsylvania in our project. The first version is Warren truss. We were thinking to change the type of the truss because the Warren Bridge is simple with the design and it is very heavy as well. Therefore we changed into Pennsylvania for a better design and a lower weight to withstand 5kg.



The Warren bridge was estimated 150g but when we tested the bridge, it could not withstand 5kg.

The First Pennsylvania Bridge was very solid and weight about 300g. The reason is because we wanted to prevent the bridge fall apart within 5kg. And we realize that the bridge is more than enough.



The Pennsylvania Bridge is holding 19kg++ with using water bottle and dumbbell

We built another bridge (240g) which is quite durable. For this, we were tested with

9kg++, however the bridges immediately fall apart.

Next bridge (200g) and it can hold 5kg dumbbell with the point load in the middle. We just tested the bridge with 5kg and it can endure the weight.

The bridge (175g) is being tested in the classroom where every one is expecting it can bear 5kg load.

6. Conclusion

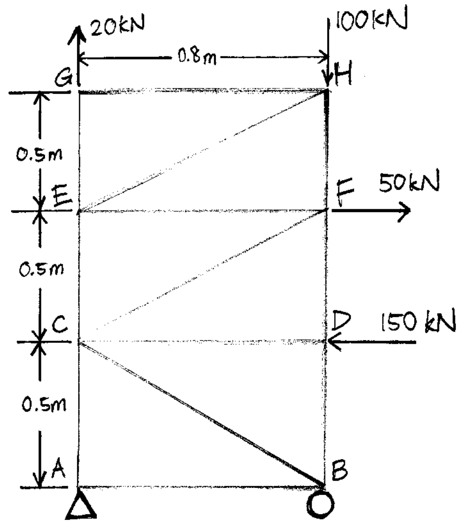
It is a success for the truss bridge model, as the material has been minimized in order to achieve better efficiency. The strategy for this project is achieved as the material is decreased throughout the construction of bridge by doing testing according to the maximum load the bridge itself can sustain. However, we also discover that it is important to have a proper way in determining the shape, force (tension/ compression/ zero/ critical) in the member in order to produced an efficient bridge not only in terms of quality and material but also time usage on producing the bridge. The first basic steps is that we have to maintain a good quality workmanship in our model .It can be done by ensuring proper usage of adhesive as well as making sure that the connection in the joint is well done. The second step would be on determining the respective force member in the bridge by applying Newton's law as well as calculating resolution force component. The final step is by applying proper and suitable type material of appropriate strength and weakness on the right area according to the force determined. In conclusion, we must follow the steps above in order to become a successful architect especially in real life practical usage by applying the method we learnt in this project so as to create a better structure as well as a minor effort in contributing to sustaining a greener environment.

7. Appendix

Truss Analysis Exercise **Case 1** (By Sia Hong Rui, 0308954)

Exercise : Truss Analysis

Case 1 :



① Determine Perfect Truss

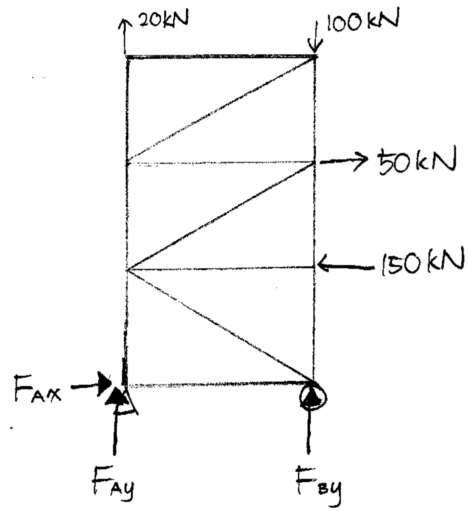
$$2J = m + 3$$

$$2J = 2 \times 8 = 16 \qquad m + 3 = 13 + 3 = 16$$

$\because 2J = m + 3 = 16$

$\therefore$ This truss is a perfect truss.

② Determine Reaction Force



$\Sigma F_x = 0$

$F_{Ax} + 50 - 150 = 0$

$F_{Ax} = 100 \text{ (kN)}$ //

$\Sigma F_y = 0$

$F_{Ay} + F_{By} + 20 - 100 = 0$

$F_{Ay} + F_{By} - 80 = 0$ ...... ①

$\Sigma M = 0$

$-(F_{By} \times 0.8) - (150 \times 0.5) + (50 \times 1) + (100 \times 0.8) = 0$

$-0.8 F_{By} - 75 + 50 + 80 = 0$

$-0.8 F_{By} + 55 = 0$

$F_{By} = \dfrac{55}{0.8}$

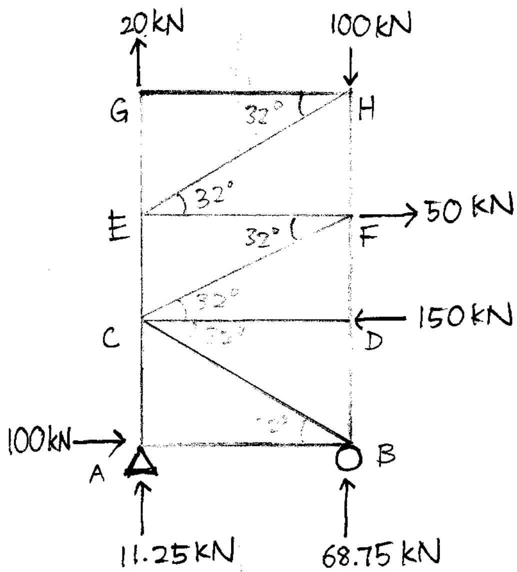
$F_{By} = 68.75 \text{ (kN)}$ //

...... Put into ①

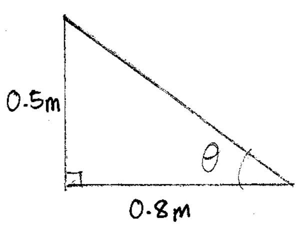
$F_{Ay} + 68.75 - 80 = 0$

$F_{Ay} = 11.25 \text{ (kN)}$ //

③ Determine force in Each Member



Determine Truss Angle

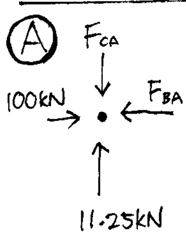


$\tan\theta = \frac{0.5}{0.8}$

$\tan\theta = 0.625$

$\theta = 32°$

Free Body Diagram @ Joint A



$\Sigma F_x = 0$

$100 - F_{BA} = 0$

$F_{BA} = 100 \text{(kN)}$ //

(compression)

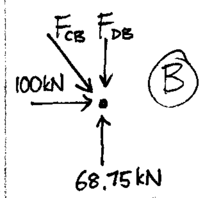
$\Sigma F_y = 0$

$11.25 - F_{CA} = 0$

$F_{CA} = 11.25 \text{(kN)}$ //

(compression)

FBD @ Joint B



$\Sigma F_x = 0$

$100 + F_{CBx} = 0$

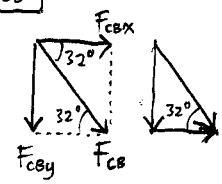
$100 + F_{CB}\cos 32° = 0$

$F_{CB} = -\frac{100}{\cos 32°}$

$F_{CB} = -117.92 \text{(kN)}$

(Tension) //

F_{CB}



$\sin 32° = \frac{F_{CBy}}{F_{CB}}$

$F_{CBy} = F_{CB}\sin 32°$

$\cos 32° = \frac{F_{CBx}}{F_{CB}}$

$F_{CBx} = F_{CB}\cos 32°$

$\Sigma F_y = 0$

$68.75 - F_{DB} - F_{CBy} = 0$

$68.75 - F_{DB} - F_{CB}\sin 32° = 0$

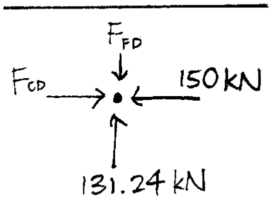
$68.75 - F_{DB} - (-117.92)(0.53) = 0$

$68.75 + 62.49 = F_{DB}$

$F_{DB} = 131.24 \text{ (kN)}$

(Compression) //

FBD @ Joint D



$\Sigma F_x = 0$

$F_{CD} - 150 = 0$

$F_{CD} = 150 \text{ (kN)}$ //

(Compression)

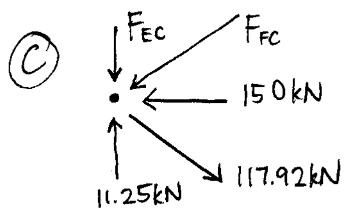
$\Sigma F_y = 0$

$-F_{FD} + 131.24 = 0$

$F_{FD} = 131.24 \text{ (kN)}$

(Compression) //

FBD @ Joint C



$\Sigma F_x = 0$

$-150 + 117.92 \cos 32° - F_{FC} \cos 32 = 0$

$-150 + 100 - F_{FC} \cos 32 = 0$

$F_{FC} \cos 32° = -50$

$F_{FC} = -58.96$ (kN)

(Tension)

$\Sigma F_y = 0$

$11.25 - F_{EC} - F_{FC} \sin 32° - 117.92 \sin 32°$

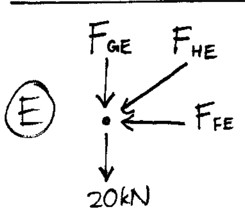
$= 0$

$11.25 - F_{EC} - (-58.96) \sin 32° - 62.49 = 0$

$F_{EC} = -20$ (kN)

(Tension)

FBD @ Joint E



$\Sigma F_x = 0$

$-F_{FE} - F_{HE} \cos 32° = 0$

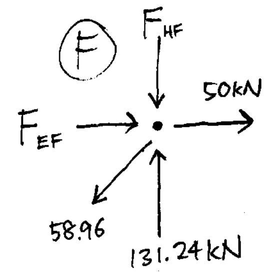
$F_{FE} = -F_{HE} \cos 32°$ — ②

$\Sigma F_y = 0$

$-F_{GE} - 20 - F_{HE} \sin 32° = 0$

$F_{GE} = -20 - F_{HE} \sin 32°$ — ③

FBD @ Joint F



$\Sigma F_x = 0$

$50 + F_{EF} - 58.96 \cos 32° = 0$

$F_{EF} = 0.0009 \approx 0$ (kN)

(Zero Force)

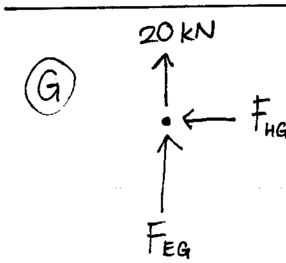
$\Sigma F_y = 0$

$131.24 - F_{HF} - 58.96 \sin 32° = 0$

$F_{HF} = 100$ (kN)

(Compression)

FBD @ Joint G



$\Sigma F_x = 0$

$-F_{HG} = 0$

$F_{HG} = 0$ (kN)

(Zero Force)

$\Sigma F_y = 0$

$F_{EG} + 20 = 0$

$F_{EG} = -20$ (kN

(Tension)

Use $F_{EF} = 0\,kN$ in ②

$$0 = -F_{HE}\cos 32^\circ$$

$$F_{HE} = 0\ (kN)$$

(zero Force)

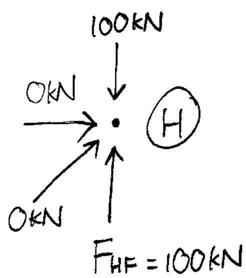
Use $F_{HE} = 0\,kN$ in ③

$$F_{GE} = -20 - 0$$

$$F_{GE} = -20\,(kN)$$

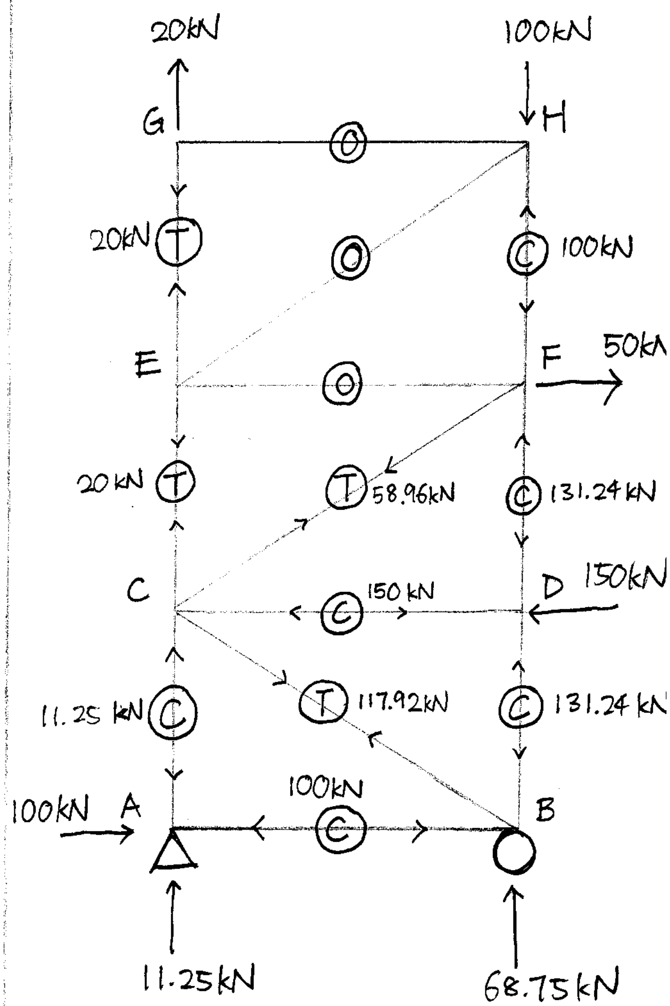
(Tension)

FBD @ Joint H



$$F_{HF} = 100\,kN$$

$$\Sigma F_x = 0 \qquad \Sigma F_y = 100 - 100 = 0$$

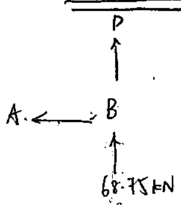


Conclusion ↑ :

Case 2 (By Lim Chee Siang, 0309452)

③ Determine Internal Forces, Free Body Diagram

FBD @ B



$\Sigma F_x = 0$

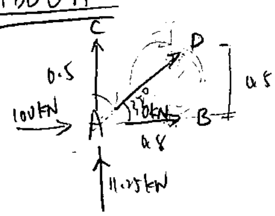
$F_{AB} = 0\,kN$

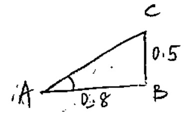
$\Sigma F_y = 0$

$F_{BD} + 68.75 = 0$

$F_{BD} = -68.75\,kN\,(C)$

FBD @ A





$\tan A = \frac{0.5}{0.8}$

$\angle A = \tan^{-1} \frac{0.5}{0.8}$

$\angle BAD = 32°$

$\Sigma F_x = 0$

$0 = 100\,kN + 0\,kN + F_{AD} \cos 32°$

$F_{AD} = \frac{-100}{\cos 32°}$

$F_{AD} = -117.92\,kN\,(C)$

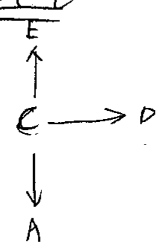
$\Sigma F_y = 0$

$0 = F_{AC} + 11.25\,kN + F_{AD} \sin 32°$

$F_{AC} = -(11.25 + -(117.92)(\sin 32°))$

$F_{AC} = +51.24\,kN\,(T)$

FBD @ C



$\Sigma F_x = 0$

$F_{CD} = 0$

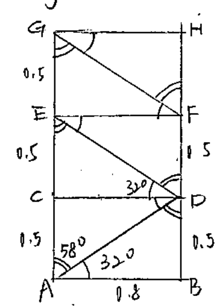
$\Sigma F_y = 0$

$F_{CE} - F_{AC} = 0$

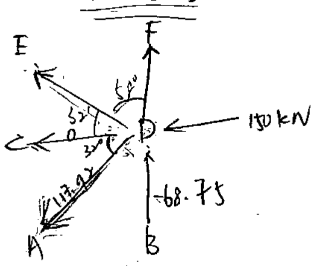
$F_{CE} = +F_{AC}$

$F_{CE} = +51.24\,kN\,(T)$

* Angle distribution



FBD @ D



$\Sigma F_x = 0$

$0 = -F_{DE} \cos 32° + F_{CD} - 150\,kN + F_{AD} \cos 32°$

$F_{DE} = \left[\frac{-150 + (117.92)(\cos 32°)}{\cos 32°} \right]$

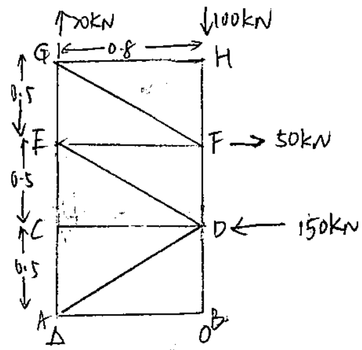
$F_{DE} = -58.96\,kN\,(C)$

$\Sigma F_y = 0$

$0 = F_{DF} + F_{DB} - F_{DE} \sin 32° - F_{AD} \sin 32°$

$F_{DF} = -[(-68.75) + (58.96)(\sin 32°) - (-117.92)(\sin 32°)]$

$F_{DF} = -24.98\,kN\,(C)$



① Determine perfect truss

$2J = m + 3$

$2(8) = (13) + 3$

$16 = 16$

$\therefore$ It is a perfect truss

② Determine Reaction Force

$\Sigma M = 0$

$\therefore \Sigma F_x = 0 \quad , \Sigma F_y = 0$

$\Sigma F_x = 0$

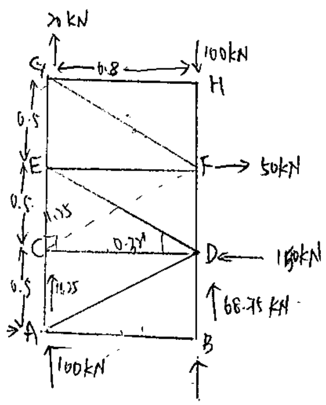
$0 = F_{Ax} - 150\,kN + 50\,kN = 0$

$F_{Ax} = 100\ kN$

$\Sigma F_y = 0$

$F_{Ay} + F_{By} + 20 - 100 = 0$

$F_{Ay} + F_{By} = 80\ kN \quad —— ①$



$\Sigma M = 0$

$0 = 100(0.8) - (150)(0.5) + (50)(1) - F_{By}(0.8)$

$F_{By}(0.8) = 80 - 75 + 50$

$F_{By} = \frac{55}{0.8}$

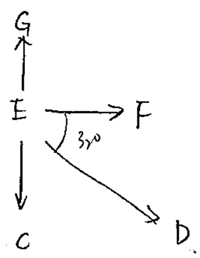
$= 68.75\ kN$

From ① : $F_{Ay} + F_{By} = 80kN$

$F_{Ay} = 80\ kN - 68.75\ kN$

$= 11.25\ kN$

FBD @ E



$\Sigma F_x = 0$

$F_{FE} + F_{ED}\cos 32° = 0$

$F_{FE} = -F_{ED}\cos 32°$

$= -(-58.96)(\cos 32°)$

$\boxed{F_{FE} = 50 \text{ KN } (T)}$

$\Sigma F_y = 0$

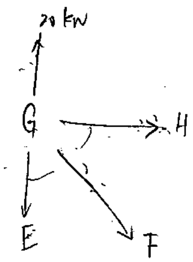
$F_{EG} - F_{EC} - F_{ED}\sin 32° = 0$

$F_{EG} - 51.24\text{KN} - (-58.96)(\sin 32) = 0$

$F_{EG} = -[-51.24 + 58.96(\sin 32)]$

$\boxed{F_{EG} = 20 \text{ KN } (T)}$

FBD @ G



$\Sigma F_y = 0$

$0 = 20kN - F_{GE} - F_{FG}\sin 32°$

$F_{FG} = \frac{(20-20)}{\sin 32°}$

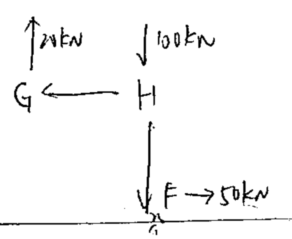
$\boxed{F_{FG} = 0 \text{ KN}}$

$\Sigma F_x = 0$

$0 = F_{GH} + F_{FG}\cos 32$

$\boxed{F_{GH} = 0 \text{ KN.}}$

FBD @ H

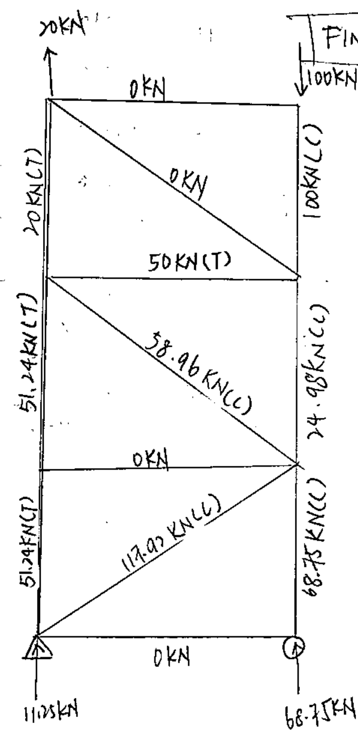


$\Sigma F_y = 0$

$0 = -100kN - F_{FH}$

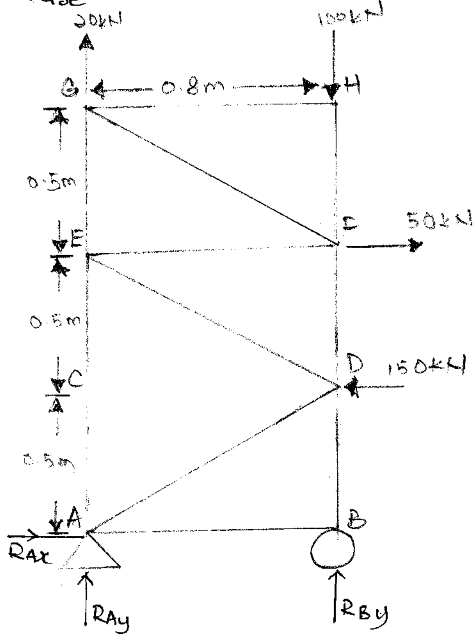
$\boxed{F_{FH} = -100kN (C)}$

FINAL ANSWER.



Case 3 (By Thuang Huah Jiunn, 0308314)

Case 3 :



1. Determine Perfect Truss

$$2J = m + 3$$

$J = 7 \qquad m = 11$

$$2(7) = 11 + 3$$

Since both sides equal, it is a perfect truss

2. Determine Reaction Force

$$\Sigma F_x = 0$$

$$0 = R_{Ax} + 50 - 150$$

$$R_{Ax} = 100\,kN$$

$$\Sigma F_y = 0$$

$$0 = R_{Ay} + R_{By} + 20 - 100$$

$$R_{Ay} + R_{By} = 80$$

$R_{By} = 68.75, \quad R_{Ay} = 80 - 68.75$

$$= 11.25\,kN$$

$$\Sigma M_A = 0$$

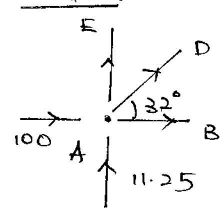
$$0 = -R_{By}(0.8) - 150(0.5) + 50(1) + 100(0.8)$$

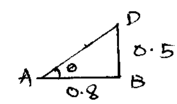
$$= -R_{By}(0.8) + 55$$

$$R_{By} = \frac{55}{0.8} = 68.75\,kN$$

3. Determine Forces at Each Member

Joint A





$$\tan \angle A = \frac{0.5}{0.8}$$

$$\angle A = 32°$$

$$\Sigma F_x = 100 + F_{AD}\cos 32 + F_{AB} = 0$$

$F_{AB} = 0, \quad 0 = 100 + F_{AD}\cos 32$

$$F_{AD} = \frac{-100}{\cos 32}$$

$$= -117.92$$

(compression)

$$\Sigma F_y = 11.25 + F_{AD}\sin 32 + F_{AE} = 0$$

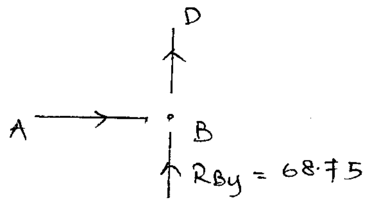
$$F_{AE} = -11.25 - (-117.92)\sin 32$$

$$= -11.25 + 62.49$$

$$= 51.24$$

(tension)

Joint B



$\Sigma F_x = F_{AB}$

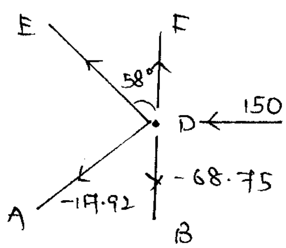
$= 0$ * (zero force member)

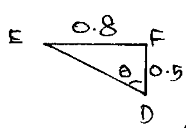
$\Sigma F_y = F_{BD} + R_{By}$

$0 = F_{BD} + 68.75$

$F_{BD} = -68.75$ * (compression)

Joint D





$\tan \angle D = \dfrac{0.8}{0.5}$

$\angle D = 58°$

$\Sigma F_x = -150 - F_{ED} \sin 58 - F_{AD} \cos 32$

$= -150 - F_{ED} \sin 58 - (-117.92) \cos 32$

$-50 = F_{ED} \sin 58$

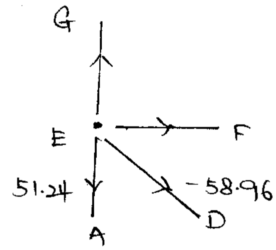
$F_{ED} = -58.96$ * (compression)

$\Sigma F_y = 68.75 + F_{ED} \cos 58 + F_{DF} - F_{AD} \sin 32$

$0 = 68.75 + (-58.96) \cos 58 + F_{DF} - (-117.92) \sin 32$

$F_{DF} = -100$ * (compression)

Joint E



$\Sigma F_x = F_{ED} \cos 32 + F_{EF}$

$0 = F_{EF} + (-58.96) \cos 32$

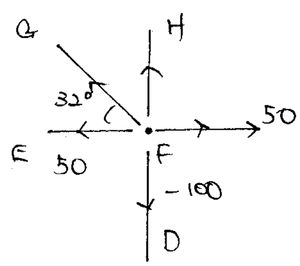
$F_{EF} = 50$ * (tension)

$\Sigma F_y = -51.24 + F_{EG} - F_{ED} \sin 32$

$F_{EG} = 51.24 + (-58.96) \sin 32$

$= 20$ * (tension)

Joint F



$\Sigma F_x = -F_{EF} - F_{GF} \cos 32 + 50$

$= -50 - F_{GF} \cos 32$

$F_{GF} \cos 32 = 0$

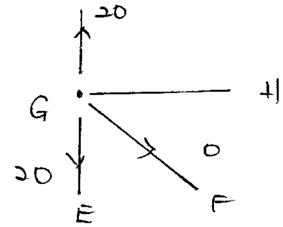
$F_{GF} = 0$ * (zero force member)

$\Sigma F_y = -(-100) + F_{GF} \sin 32 + F_{FH}$

$= 100 + F_{FH}$

$F_{FH} = -100$ * (compression)

Joint G

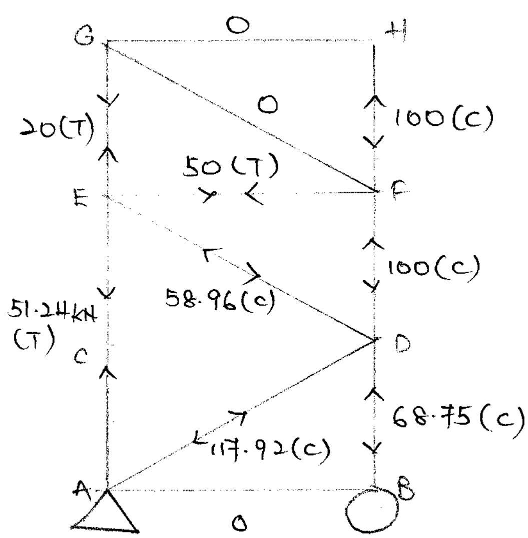


$\Sigma F_x = F_{GH} + F_{GF} \cos 32 = 0$

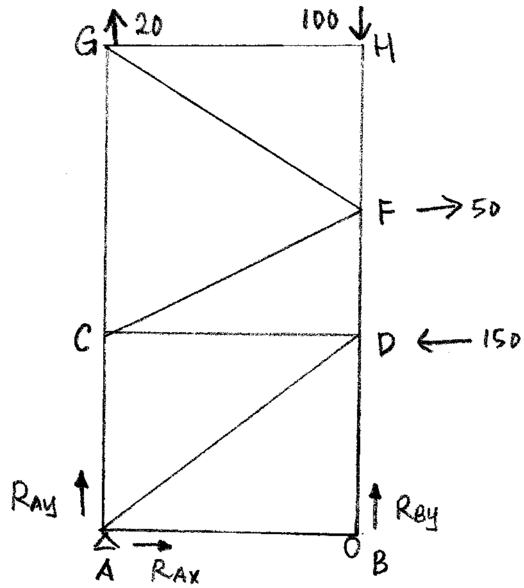
$F_{GH} + 0 = 0$

$FGH = 0$ *
(zero force member)

Forces in member



Case 4 (By Clinton Tham Vun Khee, 0308312)



Pin Joint → 2 Reaction force

Roll Joint → 1 Reaction force

$\Sigma F_y = 0$

$\Sigma F_x = 0$

$\Sigma M = 0$

2J = m+3 perfect

2J < m+3 Redundant

2J > m+3 imperfect

① Determine Perfect Truss

$2J = m + 3$

$2J = 2(7)$

$= 14$

$m + 3 = 11 + 3$

$= 14$

$\therefore 2J = m + 3 = 14$

so this is a perfect truss

② Reaction Force

$\Sigma F_x = 0$

$50 - 150 + R_{Ax} = 0$

$R_{Ax} = 100$

$\Sigma F_y = 0$

$20 - 100 + R_{Ay} + R_{By} = 0$

$R_{Ay} + R_{By} = 80$

Moment = FORCE x LEVER ARM

$\Sigma M = 0$

$-(R_{By} \times 0.8) - (150 \times 0.5) + (50 \times 1) + (100 \times 0.8) = 0$

$-0.8 R_{By} = -55$

$R_{By} = \frac{-55}{-0.8}$

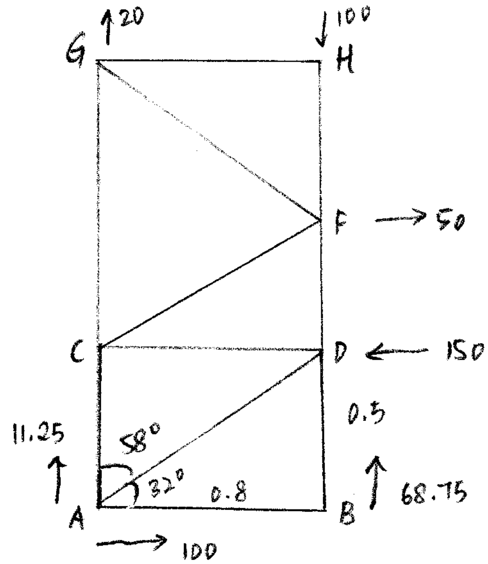
$= 68.75$

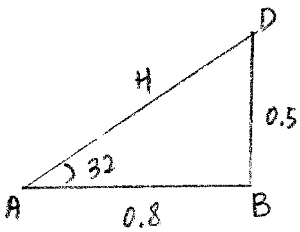
$R_{Ay} + R_{By} = 80$

$R_{Ay} + 68.75 = 80$

$R_{Ay} = 80 - 68.75$

$R_{Ay} = 11.25$





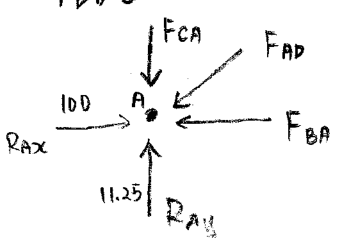
$$\tan\theta = \frac{0.5}{0.8}$$

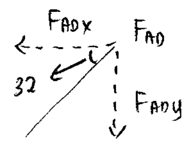
$$\tan\theta = 0.625$$

$$\theta = \tan^{-1}(0.625)$$

$$= 32^\circ$$

FBD @ Joint A





$$\sin 32^\circ = \frac{F_{ADy}}{F_{AD}}$$

$$F_{ADy} = F_{AD}\sin 32^\circ$$

$$\cos 32^\circ = \frac{F_{ADx}}{F_{AD}}$$

$$F_{ADx} = F_{AD}\cos 32^\circ$$

$$\Sigma F_x = 0$$

$$R_{Ax} + (-F_{ADx}) - F_{BA} = 0$$

$$100 + (-F_{AD}\cos 32^\circ) - F_{BA} = 0$$

$$-F_{AD}\cos 32^\circ - F_{BA} = -100$$

$$F_{AD}\cos 32^\circ = 100$$

$$F_{AD} = 117.92\text{ kN } (C)$$

$$\Sigma F_y = 0$$

$$R_{Ay} + (-F_{ADy}) - F_{CA} = 0$$

$$11.25 - (F_{AD}\sin 32^\circ) - F_{CA} = 0$$

$$-F_{AD}\sin 32 - F_{CA} = -11.25$$

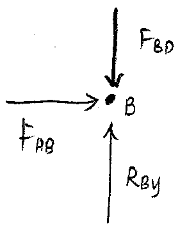
$$-(117.92)\sin 32 - F_{CA} = -11.25$$

$$-F_{CA} = -11.25 + 117.92\sin 32$$

$$-F_{CA} = 51.24$$

$$F_{CA} = -51.24\text{ kN } (T)$$

FBD @ Joint B



$\Sigma F_x = 0$

$F_{AB} = 0$

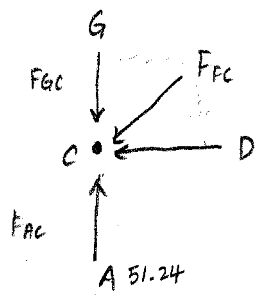
$\Sigma F_y = 0$

$R_{By} - F_{BD} = 0$

$68.75 - F_{BD} = 0$

$F_{BD} = 68.75$ (C)

FBD @ Joint C



$\sin 32 = \dfrac{F_{FCy}}{F_{FC}}$

$F_{FCy} = F_{FC} \sin 32$

$\cos 32 = \dfrac{F_{FCx}}{F_{FC}}$

$F_{FCx} = F_{FC} \cos 32$

$\Sigma F_y = 0$

$51.24 - F_{GC} + F_{FC} \sin 32 = 0$

$51.24 - F_{GC} + (-58.96 \sin 32) = 0$

$-F_{GC} = -51.24 + 58.96 \sin 32$

$F_{GC} = -20$ (T)

$\Sigma F_x = 0$

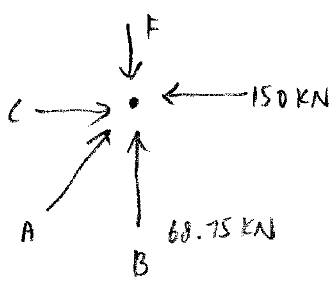
$-F_{DC} + (-F_{FC} \cos 32) = 0$

$-50 - F_{FC} \cos 32 = 0$

$-F_{FC} \cos 32 = 50$

$F_{FC} = -58.96$ (T)

FBD @ Joint D



$\Sigma F_x = 0$

$-150 + F_{CD} + F_{AD} \cos 32 = 0$

$-150 + F_{CD} + 117.92 \cos 32 = 0$

$-150 + F_{CD} + 117.92 \cos 32 = 0$

$-150 + F_{CD} = -117.92 \cos 32$

$F_{CD} = -100 + 150$

$= 50$ (C)

$\Sigma F_y = 0$

$-F_{FD} + 68.75 + F_{AD} \sin 32 = 0$

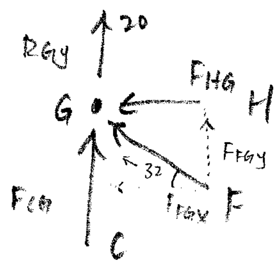
$-F_{FD} + 68.75 + 117.92 \sin 32 = 0$

$-F_{FD} = -68.75 - 117.92 \sin 32$

$-F_{FD} = -131.2$

$F_{FD} = 131.2$ (C)

FBD @ Joint G



$\Sigma F_x = 0$

$F_{HG} + F_{FGx} = 0$

$0 + F_{FG}\cos 32 = 0$

$F_{FG}\cos 32 = 0$

$F_{FG} = 0$

$\Sigma F_y = 0$

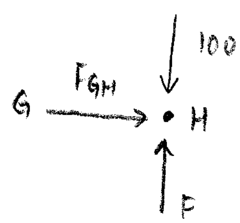
$R_{Gy} + F_{FGy} + F_{CG} = 0$

$20 + F_{FG}\sin 32 - 20 = 0$

$F_{FG}\sin 32 = 0$

$F_{FG} = 0$

FBD @ Joint H



$\Sigma F_x = 0$

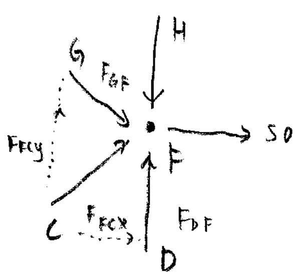
$F_{GH} = 0$

$\Sigma F_y = 0$

$-100 + F_{FH} = 0$

$-100 + 100 = 0$

FBD @ Joint F



$\Sigma F_x = 0$

$50 + F_{FCx} = 0$

$50 + F_{FC}\cos 32 = 0$

$F_{FC}\cos 32 = -50$

$F_{FC} = -58.95$ (T)

$\Sigma F_y = 0$

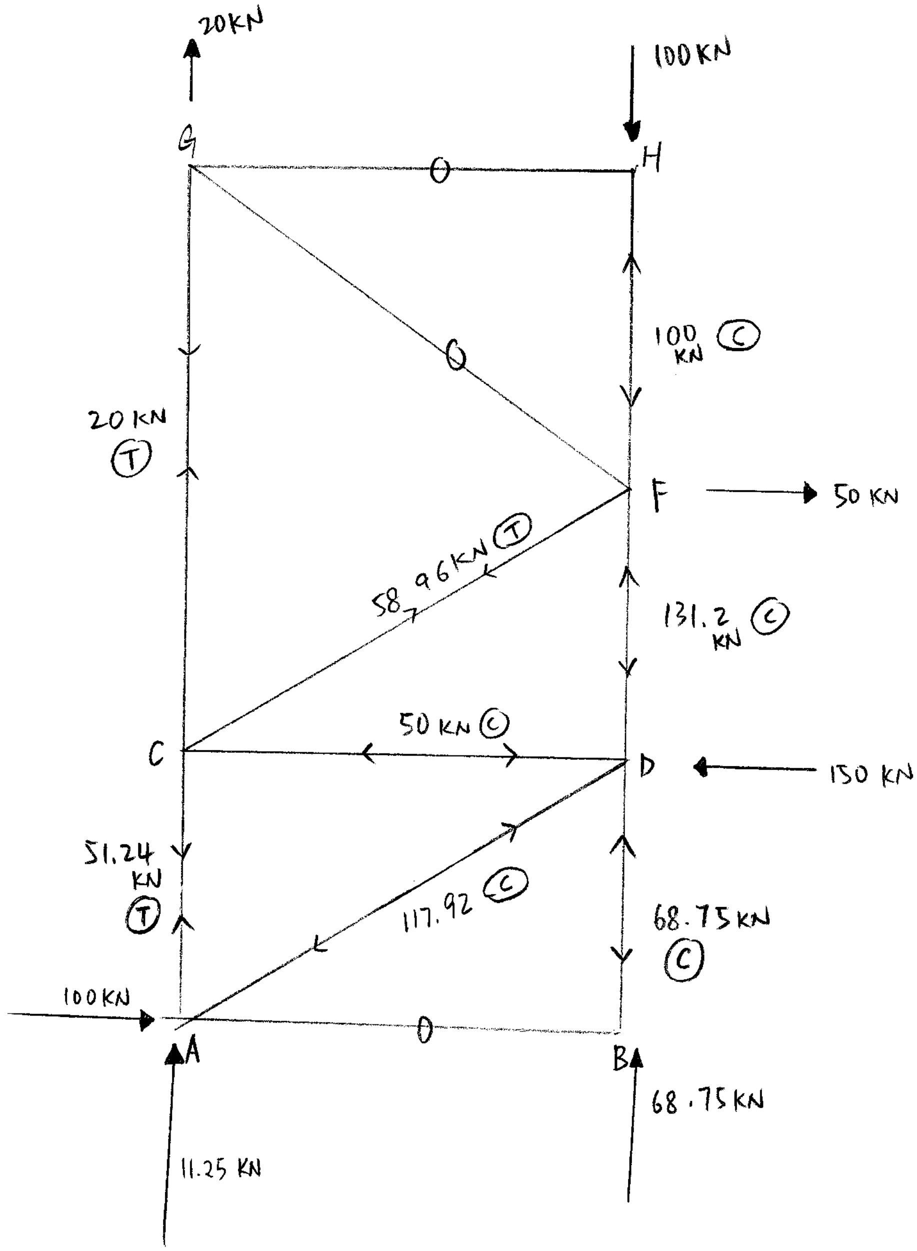
$-F_{HF} + F_{DF} + F_{FC}\sin 32 = 0$

$-F_{HF} + 131.2 + (-58.96\sin 32) = 0$

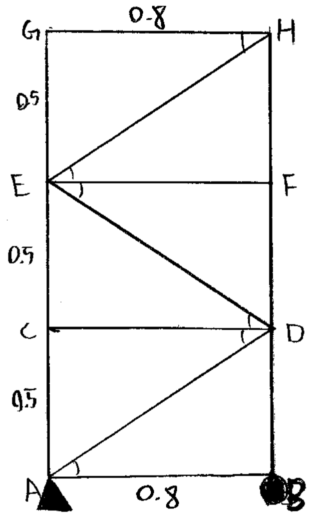
$-F_{HF} = -131.2 + 58.96\sin 32$

$-F_{HF} = -100$

$F_{HF} = 100$ (C)


20KN
100KN
G
H
0
0
100 KN C
20 KN T
F
50 KN
58.96KN T
131.2 KN C
50 KN C
C
D
150 KN
51.24 KN T
117.92 C
68.75KN C
100KN
0
A
B
68.75KN
11.25 KN

Case 5 (By Joseph Wong Shun Hua, 1101g11945)



Question 5

$\angle BAD = \angle CDA = \angle CDE = \angle DEF = \angle FEH = \angle GHE$

$\tan \angle BAD = \frac{0.5}{0.8}$

$\angle BAD = \tan^{-1} \frac{0.5}{0.8} = 32^\circ$

Perfect truss analysis

$2J = M + 3$

$2(8) = 13 + 3 = 16$

$\therefore$ Perfect truss

Motion Force

$\Sigma F_x = 0$

$F_{Ax} + 50kN - 150kN = 0$

$F_{Ax} = 160kN$

$\Sigma F_m = 0$

$-0.8F_{By} + (0.8 \times 100) + (-150 \times 0.5) + (50 \times 1) = 0$

$-0.8F_{By} + 80 - 75 + 50 = 0$

$0.8F_{By} = 55$

$F_{By} = 68.75kN$

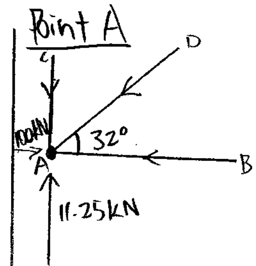
$\Sigma F_y = 0$

$F_{Ay} + F_{By} - 80kN = 0$

$F_{Ay} + 68.75kN - 80kN = 0$

$F_{Ay} = 11.25kN$

Point A



$\Sigma F_x = 0$

$100kN - F_{AB} - F_{ADx} = 0$

$F_{AB} = 0$ * due to point B has no force on horizontal.

$\therefore 100kN - 0 - F_{AD}\cos 32^\circ = 0$

$F_{AD}\cos 32^\circ = 100kN$

$F_{AD} = \frac{100kN}{\cos 32^\circ}$

$= 117.9kN$ (compression)

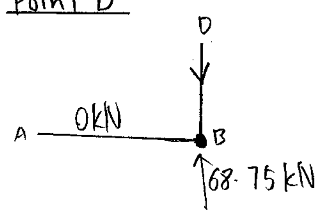
$\Sigma F_y = 0$

$-F_{ADy} - F_{AC} + 11.25kN = 0$

$-(117.9\sin 32) - F_{AC} + 11.25 = 0$

$F_{AC} = -51.23kN$ (tension)

Point B

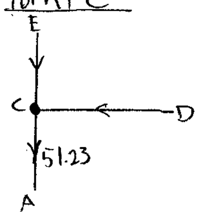


$\Sigma F_y = 0$

$68.75 - F_{BD} = 0$

$F_{BD} = 68.75kN$ (compression)

Point C



$\Sigma F_x = 0$

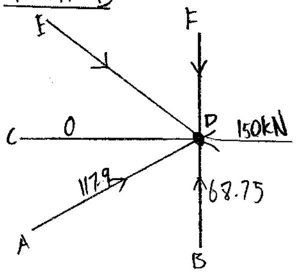
$\therefore F_{CD} = 0$

$\Sigma F_y = 0$

$-51.23 - F_{CE} = 0$

$F_{CE} = -51.23kN$ (tension)

Point D



$\Sigma F_x = 0$

$-150kN + F_{EDx} + F_{ADx} = 0$

$-150kN + (F_{ED}\cos 32) + (117.9\cos 32^\circ) = 0$

$F_{ED}\cos 32^\circ = 150kN - 100kN$

$F_{ED} = \frac{50kN}{\cos 32^\circ}$

$= 58.96kN$ (compression)

$\Sigma F_y = 0$

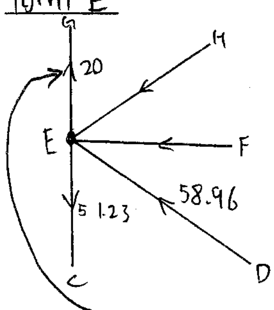
$-F_{FD} - F_{EDy} + F_{ADy} + F_{BD} = 0$

$-F_{FD} - (F_{ED}\sin 32) + 62.48 + 68.75 = 0$

$F_{FD} = -31.24 + 62.48 + 68.75$

$= 100kN$ (compressed)

Point E



$F_{EG} = 20kN$ (tension)

* because A point G, only F_{EG} and the external force (20kN going up).

So $F_{EG} = 20kN$, be in tension.

ΣF_y at point G is 0

$-F_{EG} + 20kN = 0$

$F_{EG} = -20kN$ (tension)

$\therefore \Sigma F_y$ at E is 0

$\Sigma F_y = 0$

$F_{EG} - F_{EHy} + F_{EDy} - F_{CE} = 0$

$20 - (F_{EH}\sin 32^\circ) + (58.96\sin 32^\circ) - 51.23 = 0$

$F_{EH}\sin 32^\circ = 20 + 31.24 - 51.23$

$F_{EH} = \frac{0}{\sin 32^\circ}$

$= 0kN$

$\Sigma F_x = 0$

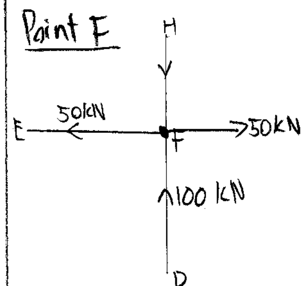
$-F_{EHx} - F_{EF} - F_{EDx} = 0$

$(0\cos 32) - F_{EF} - (58.96\cos 32^\circ) = 0$

$-F_{EF} = 58.96\cos 32^\circ$

$F_{EF} = -50kN$ (tension)

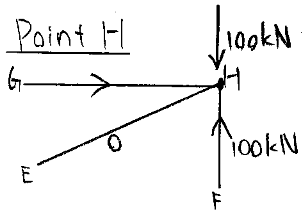
Point F



$-F_{FH} + 100kN = 0$

$F_{FH} = 100kN$ (compression)

Point H

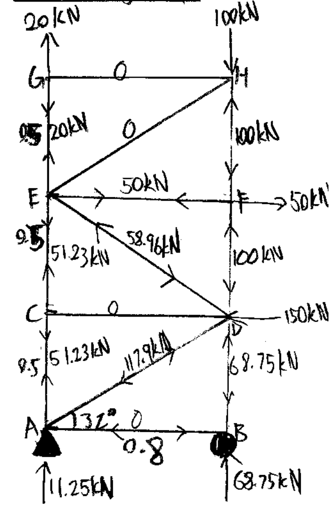


$\Sigma F_x = 0$

$F_{GH} + (0\sin 32^\circ) = 0$

$F_{GH} = 0$

conclussion



$F_{AB} = 0kN$

$F_{AC} = 51.23kN$ (Tension)

$F_{AD} = 117.9kN$ (compression)

$F_{BD} = 68.75kN$ (compression)

$F_{CD} = 0$

$F_{CE} = 51.23kN$ (tension)

$F_{ED} = 58.96kN$ (compression)

$F_{DF} = 100kN$ (compression)

$F_{EF} = 50kN$ (tension)

$F_{EG} = 20kN$ (tension)

$F_{EH} = 0$

$F_{FH} = 100kN$ (compression)

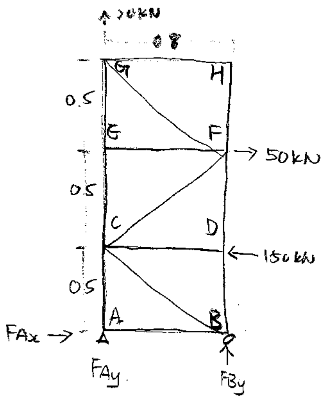
$F_{GH} = 0kN$

Question 5

JOSEPH WONG SHUN HUA

1101611Q4E

Case 6 (By Erci Kwan Zheng Hao, 0300694)



A) Determine the Perfect Truss.

2J = M + 3

2(8) = 13 + 3 = 16.

∴ It is a perfect Truss.

(external force)

B) Determine the reaction force.

$\Sigma F_m = 0$.

$100 \times 0.8 + 50 \times 1.0 - 150 \times 0.5 - F_{By} \times 0.8 = 0$.

$80 + 50 - 75 - 0.8 \cdot F_{By} = 0$.

$F_{By} = \frac{55}{0.8} = 68.75\ kN$.

$\Sigma F_x = 0$.

$F_{Ax} + 50 - 150 = 0$.

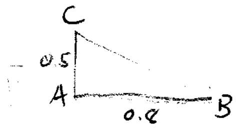
$F_{Ax} = 100\ kN$.

$\Sigma F_y = 0$.

$F_{Ay} + F_{By} + 20 - 100 = 0$.

$F_{Ay} + 68.75 + 20 - 100 = 0$

$F_{Ay} = 11.25\ kN$.



$\angle ABC = \tan^{-1}\frac{?}{?}$

$= 32°$

IS,

C) Determine the internal force.

↔ = +ve = Compression (C)

→← = −ve = tension. (T)

1) Point A

FAC, 100kN, FAB, 11.25kN

$\Sigma F_x = 0$.

$100 - F_{AB} = 0$.

$F_{AB} = 100\ kN\ (C)$

$\Sigma F_y = 0$.

$11.25 - F_{AC} = 0$.

$F_{AC} = 11.25\ kN\ (C)$

2) Point B

FBC, FBD, FAB, 68.75kN.

$\Sigma F_x = 0$.

$F_{AB} + F_{BCx} = 0$.

$F_{BCx} = F_{BC} \cdot \cos 32°$

$100 + F_{BC} \cdot \cos 32° = 0$.

$F_{BC} = -\frac{100}{\cos 32}$

$F_{BC} = -117.92\ (T)$

$\Sigma F_y = 0$.

$68.75 - F_{BD} - F_{BCy} = 0$.

$F_{BCy} = F_{BC} \cdot \sin 32°$

$68.75 - F_{BD} - (-117.92)\sin 32° = 0$

$F_{BD} = 131.24\ (C)$

∴ $F_{BCy} = -62.488\ kN$.

$F_{BCx} = -100.002\ kN$.

3) Point C

FCE, FCF, FCD, FAC, FBC

$\Sigma F_x = 0$.

$-F_{BCx} - F_{CD} - F_{CFx} = 0$.

$-(-100.002) - 150 - F_{CF} \cdot \cos 32 = 0$.

$F_{CFx} = F_{CF} \cdot \cos 32$

$100.002 - 150 - F_{CF} \cdot \cos 32° = 0$.

$F_{CF} = -58.96\ kN.\ (T)$

$\Sigma F_y = 0$.

$F_{AC} + F_{BCy} - F_{CE} - F_{CFy} = 0$

$11.25 + (-62.488) - F_{CE} - (-58.96 \cdot \sin 32) = 0$.

$-F_{CE} - 20 = 0$.

$F_{CE} = 20\ kN\ (T)$

22nd

$F_{CFy} = F_{CF} \cdot \sin 32$

$= -31.244\ kN$ 13

$F_{CFx} = F_{CF} \cdot \cos 32$ 9-

$= -50.001\ kN$.

4) Point D

FDF, FCD, 150kN, FBD

$\Sigma F_x = 0$.

$F_{CD} - 150 = 0$.

$F_{CD} = 150\ kN\ (C)$

$\Sigma F_y = 0$.

$F_{BD} - F_{DF} = 0$.

$131.24 - F_{DF} = 0$

$F_{DF} = 131.24\ kN\ (C)$

5) Point E.

$\Sigma F_y = 0$.

$F_{CE} - F_{EG} = 0$.

$-20 - F_{EG} = 0$

$F_{EG} = -20\ kN$

FEG, FEF, FCE.

6) Point F

FFG, FFH, FEF, 50kN, FCF, FDF

ɔer,

$\Sigma F_x = 0$.

$50 + F_{EF} + F_{FGx} + F_{CFx} = 0$. $F_{FGx} = F_{FG} \cdot \cos 32$

$50 + F_{EF} + F_{FG} \cdot \cos 32 + (-50.001) = 0$.

$50 + F_{EF} + 0 - 50.001 = 0$.

$F_{EF} \approx 0\ kN$.

$\Sigma F_x = 0$.

$F_{DF} + F_{CFy} - F_{FGy} - F_{FH} = 0$. $F_{FGy} = F_{FG} \cdot \sin 32$

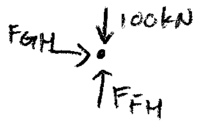
$131.24 + (-31.24) - F_{FG} \cdot \sin 32 - F_{FH} = 0$.

$131.24 - 31.24 - F_{FG} \cdot \sin 32 - 100 = 0$.

$F_{FG} = \frac{0}{\sin 32}$.

$F_{FG} = 0\ kN$.

7 Point H.



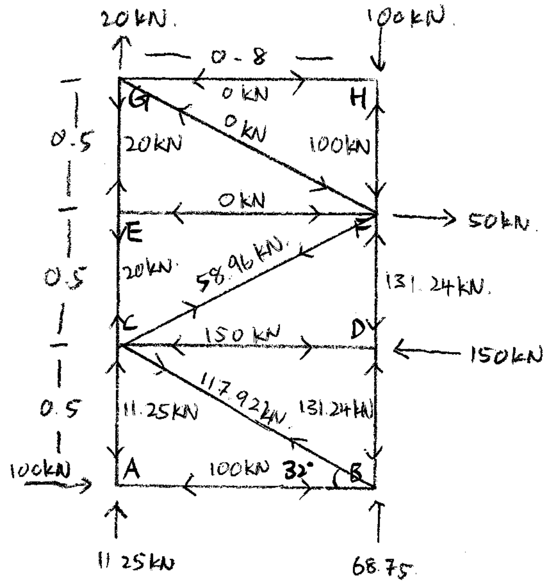
$\Sigma F_x = 0$.

$F_{GH} = 0\,kN$,

$\Sigma F_y = 0$.

$F_{FH} - 100 = 0$.

$F_{FH} = 100\,kN\,(c)$



$F_{AB} = 100\,kN\,(c)$

$F_{AC} = 11.25\,kN\,(c)$

$F_{BC} = -117.92\,kN\,(T)$

$F_{BD} = 131.24\,kN\,(c)$

$F_{CD} = 150\,kN\,(c)$

$F_{CF} = -58.96\,kN\,(T)$

$F_{DF} = 131.24\,kN\,(c)$

$F_{EG} = -20\,kN\,(T)$

$F_{EF} = 0\,kN$

$F_{FG} = 0\,kN$.

$F_{FH} = 100\,kN.\,(c)$

$F_{GH} = 0\,kN$

$F_{CE} = -20\,kN.\,(T)$

Case Study Analysis

	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6
Number of members with 0 force	3	4	3	3	4	3
Highest Critical Force	150kN	117.92kN	117.92kN	131.2kN	117.92kN	131.24

Conclusion

Truss system in case 3 is the most effictive because the internal force of it's critical member is at minimum value compared to other and it has only a minimum number of zero force member(3). This conclude that the internal forces in structure case 3 are relative effective though zero force member exist.