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PLANS OF A CIVIL AIRPORT
I N
RAYACK (LEBANON)

By. J . K . Ma'akarun.
final year engineering 1947.

I - Poetry

2 - Design of a roof truss
for a hangar & its drawings

Recd. J.R. Osborn
5/2/47

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au الى

Observations ملاحظات

1947

THESIS

Presented

TO THE ENGINEERING DEPARTMENT

IN

THE AMERICAN UNIVERSITY

OF

BEIRUT

TO OBTAIN

THE B.Sc. DEGREE IN CIVIL ENGINEERING

BY

JOSEPH K. MA'AKARUN

JUNE 1947

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R A Y A C K (LEBANON)

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INTRODUCTION

The object of this thesis is to study and design plans for a Civil Air-port in Rayack (Lebanon) .

There are several important items which must be considered in a problem of this type,some of which are :

The meteoroligical conditions, the site and the technical position.

I want to thank the following for their kindness in helping me with the preparation of this thesis:
Prof .Os born,the Ksara's observatory Director,the Director of the meteorological station in Rayack,Colonel Shurk (commander in chief of the military Air-port of Rayack) and his officers who were very generous in informations and details.

CHOICE OF THE PROBLEM

If our country is to cope with the rapidly developing method of travel by air,it must plan at once to provide the necessary landing facilities for air planes.

There are already four in Lebanon (Two on the sea shore and two in the Beka'a Valley) and about Six in Syria.

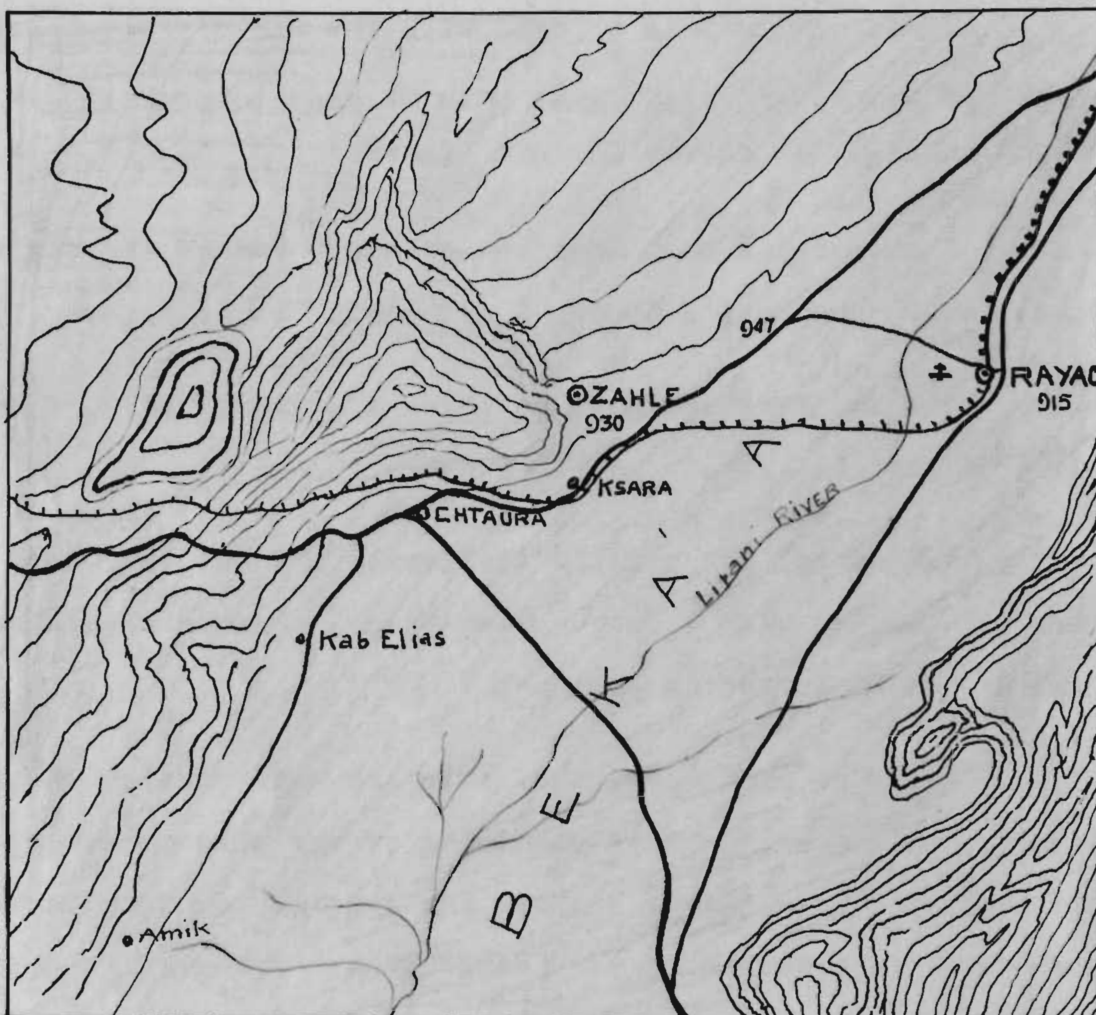
But all were designed to serve a military purpose and not for commercial use.

The Beirut air port is the newest one but very small (run ways 800 M. only) for a present day commercial use and a modern one is now being designed .

Since no one doubts that aviation will develops more and more, in a comprehensive pla/nning of air ports so spacious that they will meet future demands can readily be understood. A universal interest among our people is now directed toward the matter of airports.

Even though great change in a few years may compel revision of present efforts,nevertheless these present developments may be looked upon as an investment without which aviation can not develop.

Poor grammatical construction



Surveying Department
of
The Levant Troops

1/200000

Under theses conditions,one modern airport in Lebanon is not sufficient. In number airports need to be proportioned to the population to be served;in equipment they must be adequate and safe for the maximum volume of air traffic that they shall have to accomodate.

Being the door for main interior countries Lebanon must have modern airports serving as chief terminal station supplemented by small local airports used in cases of emergency.

Expecting also a large industrial development in the Near-East. Airports will be very useful and necessary.

SITUATION OF RAYACK AIR PORT.

The Air-port is situated by :

33° 49, 25" 6 of North latitude

and 35° 53' 24" or (2 h 23 Min 33 sec 7) of

East longitude to the altitude of 920 M. in the Center of the Beka'a Valley.

CLIMATE :

Rayack is situated on the N.E. - S W axis of the Beka'a valley at 9 Km. from Zahlé . It is a hellenic mediterannean Climate . Winter is very cold and rainy with a cold north wind . Summer is dry but without any excessive warmth.

AVERAGE VALUES

FOR 25 YEARS.

	Pressure in mm.	Temperature dgrees centigr.	Average humidity %	Evaporads in mm.	Precipitation Rain fall in mm	WIND Avg. Speed	WIND Direct.
January	683.93	5°.5	78%	486	147	10.8	N.W.N.
February	682.12	6°.6	75	37.6	155	13.8	N.W.N.
March	682.23	9.8	52	139.7	56	10.1	S.W.S.
April	682.16	13.8	55	170.5	50	11.4	S.W.S.
May	682.18	18.5	49	154.2	10	14.4	N.W.N.
June	681.05	21.8	49	212.2	3.23	16.1	N.W.N.
July	679.13	23.9	45	241.2	1.1	16.8	N.E.N.
Aug.	679.84	24.4	46	219.9	1.5	15.3	S.W.S.
September	682.20	22.1	49	169.8	0.91	12.4	S.W.S.
October	684.55	18.1	53	134.6	15.0	9.0	S.E.S.
November	684.90	12.7	64	95.4	64	8.0	N
Dec.	684.41	7.4	76	30.2	129	8/0	N.E.N.
Yearly	682.44	15.5	58%	112.0	626	12.2	

On table (I) observations are recorded for every month and an average values for the last 25 years taken by the meteorological station in Rayack & Ksara.

WIND :

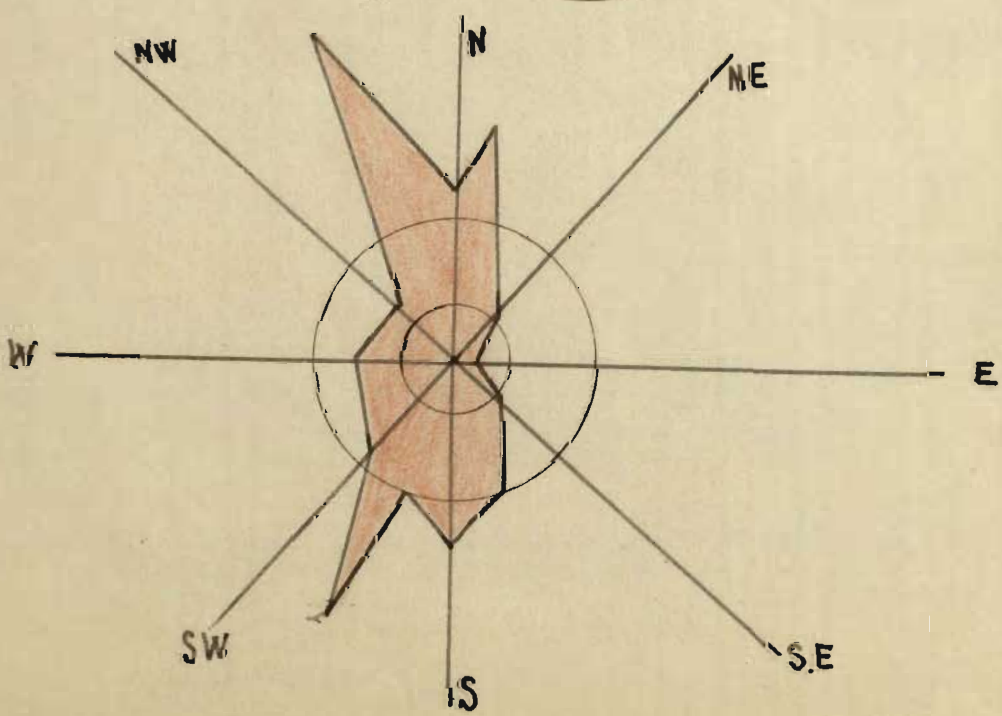
Among these conditions given in the table the wind has the more important effect on our design . As it seems from the table the prevailing winds are :

N W N , S W S , S E S , N E N .

The wind has rarely a high velocity. The maximum velocity recorded was in April 1939 of 68 Km 60.

SNOW :

The snow is recorded daily (1 , 2 , 3 days of snow etc) In general the snow in Rayack does not attain the height of 30 in. and does not fall every year. Also it does not stay long.



According to the indications given by the meteorological station it appears that our region is free from dense river fogs, ground mist, smoke, conditions, snowdrifts ,air travel interference objectionable air currents and eddies.

So in every point the meteorological conditions are favourable for the construction of the airport . In the statistics of the French Air Forces more than 90% of accidents in Lebanon are due to a mechanical cause,bad landings or take offs.

To diminish the accidents due to landings and take offs. Rayack's Airport will have a piece of land 1.5 Km. by 3 Km. in length at one kilometer and more from the center of the town.

This airport will be easily accessible from the main highways. Two beautiful highways pass near to it. (The first one Beirut , Zahlé , Rayack , Ba'albeck ~~so on~~- and a new one coming from Damascus, Darzanaun bridge, Rayack , Ba'albeck, Homs , Hama Aleppo ~~so on~~).

The ideal also in the location of this airport is that it is near to the main center of the D . H . P . railway company. The termini of the standard gage (Rayack - Aleppo - Turkey or Bagdad) and the narrow gage (Beirut - Rayack , Damascus Hedjaz) are half a mile from the new airport.

So a spur line railroad comection would be very economical and useful . It could facilitate transfer of passengers and freight and facilitate airplane supply shipments.

Bounded by streets and railways . The Airport in Rayack will have wide thorough fares which will lead off from it in all directions.

It has an easy access to various public utilities such as electricity , gas , water , etc...

Poorly written

The neccessary approach to the landing field does not lead accross the town.

An airport should be of proper size in addition to being correctly placed . According to Karl Lohmann, among existing flying fields there is great variation in size from an airport the size of mitchel field in cleveland -covering 1000 acres down to 40 acres airports in Boston and Pittsburgh, and there are others elsewhere as small as 25 acres . These numbers are taken in 1931 and I think there are enough little and old to correspond with our modern time and the future development.

Book title in footnote

In my case the airport of Rayack will have a piece of land 1,5 X 3 kilometers about 1110 acres which I think is more than enough for immediate and future development.

The size of the airport is governed in general by the types of planes that are to utilise it , the volume of traffic that is to be accomodated and the probable crowds that are to congregate there.

Also the elevation of the property above the sea level must be considered .

If helicopter planes, vertical in their rising and landing are ever used to the exclusion of other kinds of aircraft then the area required for the airport will be smaller.

The roof of a large house will be good enough for the rising and landing of helicopters.

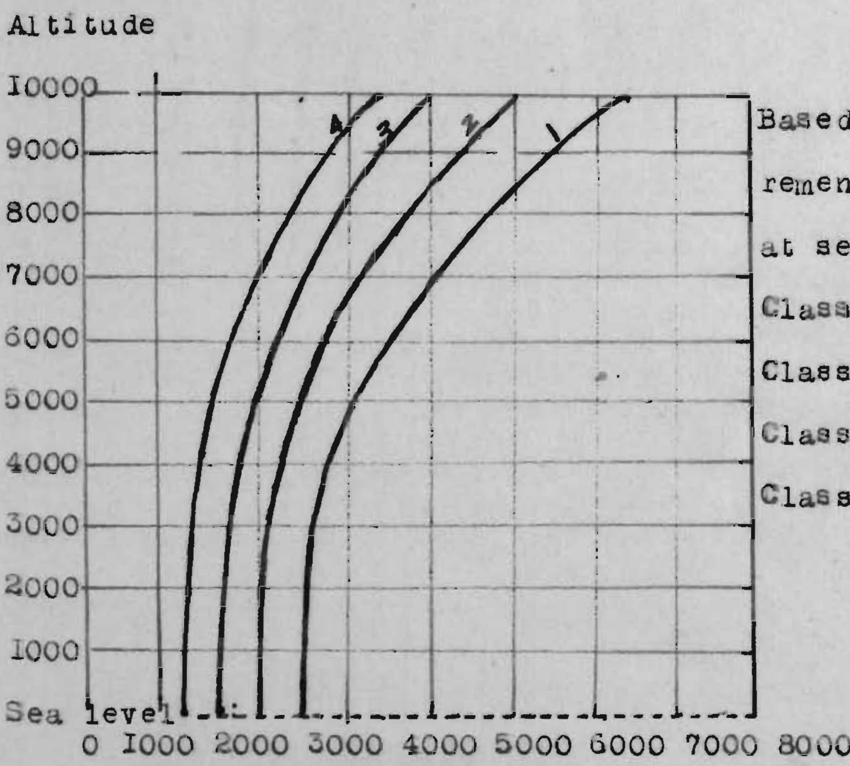
In 1930 lighter planes leave the ground in from 400 to 800 horizontal feet . In 1939 the french lighter planes (Poteze 29) for 2 persons) leave the ground in from 150 to 250 meters horizontal distance . The Heavier in from 1000 to 2000 horizontal feet . But they all require additional space for the runway in the event of the stolling of the engine.

Airports, therefore, need to be provided with certain minimum runs for the planes.

According to the United States aeronautical Standards the " A " rating applies to landing areas that provide runways of 2500 feet and " B " rating applies to those whose runways are 2000 feet , a distance which is sufficient for the starting of most planes in 1931 . There are some plane carrying passengers that require 3500 in which to make their start.

~~Anyhow in my case~~ I have two runways of 2 Km. each(one directed north south and the other N E N - S W S . making an angle of about 25° . These directions have been chosen to correspond with the prevailing winds. I500' to 2000'are left free on both sides of the runways to have a good unobstructed take - off and landing . In this manner all the length of the runway will be used without any loss.

Because a rarified atmosphere does not permit of the operation of an airplane at the same speed as the denser air of a lower elevation ,the lengths required for the take off and landing increases with the altitude and the size of the field must be increased accordingly. A take off of I500 or a location at sea level,for example,would have to be increased to 2300 ' as a place which is a mile above the sea level.



Based on minimum requirements of landing area at sea level.

Class " 1 "-Rating 2500 ft.

Class " 2 " " 2000 "

Class " 3 " " 1600 "

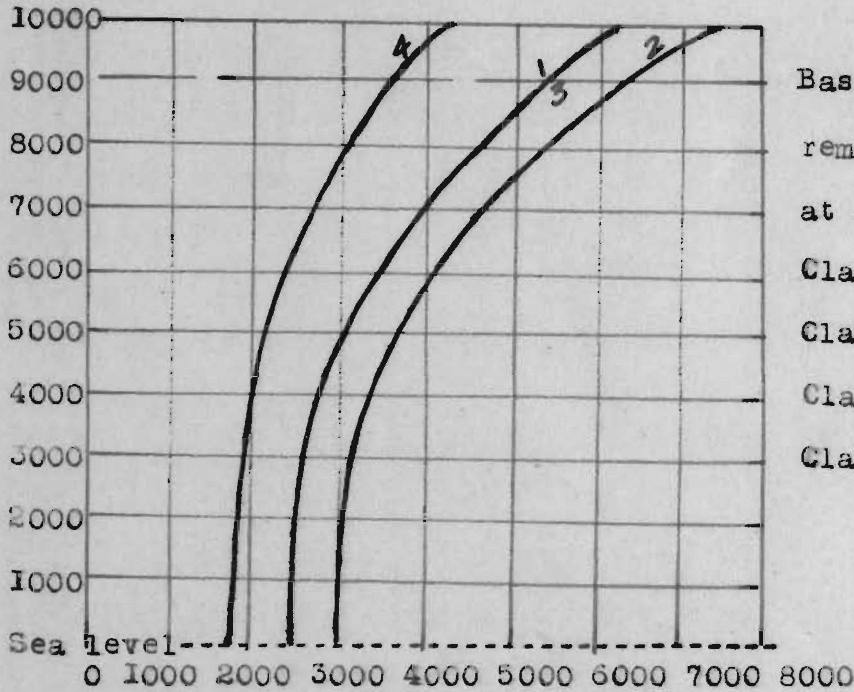
Class " 4 " " I320 "

(Fig. 2)

Fig. (2) - Required increase in landing area at various altitude above sea level (from airport Rating regulations) . Department of Commerce .) May 1928)

Fig. (3) Required increase in landing strips at various altitude above sea level.

Altitude



Based on minimum requirements of landing strips at sea level.

Class " 1 "	Rating	2500	Ft.
Class " 2 "	"	3000	"
Class " 3 "	"	2500	"
Class " 4 "	"	1800	"

Length of landing strips in feet.

At 900 M. or 3000 feet above sea level . The runways in the Airport of Rayack Having a horizontal length of about 7000 ft. each are good enough the time being for the take off and landing of a 21 passengers airplanes.

I don't think that airplanes crossing the near East will be

Poorly written

for more than 21 passengers.

Even 21 is a large number. ~~Anyhow~~ in case of increasing traffic a possible enlarging of the airport may be easily done. Being limited on the South by a cultivated land where no buildings are erected. The Airport has a free view without any obstruction for a distance not less than 15 Kilometers. We have also the same distance and even more towards the North. A man standing on the terrasse of the Airport station which has 3 stories above the ground level can easily see all around him without any obstruction to a radius of 20 Km.

So nothing interfere with the plane as it follows the necessary angles of ascent and descent,which amount to 1 foot up or down to each 7 feet of forward travel in 1931 and to 15 feet of forward travel nowadays.

Obviously from this calculation an adjacent building 40 feet high in the path of ingoing out going planes would render useless a portion of the landing field 280 ft. in radius as far as the rising and alighting of air planes is concerned.

That is why in my case I design the buildings and hangars in a central place where a distance of not less than 200 meters or 670 ft. is separating them from the main runways.

Also no building in Rayack are more than 2 Stories .

The residential section is well planned . We have residential houses of one to two stories surrounded by gardens . This residential is placed to the East of the airport in such a place and at such a distance from the airport so that the noise incident to the operation of the engines in the airplanes and the flashing or rotating of the airway beacons through the night which are very disturbing to overly nervous peaple are very much reduced by the prevailing winds, blowing from the North or from the South.

In the United States ,the flight of an airplane must be above 500 feet in crossing the property of an adjoining owner other wise it may be regarded as trespass . " Where lower altitudes are neccessary therefore the owners of airports must secure the Consent of adjoining property awners,or acquire such rights by Condemnation.

Here there is no law or rule determining the flight of an airplane.

THE DEVELOPMENT OF LANDING FIELDS.

The type of the development of a landing field depends upon the particular kind of airport that it is proposed to establish.

Being at the same time a terminal and an intermediate airport on a rapid transit system, it will require a multiplicity of facilities.

RUN-WAYS : Landings and take-offs of aircraft are made, against the prevailing winds, so that the direction and character of the landing strips or runways should be laid down accordingly; that is, the runways should be in line with the prevailing winds.

These runways are on a smooth surface with 2% slope. This area is capable of being made firm under all conditions of weather . It has a good natural drainage to the Litani river which is close to it . The whole land is capable of sustaining a covering of firm sod.

Runways are 120 M. wide in the smallest sections and more than 240 M. at the ends ,because occasionally the planes are carried off their course by the wind, or the pilots have to execute a ground loop upon landing . It is therefore, customary to provide landing strips more than 500ft. wide that are smooth and well drained and to have then substantially paved or asphalted.

The main runways are so placed as to avoid approaching the airport buildings directly. Two secondary runways connecting the two main ones are intersecting near the terminal airport station, so they necissitate less taxiing than otherwise which is an advantage.

Also the main runways separated at the base by a distance of 2500 ft. feet which is an advantage in separating incoming and out going planes. It is an advantage also because the buildings are erected inside the area and there is no unsteady wind curents over the runways produced against adjacent structures.

Taxiways around the perimeter of the field are helpful in that they provide direct access to and from the runways.

The runways are surfaced with sand asphalt, their construction is subject to the same general principles that govern the construction of roads.

This sand asphalt may have 5"- 6"in thickness and contain from 5 - 8% bituma.

In some cases where soft asphalt is used in a sand asphalt mat it is covered with a coat of stone chips or a dense asphaltic concrete wearing surface utilising a harder bituma thus producing a very flexible pavement with a top wearing surface particularly adopted to runways construction. No layer should be laid over 3" in thichness at a time because it is difficult ot obtain good compaction and shoving under traffic may result.

I choose this kind of asphalt for runways because ~~it~~ of the following advantages :— ~~is good for the following reasons.~~

I - It produces a flexible pavement particularly adopted to runways.

2 - With two white lines on both sides it is visible at night and skid proof when wet.

3 - It is economical both as to first,cost and as to cost of maintenance.

4 - It is able to sustain heavy loads and to withstand the high impact of alighting planes. The force of the impact of an alighting plane with a given load subjects the pavement upon which it alights to a strain several times as great as would be made upon it by the same weight of " static load "

Attention is called to the fact that in planning types of pavements for runways,the loads to be sustained,including the strain of the impact for the heaviest planes must always be considered.

According to the U . S . Department of Commerce the heaviest planes for which runways have to be constructed are of 30,000 pounds weight. This number is taken in I93I. Today airplanes are weighing much more. But to our country 30,000 pounds may be accepted .

The construction at Rayack field provides runways in a series of strips or panels I5 feet in width,6 to 8 inches thick,and doubled together at the joints,and 6700 feet in length of these runways are 360 feet in width.

At the intersection of the main,runways,or in the heart of the best landing area, a large circle 100 feet in diameter with a 4 feet margin painted white will point out the runways for incoming planes overhead.

BUILDINGS :

Buildings as well as runways are essential features in the development of the more complete airports.

These buildings include terminals with administrative facilities,waiting rooms for passengers,for pilots in passage,restaurants,offices,control towers,fire and ambulance stations,infirmaries garages and storage facilities,sleeping quarters for travelers bleachers for observation space,places for radios and for meteorological instruments,facilities for shoping,equipment for service of various kinds as well as the heating plant because in Rayack the temperature in winter may drop below 0° centigrade. Also a row of villas as it is shown in the contours map is a proper housing of the field personnel.

The Airport station is in some respects the heart of the airport. In connection with it will be the loading and unloading platforms;within it will be the main waiting rooms ticket offices, check rooms,concession stands,the administrative offices,and a restaurant.

This airport station is located at the center at the point of the intersection of the secondary runways. as it is shown on the map. It contains an underground floor used for storage & baths and two over ground floors,with the different offices,and waiting rooms,imfirmarie etc. - Above these 3 stories is the observation post surrounded by terrasses,surmounted by an air socket.

This control station is commanding an unbroken view of the field and that is why it is elevated above the surrounding buildings. A place on the top of the terminal or airport station is therefore a desirable position in this respect and for this purpose.

HANGARS :

In number,size,and importance the hangars occupy an important position upon the airfield. It is to them that arriving planes will be moved or from them that many departing planes will be taken They will need to be convenient of access and not too far from each other. The danger of fire may be avoided by using steel structures with masonry or concrete.

In this airport 12 hangars are amenaged in such a way ,that they will not interfere with control tower vision.

In size the hangars vary from 100 feet by 100 feet 100 feet by 200 feet to dimensions of 200 feet by 200 feet ,and about 25 feet high and provide a clear,unabstructed door opening on each side.

The area furnished by these hangars excluding 2 for repairing shops is about 5 acres and according to E. P. Goodrich space of 5 acres in area with be required for the parking of about 75 planes built to fly over land.

How the planes shall be removed from the hangars is dependent upon their size. The wing spread of the largest number of planes is from 30 to 40 feet and in the next largest number from 40 to 50 feet, planes,indeed,as to their wing spread vary all the way from 20 to 100 feet. They vary in height,also,from 10 to 18 feet.

Of course there are planes that are being built with a wing spread of 262 feet and an overall height of 31 1/2 feet.,but we don't need this kind of planes in the Near-East,they are uneconomical .

The largest airplane used by the French Air forces for passengers in Lebanon and the Near East was able to transport not more than 12 passengers having each one goods weighing not more than 25 Kgs.

This kind of airplane belonging to the(Air France line) was doing the travel between the Near East and France. There were also planes for 6 and 5 passengers and even less.

PLAY GROUNDS :

We must be aware not only of the importance of the opportunity for play but also of the need of making suitable provision for it in the plan of the airport . Provision should be made that the adult population of the neighborhood man share with the personel of the Airport the facilities of the play field or athletic field.

Nothing is more useful and necessary for a pilot or an office man after 8 hours of office work or so many hours of flight than a time to spend in playing (tenis, football, swimming etc...) .

Passengers need a peaceful corner a peaceful park where they can rest easily before traveling.

Pilots need a lot of rest after a travel. They need peace and health to overcome the difficulties of the atmosphere and airplanes.

A great variety of the standard of the space required for play grounds and play fields have been advocated by different persons,and perhaps the most various of these standards are those that concern the space required by each individual engaged in play . these recommandations have varied any where from 35 up to 200 square foot for each person playing at any given time on the play ground areas.

So a space to the East of the runways and building is reserved for organized games and sports for the personel of the airport and for the adult population of the neighborhood . So we have.

I - a football field	I60	by	360	feet	
2 - Tennis	36	by	78	feet	(double)
3 - Volley Ball	30	by	60	feet	
4 - Basket Ball	50	by	94	feet	
5 - Field Hockey	I50	by	270	feet	
6 - Swimming pool	200	by	I00	feet	and gymnasium.

OTHER UTILITIES :

In addition to buildings,such structures as fences and similar barriers should be erected for the protection of the public and for the purpose of operating the planes without interference.

They should segregate wisiters and passengers from the field. An adequate system of lights will illuminate the vicinity ,these to include beacon lights (blue) boundary lights (red) and might wind indicators,(a neon lighted wind tee) ,the illuminated circle. Runways will be illuminated at night and red lights will mark such obstructions as water towers,flag poles,and towers for transmission lines,either those that are provided upon the grounds or those that exist in the immediate vicinity of the airport.

If the radar will be used in all the airplanes in such a case that the precautions during the night will be diminished . I hope that this thing happens,because it will contribute to the safety of passenger to the passengers and to the development of the air transport.

CONCLUSION

The subject of airport is related to air in much the same way as the subject of harbors and docks is related to water or that of stations and yards is related to railroads. Similarly airports may become the focal points of civic development. In number airports need to be proportioned to the population to be served and in equipment adequate and safe for the maximum volume of air traffic. That they shall have to accomadate. Just as there are systems of highways,there will soon be air routes and the airports will be needed as we need garages for this big number of automobiles.

The importance of aviation ,the extent of its properties and the peculiar qualities of its technique would seem to justify a separate public department in Lebanon for its maintenance and administration.

It is not sufficient to design and study the main points but we have to go more deeper and more in details. We have to consider the first impression of a city as seen upon arrival at an airport. As part of the air mosaic of the city ,and to encourage good first impressions,it is essential to have an orderly arrangement of design in the airport,appropriate architectural treatment,and suitable use of grass and foliage.

Community builders must plan so that the eye of civilization, looking down upon the earth, sees order, harmony, beauty. This will not be so difficult because architects all through the ages have been planning with the bird's eye view in mind.

Every thing should be done to inspire confidence and satisfaction in the traveling public.

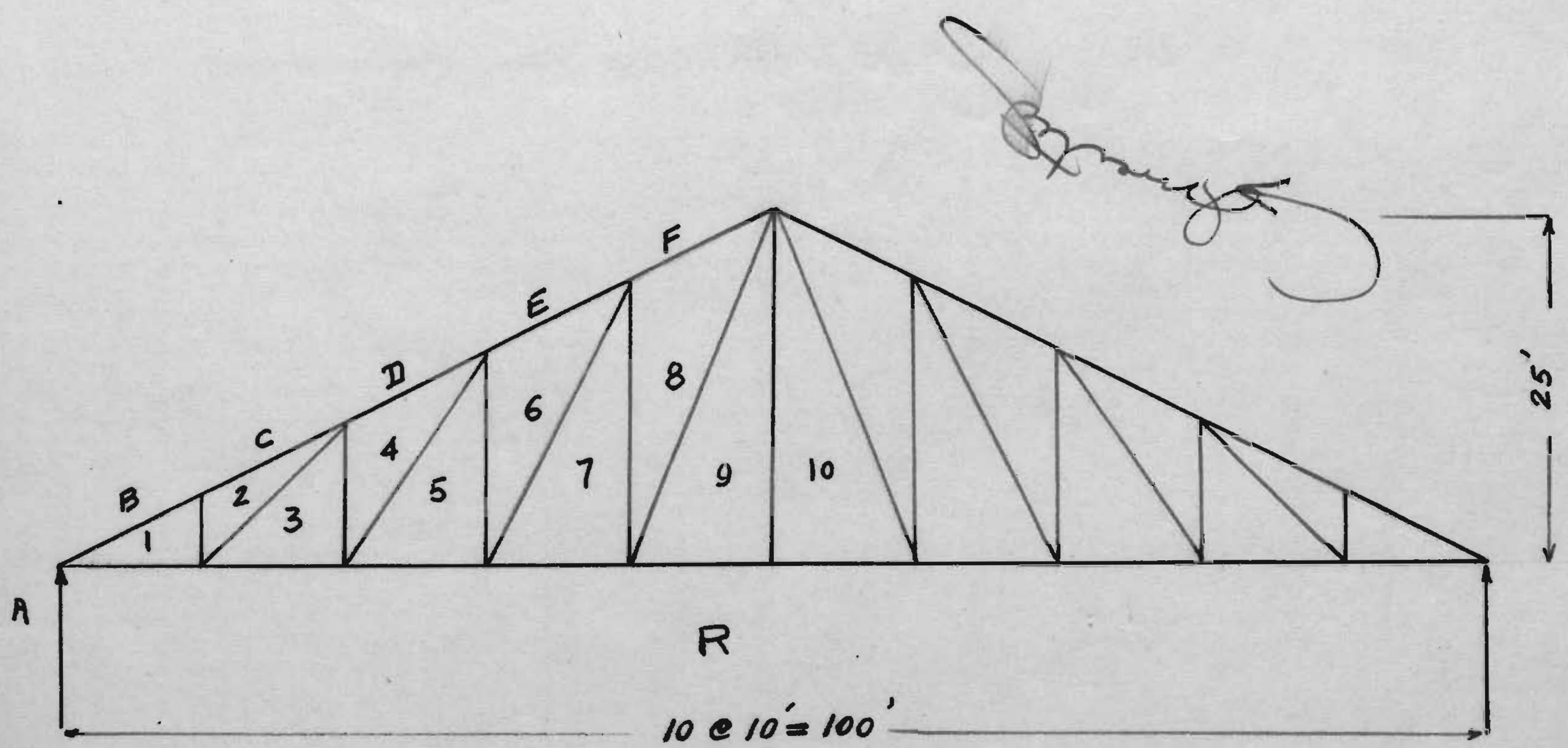
- - - - - - - - - - -

Ma'akarun,J.
May 1947

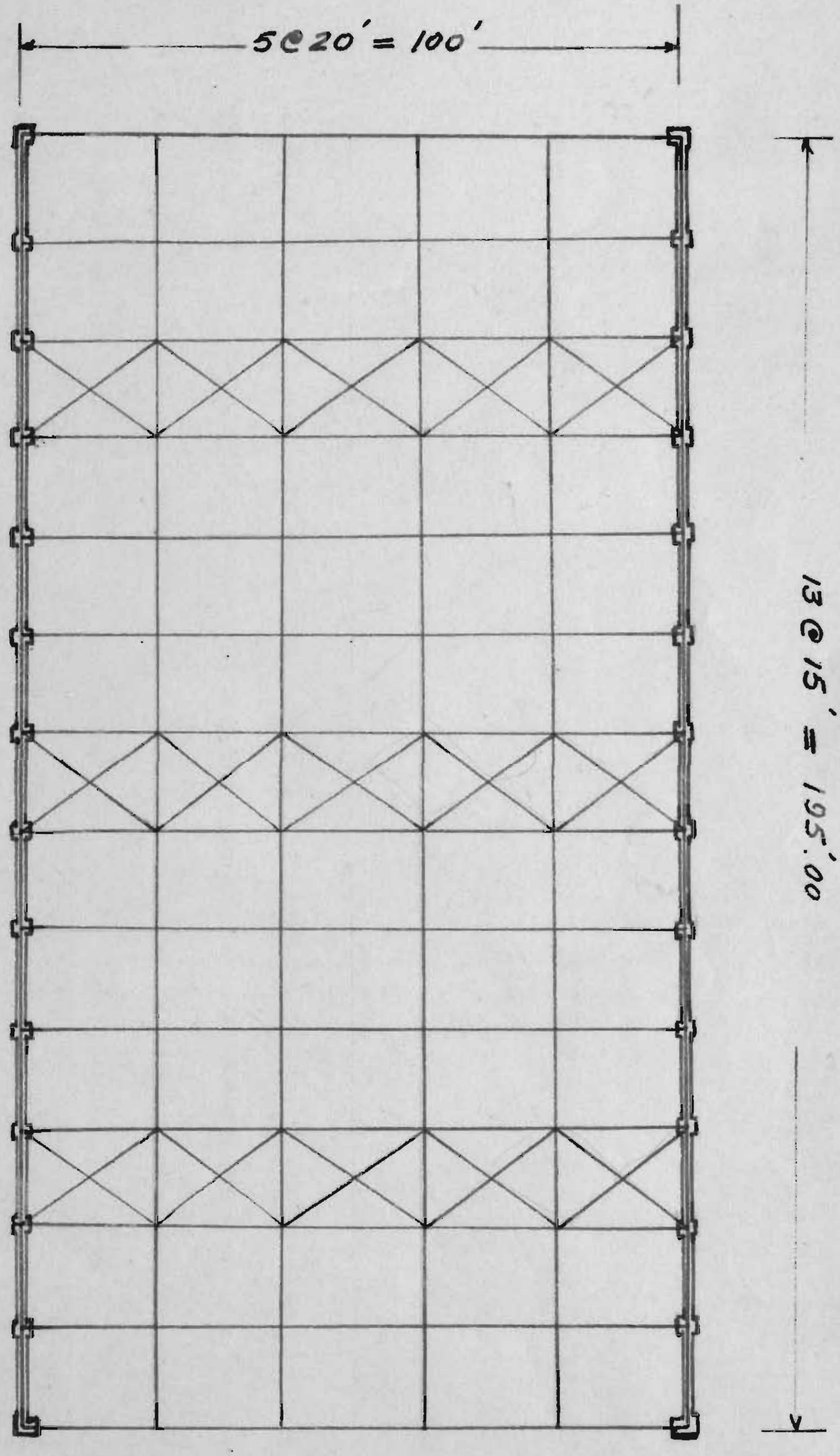
D E S I G N O F A R O O F T R U S S
F O R
A H A N G A R .

I N

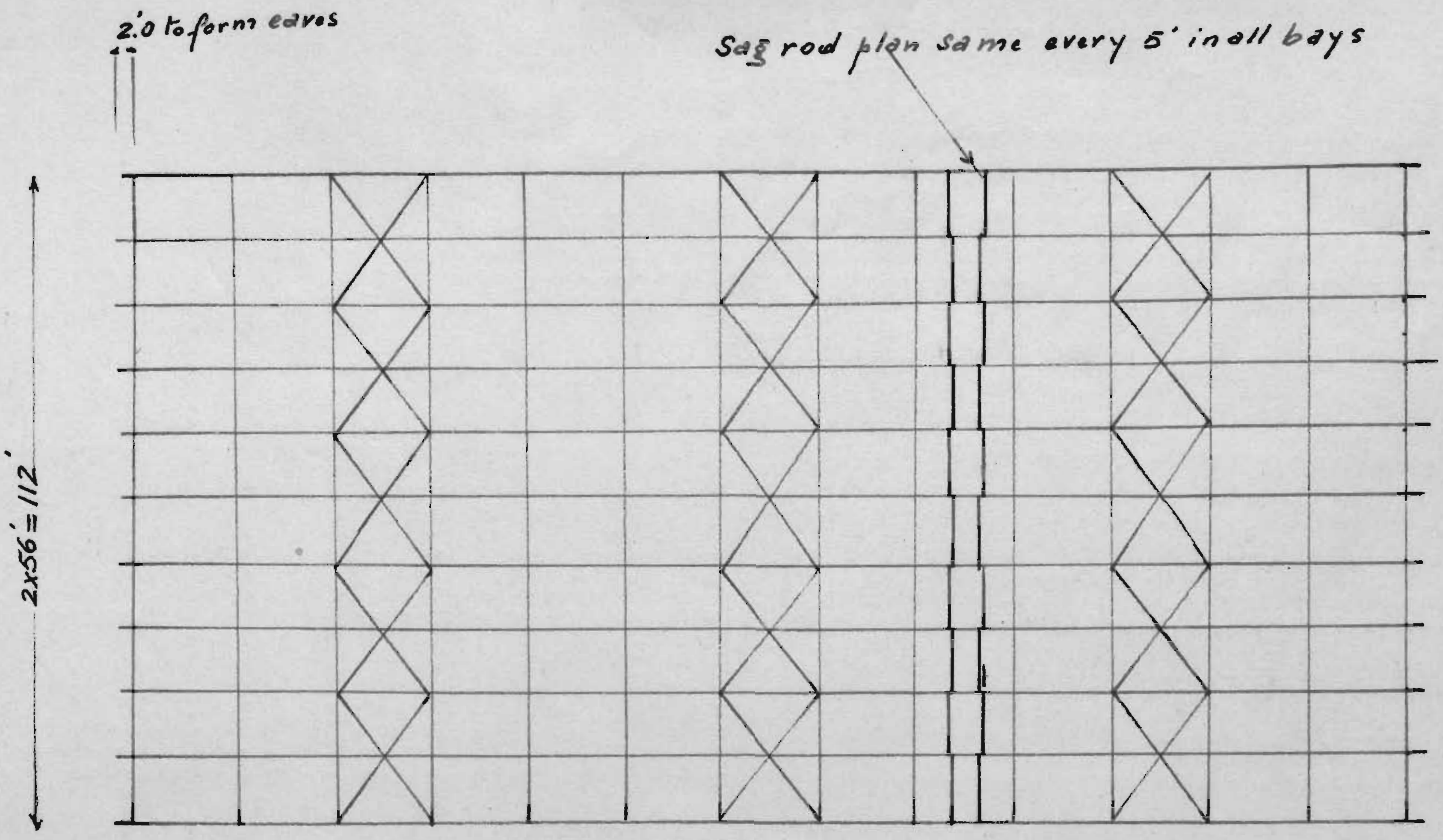
R A Y A C K A I R - P O R T



A
B
C
D
E
F
1
2
3
4
5
6
7
8
9
10
R
10 @ 10' = 100'
25'



Bottom Chord Bracing



Plan Showing Purlins & Top Chord Bracing

Spacing of the trusses	:	15'
Basic unit stress	:	20000 psi
Roof	:	1/4 Slate Shingles.
Sheathing	:	1" white pine
Joists	:	2"X 10 white pine at 12" centers
Purlins	:	10" channels 30 lbs at each panel point
Truss & Bracing	:	Sutherland & Bowman's Formula
Wind	:	15 lbs/ft^2 on vertical surface
Snow	:	10 lbs/ft^2

SUTHERLAND & BOWMAN'S FORMULA

$$W = \left(\frac{1}{2} (L - 50)^2 + (L - 20) \left(18 + \frac{8(W+P)}{100C}\right) \right) \left(\frac{16000}{St}\right)$$

W = total Weight of truss in ibs

L = Span of trusses in feet

C = Total length of upper chord in feet

P = total vertical load carried by truss exclusive its own weight in ibs.

St = unit stress used in design of tension member ibs /in2

P.is equalto :

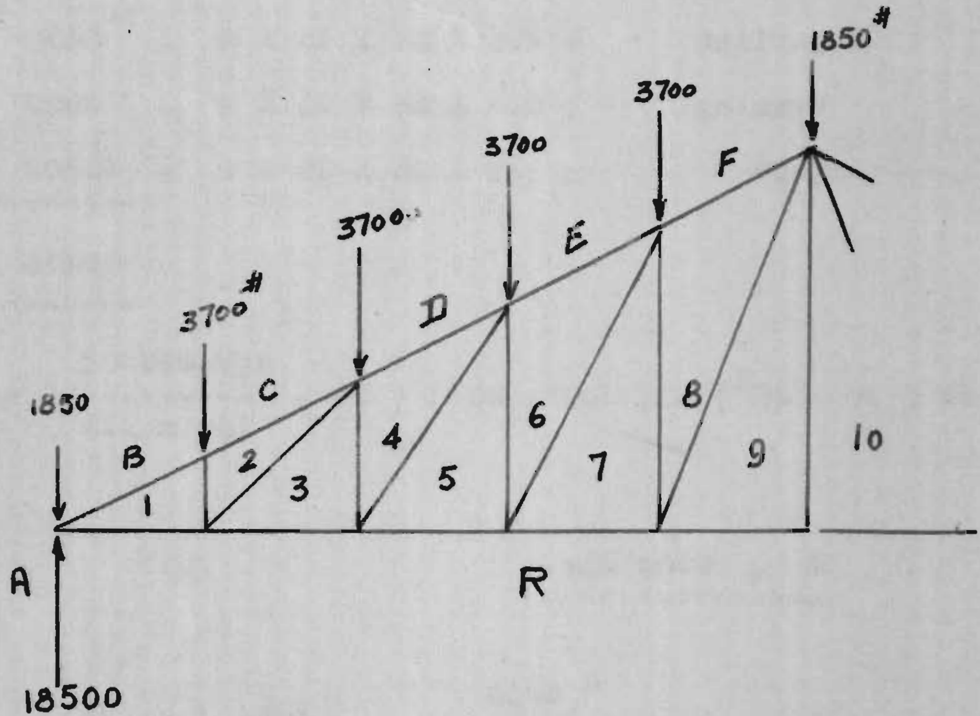
Roofing	:	9 X 56 X I5 X 2	=	I5I20
Sheathing	:	2.5 X 56 X I5 X 2	=	4200
joists	:	4 X 56 X I5 X 2	=	6700
purlins	:	3.5 X 56 X I5 X 2	=	5650
bracing	:	0.6 X 56 X I5 X 2	=	I000
Snow	:	I0 X 56 X I5 X 2	=	I5800
				49470 ib.

$$W = (I/2 (I0 - 50^2) + (I00 - 20) (I8 + \frac{8(W+49470)}{100 \times 112}) 4/5$$

W = 4600 Ibs.

$$\frac{4600}{56 \times 30} = 2.74 \text{ Ibs} / ft^2$$

DEAD LOAD



I - DEAD LOAD STRESSES

Roof	=	9	9
Sheathing	=	2/5	2.5
Joists	=	4/0	4.0
Purlins	=	3/5	3.5
Truss & Bracing	=		3.34
			22.34.

Load per panel is : $\frac{22.34 \times 15 \times 56}{5} = 3700$ lbs

I - R

$18500 \times 10 - 1850 \times 10 = (I - R) \times 5$

I - R = + 33300 lbs

I - B $\frac{33300 \times 11.2}{10}$

I - B = - 37300 lbs

I - 2

$\frac{18500 \times 10 - 16650 \times 10}{5}$

I - 2 = - 3700 lbs

2 - 3

$$3700 = \frac{(2 - 3) \times 10}{14.14}$$

2 - 3 = + 5240 Ibs.

3 - R

18500 X 20 = 1850 X 20 + 3700 X 10 + (3 - R) X 10

2 - R = + 29600 Ibs.

2 - C

$$18500 \times 10 = 1850 \times 10 + (2 - C)_H \times 5$$

2 - C = - 37300 Ibs.

5 - R

18500 X 30 = 1850 X 30 + 3700 X 20 + 3700 X 10

+ (5 - R) 15

5 - R = + 25900 Ibs

4 - 5

$$\frac{3700 \times 18}{10}$$

4 - 5 = + 6650 Ibs

3 - 4

$$\frac{6650 \times 15}{18}$$

3 - 4 = - 5550 Ibs.

4 - D

$$\frac{29600 \times 11.2}{10}$$

4 - D = - 33200 Ibs.

7 - R

$$18500 \times 40 = 1850 \times 40 + 3700 \times 30 + 3700 \times 20 + 3700 \times 10 + (7 - R) \times 20$$

7 - R = + 22200 Ibs.

6 - 7

$$\frac{3200 \times 22.4}{10}$$

6 - 7 = + 8300 Ibs.

5 - 6

$$\frac{8300 \times 20}{22.4}$$

5 - 6 = + 7400 Ibs.

6 - E

$$\frac{25900 \times 11.2}{10}$$

6 - E = - 29000 Ibs.

9 - R

$$18500 \times 50 = 1850 \times 50 + 3700 \times 40 + 3700 \times 30 + 3700 \times 20 + 3700 \times 10 + (9 - R)\ 25$$

9 - R = + 18500 Ibs.

8 - 9

$$\frac{3700 \times 26.9}{10}$$

8 - 9 = + 9950 Ibs.

7 - 8

$$\frac{9950 \times 25}{26.9}$$

7 - 8 = - 9250 Ibs.

9 - IO
------

9 - IO = 0

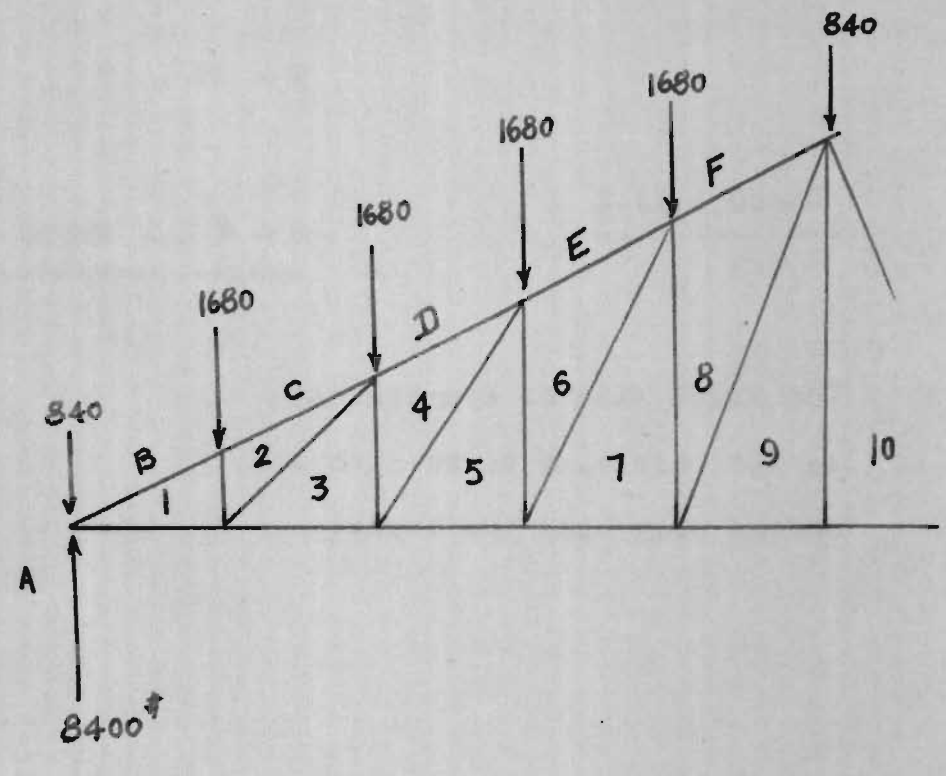
8 - F

$$\frac{22200 \times 11.2}{10}$$

8 - F = - 25000 Ibs.

Note : The right side is symmetrical to the left side so we have to design only half the truss.

SNOW LOAD



II - SNOW LOAD STRESSES

Snow Load

10 X 56 X 45 X 2 = 16800

Load per panel

$$\frac{16800}{10} = 1680 \text{ lbs.}$$

1 - R

8400 X 10 = 840 X 10 + (1 - R) 5

1 - R = + 15120

1 - B

$$\frac{15120 \times 11.2}{10} = 1 - B$$

1 - B = - 17000 lbs.

2 - C

15120 X 11.2 = 2 - C X 10

2 - C = - 17000 lbs.

1 - 2

15120 - 13440

1 - 2 = - 1680 lbs.

3 - R

8400 X 20 = 840 X 20 + 1680 X 10 + (3 - R) 10

3 - R = + 13440 lbs.

2 - 3

$$\frac{1680 \times 14.1}{10}$$

2 - 3 = + 2370 Ibs.

5 - R

8400 X 30 = 840 X 30 + 1680 X 20 + 1680 X 10 + (5 - R) 15

5 - R = + 11760 Ibs.

4 - 5

$$\frac{1680 \times 18}{10}$$

4 - 5 = + 3020 Ibs.

3 - 4

$$\frac{3020 \times 15}{18}$$

3 - 4 = - 2520 Ibs.

4 - D

$$\frac{13440 \times 11.2}{10}$$

4 - D = - 15000 Ibs.

7 - R

8400 X 40 = 840 X 40 + 1680 X 30 + 1680 X 20

+ 1680 X 10 + (7 - R`) 20

7 - R = + 10080 Ibs.

6 - 7

$$\frac{1680 \times 22.4}{10}$$

6 - 7 = + 3760 Ibs.

5 - 6

$$\frac{3700 \times 20}{22.4}$$

5 - 6 = - 3360 Ibs.

6 - E

$$\frac{11760 \times 11.2}{10}$$

6-E = - I3200 Ibs.

$$8400 \times 50 = 840 \times 50 + 1680 \times 40 + 1680 \times 30 + 1680 \times 20 + 1680 \times 10 + (9 - R)\,25$$

9 - R = + 8400 Ibs.

8 - 9

$$\frac{1680 \times 26.9}{10}$$

8 - 9 = + 4500 Ibs.

7 - 8

$$\frac{4500 \times 25}{26.9}$$

7 - 8 = - 4200 Ibs.

8 - F

$$\frac{10080 \times 11.2}{10}$$

8 - F = - II300 Ibs.

9 - I0

9 - I0 - 0

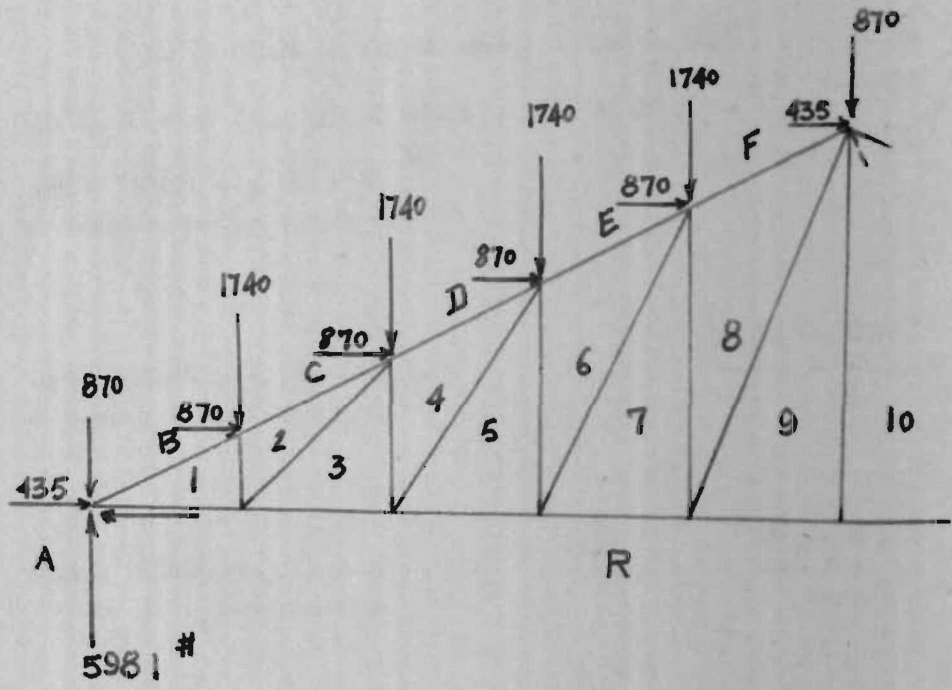
- - - - - - - - - - -

Purlins :

Use I0" X 25/8 [@ 30# on panel points

Use sag rods each 5'

WIND FROM THE LEFT



III - WIND LOAD STRESSES

Wind from the left

$$Pn = P \frac{2 \sin\theta}{I + \sin^2\theta}$$

P = pressure on a surface normal to the direction of the wind.

Pn = pressure normal to the inclined surface.

θ = angle between the inclined surface & the horizontal surface & the horizontal

$$Pn = \frac{I5 \times 2 \times \frac{25}{56}}{I7\left(\frac{25}{56}\right)^2}$$

$$Pn = II.6$$

Total load is :

$$II.6 \times 56 \times I5 = 9750 \text{ Ibs.}$$

Vertical Component is :

$$\frac{9750 \times 50}{56} = 8700 \text{ Ibs.}$$

Horizontal Component is :

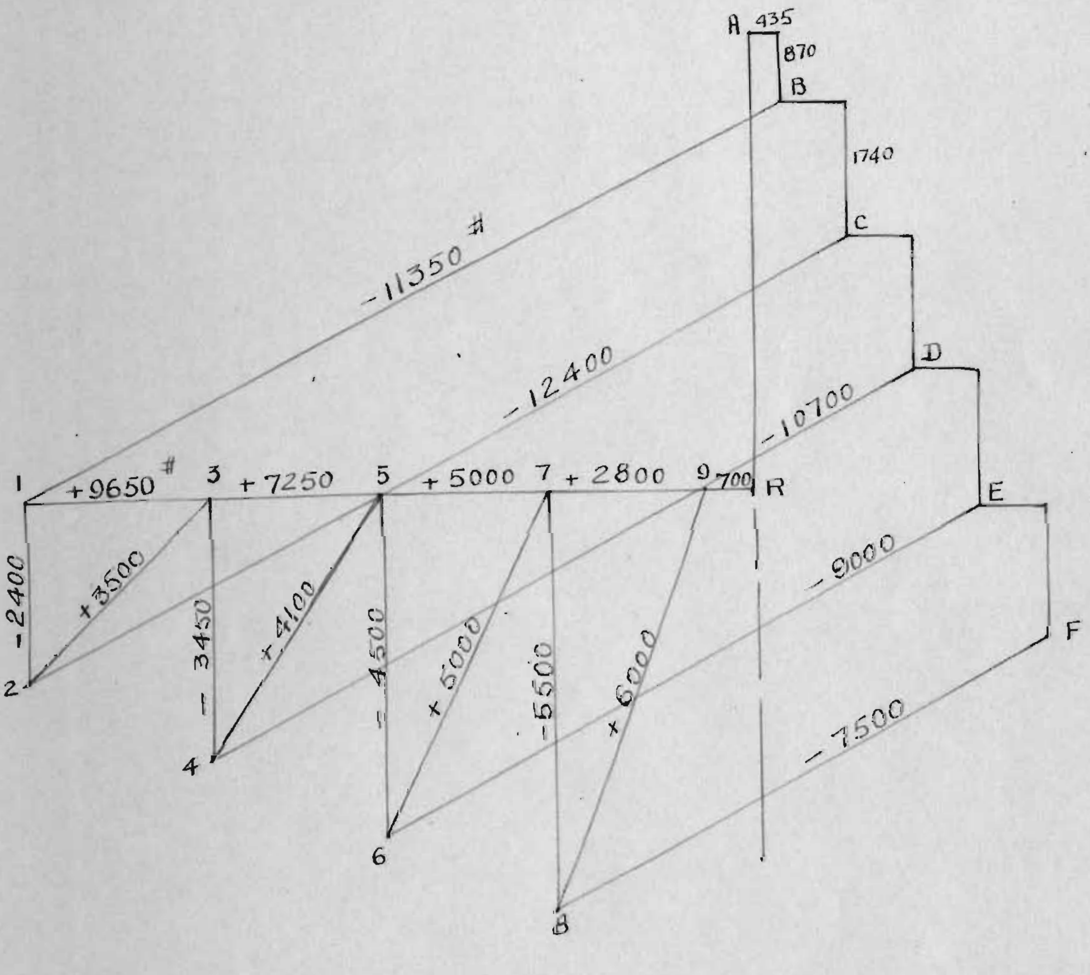
$$\frac{9750 \times 25}{56} = 4350 \text{ Ibs.}$$

Note :

The stresses due to the wind from the right are similar to the stresses due to the wind from the left.

WIND LOAD STRESSES

$1^{cm} = 1^{kip}$



Members	Individual Stresses				Combined Stresses			Maximum Stresses			
								With Wind		Without Wind	
	D.L.	S.L.	S.L/2	W.L.	D.L+S.L	D.L+S.L/2+W.L	D.L+W.L	Tens	Comp	Tens	Comp.
I-R	33300	I5I20	7560	9650	48420	505I0	52950	505I0		48420	
3-R	29600	I3440	6720	7250	43040	43570	36850	43570		43040	
5-R	25900	II760	5880	5000	37660	36780	30900	36780		37660	
7-R	22200	I0080	5040	2800	32280	30040	25000	30040		32280	
9-R	I8500	8400	4200	700	28900	23400	I9200	23400		26900	
I-B	37300	I7000	8500	II350	54300	57I50	48650		57I50		54300
2-C	37300	I7000	8500	I2400	54300	58200	49700		58200		54300
4-D	33200	I5000	7500	I0700	48200	5I400	43900		5I400		48200
6-E	29000	I3200	6600	9000	42200	44600	38000		44600		42200
8-F	25000	II300	5650	7500	36300	38I50	32500		38I50		36300
I-2	3700	I680	840	2400	5380	6940	6I00		6940		5380
3-4	5550	2520	I260	3450	8070	I0260	9000		I0260		8070
5-6	7400	3360	I680	4500	I0760	I3580	II900		I3580		I0760
7-8	9250	4200	2I00	5500	I3450	I6850	I4750		I6850		I3450
9-I0	0	0	0	0	0	0	0		0		0

2-3	5240	2370	I185	3500	7610	9925	8740	9925	7610
4-5	6650	3020	1510	4100	9670	12260	10750	12260	9670
,6-7	8300	3760	1880	5000	12060	15180	13300	15180	12060
8-9	9950	4500	2250	6000	14450	18200	15950	18200	14450

DESIGN OF MEMBERS

Members	Stress	Req.Area in 2	Section	Area in2	Number of rivets
I R	50510	2.52	2Ls 3X21/2XI/4	2.62	7 3/4 RIVETS Hole 7/8 pitch 3
3 R	43570	2.I8	2Ls 3X2 I/2XI/4	2.62	6 " " " " "
5 R	37660	I.88	2Ls 3X2I/2XI/4	2.62	6 " " " " "
7 R	32280	I.6I	2Ls 3X2I/2XI/4	2.62	5 " " " " "
9 R	26900	I.34	2Ls 3X2I/2XI/4	2.62	4 " " " " "
I B	57I50	4.95	2Ls 4X3X3/8	4.96	6 " " " " "
2 C	58200	5.00	2Ls 4X3X3/8	4.96	6 " " " " "
4 D	5I400	4.45	2Ls 4X3X3/8	4.96	5 " " " " "
6 E	44600	3.90	2Ls 4X3X3/8	4.96	4 " " " " "
8 F	38I50	3.3	2Ls 4X3X3/8	4.96	4 " " " " "
I 2	6940	0.62	2Ls I3/4XI/4XI/8	0.72	2 " " " " "
3 4	I0260	I.85	2Ls 2I/2X2X3/8	3.I	2 RIVETS " " "
5 6	I3580	2.44	2Ls 2I/2X2X3/8	3.I	2 RIVETS
7 8	I6850	3.02	2Ls 2I/2X2X3/8	3.I	2 RIVETS " " "
9 I0	0	0	0	0	0
2 3	9925	0.495	2Ls I3/4XII/4X3/I6	I.06	2 RIVETS " " "
4 5	I2260	0.6I	2Ls I3/4XII/4X3/I6	I,06	3 RIVETS " " "
6 7	I5I80	0.76	2Ls I3/4XII/4X3/I6	I.06	3 RIVETS " " "
8 9	I8200	0.9I	2Ls I3/4XII/4X3/I6	I,06	4 RIVETS. " " "

DESIGN OF MEMBERS

Members	Stress	Req.Area in 2	Section	Area in2	Number of rivets
: I R	50510	2.52	2Ls 3X2 1/2X1/4	2.62	7 3/4 RIVETS Hole 7/8 pitch 3
: 3 R	43570	2.18	2Ls 3X2 1/2X1/4	2.62	6 " " " " "
: 5 R	37660	I.88	2Ls 3X21/2X1/4	2.62	6 " " " " "
: 7 R	32280	I.6I	2Ls 3X2I/2X1/4	2.62	5 " " " " "
: 9 R	26900	I.34	2Ls 3X2I/2XI/4	2.62	4 " " " " "
: I B	57I50	4.95	2Ls 4X3X3/8	4.96	6 " " " " "
: 2 C	58200	5.00	2Ls 4X3X3/8	4.96	6 " " " " "
: 4 D	5I400	4.45	2Ls 4X3X3/8	4.96	5 " " " " "
: 6 E	44600	3.90	2Ls 4X3X3/8	4.96	4 " " " " "
: 8 F	38I50	3.3	2Ls 4X3X3/8	4.96	4 " " " " "
: I 2	6940	0.62	2Ls I3/4X1/4X1/8	0.72	2 " " " " "
: 3 4	I0260	1.85	2Ls 21/2X2X3/8	3.I	2 RIVETS " " "
: 5 6	I3580	2.44	2Ls 2I/2X2X3/8	3.I	2 RIVETS
: 7 8	I6850	3.02	2Ls 2I/2X2X3/8	3.I	2 RIVETS " " "
: 9 I0	0	0	0	0	0
: 2 3	9925	0.495	2Ls I3/4XI1/4X3/I6	I.06	2 RIVETS " " "
4 5	I2260	0.6I	2Ls I3/4XI1/4X3/I6	I,06	3 RIVETS " " "
6 7	I5I80	0.76	2Ls I3/4XI1/4X3/I6	I.06	3 RIVETS " " "
8 9	I8200	0.9I	2Ls I3/4XI1/4X3/I6	I,06	4 RIVETS. " " "

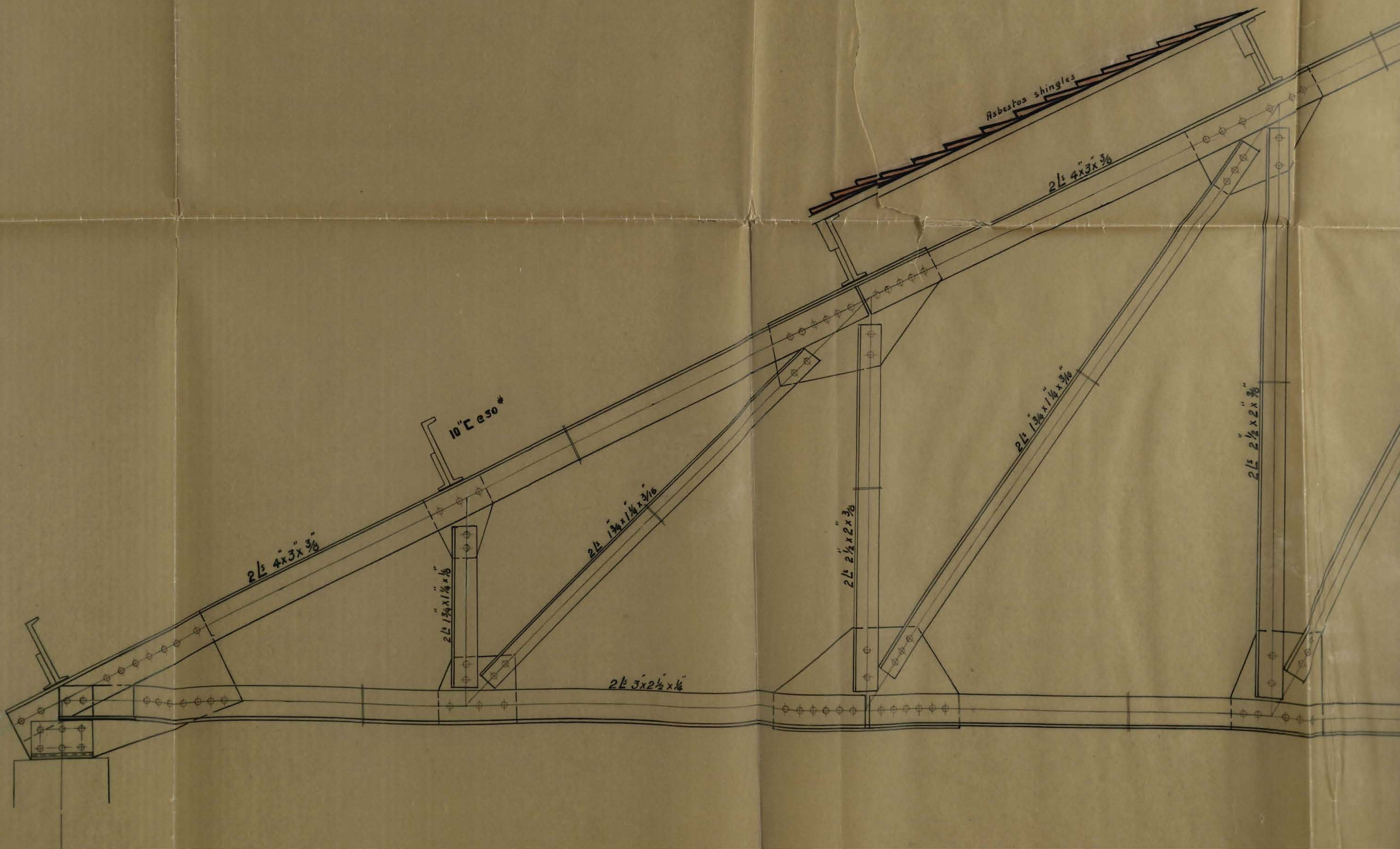
TRUSS

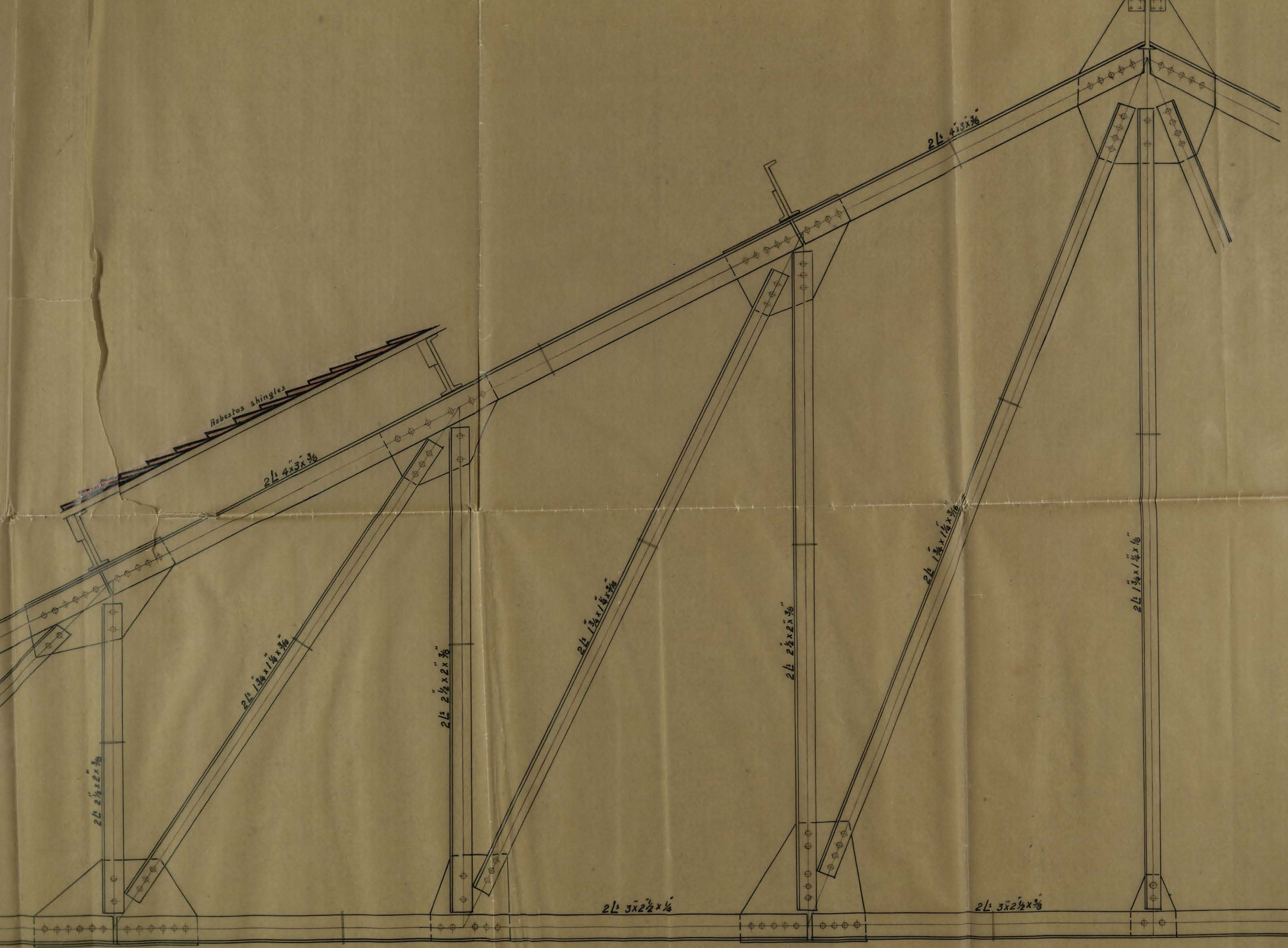
DESIGNED. By Mr J. Ma'aKarun

June: 1947

Scale: 1' = 1.5 cm

A.I.S.C speci.
3/4" rivets 7/8" hole
3/8" G.pl.





Asbestos shingles
2L̲s 4"x3"x3/8"
2L̲s 4"x3"x3/8"
2L̲s 2½"x2"x3/8"
2L̲s 1¾"x1¼"x3/16"
2L̲s 2½"x2"x3/8"
2L̲s 1¾"x1¼"x3/16"
2L̲s 2½"x2"x3/8"
2L̲s 1¾"x1¼"x3/16"
2L̲s 1¾"x1¼"x1/4"
2L̲s 3"x2½"x1/4"
2L̲s 3"x2½"x3/8"