PLAN OF A MODERN AIRPORT AT BAGHDAD

ISAAC S. SHINA

A THESIS.

P L A N O F A M O D E R N A I R P O R T A T B A G H D A D.

By

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PREFACE.

This thesis is intended to present, in a brief and concise manner, the fundamental principles involved in the planning of a modern airport for Baghdad.

In the attempt to insure accuracy, various professors were consulted and asked to criticize the design.

I am deeply indebted to the following for their help in the preparation of this thesis: Prof. J. R. Osborn (Chairman of the Engineering Department at the American University of Beirut); Profs I. A. Rubinsky, E. J. Romanski , K. K. Yeramian and N. E. Manasseh of the Engineering Department at the American University of Beirut.

Many thanks are also due to the United States Information Service Library for supplying me with valuable references.

I. S. SHINA.

Beirut,
June 1947.

INTRODUCTION.

Not very long ago, aviation was in an experimental stage, nowadays, aviation is undergoing rapid progresses due to the increase in the need for it as a means of express transportation.

A well conceived and a flexible master plan must be drawn up at the very beginning when studying the program of airport construction.

In the past, it was thought that in airport construction, the draining, lighting, and the construction of the buildings and runways were unrelated problems. Now, in order to have the airport function smoothly, all the elements should be interrelated and planned together at the start.

The airport should be a recreation center at the same time when fulfilling its duty as an exchange between surface and air transportation. Observation terraces, a spacious dining room, a nice coffee shop etc., all these offer pleasant times to the passengers or non passengers.

"The two groups who have most to do with the solution of the air terminal problem now and in the future are the airlines, who use the airports, and the cities, who own the facilities." (1)

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(1) "What's wrong with our air terminals" by Mr. Marc Thompson. Architectural Forum . Jan. 1946. Page 123.

"The average air traveller thinks not of the now-accepted freedom of the blue skies, but of the series of unscheduled waits every plane journey entails: buying a ticket, transportation to the airport, keeping up with luggage, checking in, waiting to take off. He thinks too of the disagreeable standing in line, of crowded taxis and confusing buildings, of dashes through rain or snow to and from the plane, of no place to sit. And he remembers the ugliness of it all: cramped downtown offices, rides through city slums to equally hideous airports, overlapping buildings in every style, dirty interiors badly lighted, badly ventilated and badly designed."(1)

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(1) "What's wrong with our air terminals" by Mr. Marc Thompson. Architectural Forum . Jan. 1946. Page 124.

CHOICE OF THE PROBLEM.

From its geographical position, Iraq forms a good center for world airways. Baghdad -the capital- is situated on the banks of the Tigris river with its major part on the East bank. Two big steel bridges connect both sides of the river. Baghdad has only one civil airport situated on the West bank of the river about two kilometers from the center of the city. Modern planes are not able to land over these present runways because they are not long enough to provide the distance required by these heavy planes to land and take off.

The airway station is a small one with not enough facilities and which becomes very crowded in a rush time.

Nowadays the present Baghdad civil airport is accomodating 15-25 planes daily. This number evidently will increase in the near future due to the increase in the number of the passengers following the decrease of the transportation costs, besides the increase in the number of the planes themselves following the ease of production after the war is over.

The new proposed airport is situated at about three and a half kilometers from the center of the city on the west side of the river. It covers an area of about 800 acres, which is almost flat. To the East of this area run Iraq's two main railway lines: Baghdad-Basrah to the South, and Baghdad-Mosul to the North.

The airport site is located on the highway across the Syrian-Iraqian desert, hence the cars coming from Syria will be inspected in this place too. The future progress of commercial air transportation necessitates Baghdad to have a modern airport with a big airway station and long runways able to cope with the future conditions. Adequate provision to a further expansion of the new airport has been accounted for by using a large area for the airport and by the ease of enlarging the airway station itself.

OUTLINE OF THE PROBLEM.

The following headings comprise the main points which must be studied when developing a plan for an airport.

1- Providing the necessary money.

2- Selecting the airport site.

3- Planning of the airport layout.

The airport construction includes:

a) Clearing of the landing area.

b) Grading of the landing area.

c) Laying the drainage structures.

d) Constructing the runways.

e) Installing the lighting system.

f) Constructing the airway station and the hangars.

g) Installing the instrument landing aids.

The main points which I shall endeavour to take up in my discussion are: The selection of the airport site, the planning of the airport layout, the laying of the drainage structures, the construction of the runways, the hangars and the airway station construction.

The following plans will be presented:

1- Runway plan with the location of hangars and airway station.

2- Drainage plan of the area.

3- Plans of a four-storey airway station.

4- Main facades.

5- Perspective.

6- Section of the concrete runway with details.

GENERAL INDICATIONS
about the
SELECTION OF THE AIRPORT SITE.

When selecting the site for an airport, the following poi - nts should be investigated.

1- SIZE :

Municipal airports at focal points should be 640 acres in area (1 sq. mile) or more providing marginal areas for future expansion. It is always essential to provide landing areas large enough for the operation of the aircraft to be accomodated under the most unfavorable conditions likely to prevail.

2- TOPOGRAPHY AND PHYSICAL SURROUNDINGS :

The airport site should be reasonably level to reduce to a minimum the cost of gradi-ng. The effective length of the landing area available is reduced when vertical obstructions are present in the appro-aches to the airport, and thus it is necessary to provide a larger area than would be necessary if those obstructions did not exist.

3- ALTITUDE OR ELEVATION ABOVE SEA LEVEL :

The altitude of the airport site above sea level influences to a great extent the length of the runways and consequently the area of the air-port site. Airplanes land and take off at higher speeds and climb at flatter angles as the altitude above sea level increases. This is due to the normal decrease in the lifting effect of the air on the wings and the effects on certain type of motor, resulting in a decrease of the horsepower delivered.

"For every 1000 feet above sea level, the runway length is increased 500 feet." (1)

"Owing to the increased rarity of the atmosphere at increasing altitudes, other factors being equal, a plane would need double the take off run which is needed ar sea level to rise from the ground at an altitude of about 7500 feet and proportiomately longer or shorter runs at altitudes above or below 7500 feet."(2)

4- METEOROLOGICAL CONDITIONS .

a) Temperature:

A longer run before the take off is required on a very hot day, as a result of decreased air density due to the temperature effect alone and the rate of climb will be decreased.

b) Barometric pressure:

A decrease in barometric pressure necessitates a longer run due to the decrease in density.

5- ORIENTATION :

The longest airport dimension should normally lie in the direction of the prevailing wind and open air approaches.

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(1) "Military Airfields" Construction and design problems. by James H. Stratton, M. A.S.C.E. Transactions A.S.C.E. (1945). Paper No. 2247 Page 692.

(2) "Airports" Some elements of design and future development. by John Walter Wood , Copyright 1940 Page 10.

6- <u>RELATION TO TRANSPORTATION</u> :

The airport site should be situated reasonably close to a focal point of existing and projected systems of air and surface transportation.

7- <u>COMMUNICATION</u> :

The airport should be connected to the city by an express highway.

8- <u>SOIL</u> :

In order to convey the rain water to the underground drainage structures, a porous soil is an important element. The soil should be soft enough to facilitate excavation for the drainage structures and firm enough to form a compact bed for the runways.

9- <u>LOCAL FACILITIES</u> :

The presence of nearby materials of construction (bricks, gravel and sand pits) reduces the cost of construction. The two sources of power - water and electricity - when present and available, together reduce the cost of operation, because water is important to condition the turf or some other kind of grass which is grown in the airfield to avoid dust and to bind the soil, and electricity to light the various lighting systems of the landing areas.

10-<u>EXPANSION</u> :

The airport site should be flexible, that is, it should provide an easy matter for future expansion. However it is an easy problem to account for it beforehand by preparing marginal areas around the airport area which can in the time where they are not yet needed be developed into entertaining areas such as athletic fields or even race course s or the like which may constitute a good source of income for the airport.

11-COST :

"A well conceived plan is worth many times its cost", says a competent architect.[1] It is necessary always to forecast future developments and the way to incàrporate the future expansions with the present installations.

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(1) Mr. Marc Thompson in an article "What's wrong with our air terminals" . Forum , January 1946.

RUNWAYS.

Layout :

The runways are an integral part of the airport in operation. They should be incorporated into the carefully unified airport plan.

Orientation :

The orientation of airport runways depends upon the variation in the local conditions at airports - prevailing winds, force and direction of winds, height, size, position of buildings and other physical obstructions. The runway should be oriented parallel to the prevailing wind of the locality, hence a study of wind conditions at the airport should be based upon a 10-year record of the meteorological station if possible. The airport section of the Civil Aeronautics Board specifies that there should be a sufficient number of runways to permit landings and take offs to be made within 22½ degrees of the true wind direction above 5 miles an hour for 75% of the time for class 1 airports, 80% of the time for class 2 airports, and 90% of the time for class 3 and class 4 airports. Class 3 and class 4 airports are for transport operation.

Length :

The Civil Aeronautics Board recommends the use of the following tentative classification for airports.

Planning classification	Length of landing strip in feet	Glide path approach to ends of runways
1	1800-2500	20 to 1
2	2500-3500	30 to 1
3	3500-4500	30 to 1
4	4500 and over	30 to 1

The four classes include : Small private owner planes; large size private owner types and small transport planes; present day transport planes; the largest planes in use and those planned for the immediate future.

Overshoot of safety strip :

Usually an extra length is added to the runway for the various reasons which may be summarized as follows.

1- Mistake made by the flier in the direction of the wind.

2- Air brakes or wheel brakes may not be functioning well.

3- Mistake in the calculation of the original length of the runway.

4- A big velocity when landing.

5- Approach at big angle.

Runway patterns.: (1)

"The four main runway patterns are :

1- Tangential.

2- Triangular.

3- Unistrip.

4- Multistrip.

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(1) "Aeronautics" April 1946. Vol. 14 No. 3 Page 43.

The basic difference between the tangential, the triangular, and the multistrip patterns is that the airport buildings are centralized in the tangential pattern but are usually to one side in the other patterns.

<u>The tangential pattern</u> :

The essential advantage claimed for this type of runway has to do with the traffic movements that can be handled in safety in a given time. The aircraft should be at the greatest possible horizontal separation while they are moving fast and they should only come close together near the loading apron when their speed has been dissipated.

<u>The triangular pattern</u> :

If there is a single triangle, only one runway can be used at a time and that for only one aircraft movement, either taking off or landing. In case the main triangle is supplemented by secondary triangular plans, the result is a series of parallel runways. When using this type, there is a difficulty in making a good use of the central area emclosed within the triangle.

<u>The unistrip pattern</u> :

This pattern has proved to be an extremely practical one when used. It would not be satisfactory for a major city airport. This is essentially made very wide and intended for the take off or landing of one plane at a time.

<u>The multistrip pattern</u> :

This type approaches the tangential pattern. It differs in only minor points from the triangular pattern."

Runway surfaces :

Any of the following materials may be used for the surfacing of the runways.

1- Gravel or cinder, which are both unsatisfactory because the particles become scattered by the wind or by the traction of the plane wheels, and those flying particles may injure the planes or the onlookers.

2- Simple turf ; which has a low first cost and a high maintenance cost.

3- Bituminous concrete similar to that used on highways. Two types may be distinguished:

a) The premixed type.

b) The penetration type.

4- Portland cement concrete. This is usually used on a firm subbase. It is ideal for runways. One of its advantages is that the stresses in a concrete slab may be accurately computed.

CONCRETE PAVEMENT RUNWAY.

Factors affecting the subgrade support :

Several factors influence the bearing value of the subgrade, such as: variations in the soil moisture resulting from fluctuating ground water; deformation of the subgrade due to loading; seepage through joints etc. These influences may be taken care of by compacting the subgrade and using firm base courses.

Military airplane wheel loads for pavement design. (1)

Class	Wheel load lbs.	Contact pressure p.s.i.	Contact area sq.in.
I	60,000	75	800
II	37,000	65	570
III	15,000	55	273
IV	5,000	45	111

Base courses for concrete pavements. (2) When used in pavement designs for class I and II airfields, wheel loading values of the subgrade moduli commonly assumed in highway practice result in excessively thick pavements (10-15 in.). Such thick slabs obviously are undesirable because of the high temperature stresses that would result. Furthermore, experience has shown that concrete slabs more than 8 in. thick are inferior in the lower portion. This is due to difficulties in vibrating the concrete.

The excessively thick pavements for class I and II airfields required for subgrade of low bearing value are avoided by the use of base courses to improve the support of the pavements.

Airfield concrete sections for pavements used by Corps of Engineers.

Standards of the Corps of Engineers for concrete pavement sections are shown on design drawing handed with the set of plans. Edges are thickened only at free sides and at longitudinal expansion joints. Joint spacing are shown on the design.

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(1) and (2). "Military airfields" Construction and design probs. by James H. Stratton, M. A.S.C.E. Transactions A.S.C.E.(1945). Paper No. 2247,P.670

Factors affecting the design of concrete pavements.

The principle factors affecting the stress condition of concrete pavement slabs are the loads, temperature warping, and subgrade reaction.

Base courses:

Crushed rock, gravelly and sandy soils, varieties of gravels are used alone or mixed together to provide base courses.

Widths and grades of runways.

The normal width is 500 feet of graded area, of which the center 150 feet is paved. Sometimes 75 feet shoulders on either side of the paved strip are allowed.

Maximum allowable grades are as follows: For runways 1.5% longitudinal and transverse; for turfed all over field 3% in any direction. When runways are designed for 120,000 lb. gross load, the maximum allowable longitudinal grade is 1% although 0.5% is preferred.

Pavement thickness:

According to specifications, pavement thickness are not less than 1.5 in. for wheel loads up to [illegible], 15,000 lb.; and not less than 3 in. for wheel loads up to 37,000 lb. For wheel loads exceeding 37,000 lb. the thicknesses are designed in accordance with the requirements in each specific case, but in general do not exceed 6 inches.

Design of concrete pavements:(1)

"For unfavorable subgrade conditions, the use of thicker slabs with steel reinforcement cannot

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(1) A. Casagrade, M. A.S.C.E. Transactions (1945) Page 687.

be avoided.

Warping stresses might be controlled by a sufficiently small size of the slabs say 12 by 12 feet for a pavement 12 in. thick.

The wire mesh reinforcement will preferably be used in two layers spaced about 3 inches from the top and bottom of the slab. Some additional reinforcement in the top of the pavement should be provided at the corners."

AIRPORT BUILDINGS.

The airport buildings should be centrally located with respect to the entire airport and to the runways and should be in position to:

1- Facilitate a unified airport control.

2- Be within reasonable distances from the other buildings.

3- Provide a free air approach for the planes.

Airway station:

It is necessary in the design of the buildings to obtain the greatest efficiency. It is of prime importance that all traffic approaching the terminal area should be routed to destination in the minimum of time, at the same time cross traffic should be avoided for vehicles and pedestrians.

The airport station should be in key position in regard to runways, the building should be planned for expansion, should be functional and expressive of air transportation.

Hangars:

They should be located so as to provide for a smooth plane traffic circulation and situated on a relatively narrow airport frontage and yet enough spaced from each other to avoid the spread of fire from one to another and also not to limit the free movement of larger planes.

The hangar should also provide for expansion of the plane storage area and for the increase in the clear door heights in order to be able to accomodate for an increase in plane wing span and height.

Apron:

It is an important part in the airport layout. It should be planned to accomodate all the planes which may be berthed at one time. In this place the passengers and cargo finally board or leave the plane.

DRAINAGE FACILITIES.

A drainage system for an airfield serves the three following functions:

1- To remove ground water flow from the airfield area.

2- To collect and divert the surface and ground water flow originating from lands adjacent to the airfield area.

3- To remove the surface runoff from the field.

When designing the airport drainage structures, informations must be obtained about the character of the soil and the subgrade, nature of the future development plan of the airport, existing surface grades, high and low water level, rainfall and snowfall characteristics of the locality, approximate final grades, and various other minor informations.

In the case of a pervious soil, e.g. sand and gravel, the water is readily absorbed into the soil when an adequate subsurface drainage is installed.

In a nonporous soil such as clay, the field should be steep enough to provide a good gradient enough to make the water run off rapidly but not very steep as to cause surface erosion.

Some airports use hundreds of miles of subsurface drainage structures varying in diameter from 3 inches to 10 feet mains.

<u>Tile drainage</u>:

The main difference distinguishing between tile drains and other conduits is that water enters at every joint all along the line (for small tile at 1-ft. intervals.).

a) <u>Slope</u>:(1)

"A fall of 1/10 foot per 100 feet is as flat as tile should, as a general rule, be placed, and it will be found difficult to maintain even this grade, A fall of 3/10 foot per 100 feet is a nice grade to work to, and, of course, for falls greater than this, the tile is correspondingly easier to install.

b) <u>Spacing</u>:

In close dense soils, largely clay, 30 to 40 feet is a good spacing; in sandy soils etc. the spacing is correspondingly larger.

c) <u>Depth</u>:

The depth of tile drains laterals varies from 18 in. to 4 feet."

Of course several other points have to be considered, such as: The total area to be drained, the size of the nonpermeable areas (the runway pavements and aprons) which must be drained, the speed with which drainage must be accomplished, and the compressive loads transmitted to the drainage structures by the weight of plane wheels passing over them.

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(1) "Land drainage and reclamation" by Ayres and Scoates (1928) Page 341.

BAGHDAD AIRPORT.

Baghdad is nearly 35 m. above sea level, its population is something above 500,000 .

Airport:

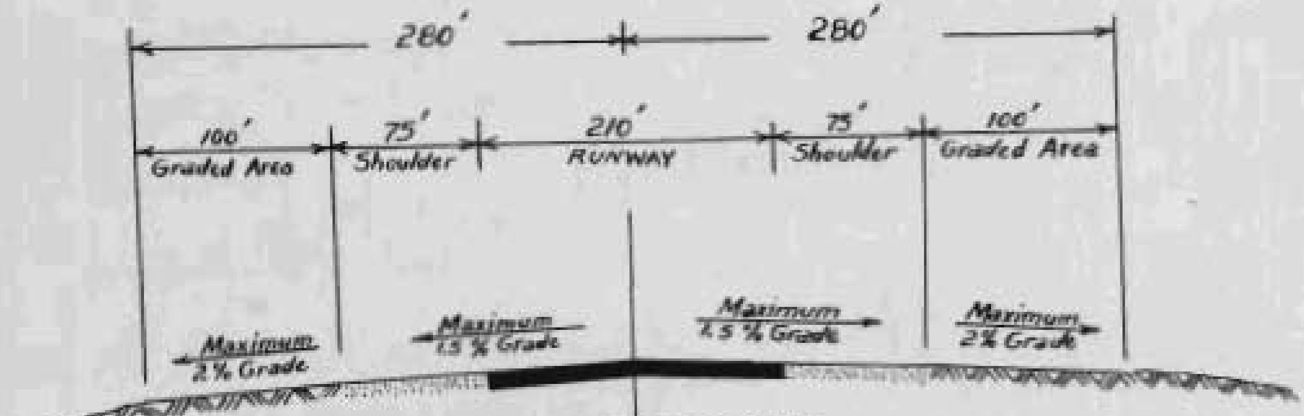
The new proposed airport lies on the west bank of the Tigris river, approximately 3½ Km. from the center of the city.

The 800 acres airfield (about 325 hectares) lies on a relatively flat ground near the old airport actually existing.

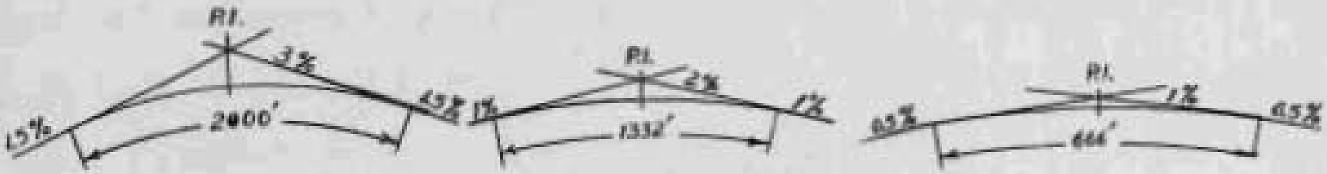
Landing area:

There are three runways which measure respectively 2.000 Km; 1.500 Km; and 1.325 Km. in length. The first one is provided with 250 m. overshoot (safety strip) on both ends to take care of possibilities of accidents. It is of a concrete pavement 65 m. wide with 75 ft. shoulders and 100 ft. of graded area on both sides. The thickness of the concrete pavement is 7 inches. A transverse section and a plan ~~is~~ are/ shown on the next page indicating the sizes and the maximum grades permissible by the American Corps of Engineers in military airfields.

The other two runways are of bituminous concrete pavement 5 cm. thick . They are 50 m. wide with 50 ft. shoulders and 75 ft. of graded area on both sides. The longer runway lies in the ~~d~~ direction of the prevailing wind being north west and having a maximum velocity of 78 M.P.H.



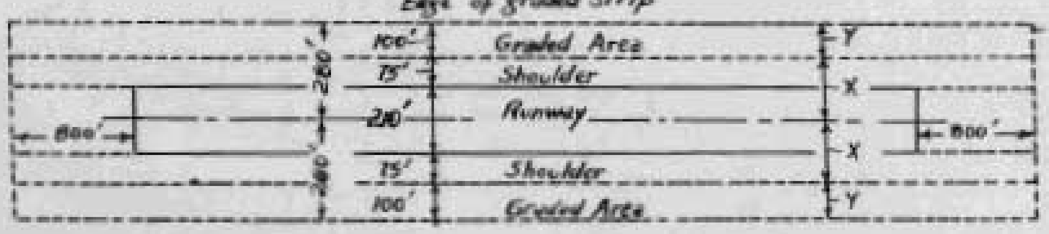
TRANSVERSE SECTION



LONGITUDINAL SECTIONS

Showing three examples of permissible grade changes.

Edge of graded strip



Max. longit. Grade in Area X or Y = 1.5 % (1% for 126,000# wheel load)

" trans. " " " Y = 2 % ; in Area X = 1.5 %

Longit. grade changes in Area X { Min. dist. between P.I. = 1000'
" vert. curve = 666' per each 1% Algebraic diff.

" " " " " Y at edge of graded strip { Max. Algebraic diff. = 2 %
Min. Curve = 300' (Min. dist. between P.I.s = 300')

No base course is provided because there is no necessity for it since the clay is firm enough to support the pavement above it.

The transverse grade will be made as shown on the section being 1½% for the runway and shoulder and 2% for the graded area. The longitudinal grade will be 1% maximum where needed because the ground is almost flat.

Airway station:

The building is a framed structure and the walls are of bricks. Exterior walls are made 35 cm. thick (one brick and a half) ; and interior ones are made 23 cm. thick.

The station measures 120 m. by 42 m. It is a four story high building. It has a total height of 20 m.

According to the informations which I obtained about the region where the building is to be erected, water may be found at a depth of 3 m. from the surface of the soil. Hence it will be very difficult to pour foundations under water especially because the ground is clay which is very detrimental to the concrete. On the other hand, the bearing power of the soil is low and according to the experience prevailing at Baghdad several buildings have failed because of no adequate foundations. Nowadays piles are used more extensively especially for big public buildings, and for this airway station, piles are going to be used. The way in which they are going to be used will be the general one in practice at Baghdad i,e. ~~gxxxxxx xf fxxx~~ 6 in.dia. steel shell piles filled with concrete. These piles are driven with pneumatic hammers. The length of the piles will be 25 ft. which is the common length used in practice there.

The ground floor comprises various services. It has a coffee shop, a mail room, an inspection room, a medical examination room, a storage room, ticket offices, lounge, a fire fighting station and various other utilities. Besides all these, there is a large waiting hall extending two stories in height. It covers an area of 870 sq. m. There are eight columns inside the hall to support the roof above which is of beam, girder and slab construction. The size of the hall is big because it is necessary to accomodate for a great number of passengers especially in a rush time when car convoys coming from Syria bring the over land passengers and at the same time having air passengers arriving or taking off. The ticket offices open to the main hall with counters in front of them.

Passengers enter the airway station from a main large entrance door and there are two other doors for luggage.

All measures pertaining to the comfort of the passengers have been taken. There is an ease in circulation inside the airway station, corridors are 3 m. in width. Doors inside the airway station are wide, their widths differ with the function of the rooms to which they open.

Enough lighting is insured for the rooms by the large openings to the outside.

In order to add to the convenience of the airway station, it will be air conditioned because of the extremely hot weather which prevails in Baghdad in summer.

The concourse is incorporated with the main building. It is about 6 m. in width extending all along the building. It is 2-story high in the middle portion and 1-story high on both sides. It overlooks the field; four doors open to it, two from the waiting hall and the other two from the sides; in turn it opens to the field through four doors. There is a colonnade all along the concourse. These columns support the terrace slab in the upper story. The middle seven columns go up two stories in height while those to the sides go up 1 story in height only. The concourse's wall to the outside is receded from the columns by a short distance and it is made of a 1 m. high masonry wall and the rest is made of glass which goes high up to the roof slab.

The first floor houses a few rooms for the lodging of some passengers, a pilots dormitory, weather bureau offices, a dining room and a large public observation terrace overlooking the field on three sides. The other two stories house the various x airport offices and the control room.

In order to protect from direct sun rays, especially in summer, modern shutters will be installed in the windows.

Bathrooms which do not have an opening to an outside wall will be aerated by ducts. The door opening to the bath will be made a bit higher than the level of the floor, so the air can enter from below the door and be sucked by the duct to the roof.

The ground floor comprises the following rooms with their respective areas indicated in front of them.

GROUND FLOOR.

ROOM	AREA in sq. m.
Waiting hall	870
Passengers luggage examination room	210
Coffee shop	150
Customs office	85
Outbound luggage storage	78
Passport control office	80
Commissary	40
Barber shop	37
Kitchen	27
Pantry	11
Store	9
Post office working room	210
Medical examination & first aid room	54
Lounge	155
Air police station	76
Dormitory	70
Ambulance car & fire fighting station	148
Kitchen	22
Bathroom & W.C	20
4 ticket offices x22	88
2 toilets x12	24
2 stair cases x30	60
Janitor room below the stairs.	
Concourse	675

The first floor comprises the following rooms with their respective areas indicated in front of them.

FIRST FLOOR.

ROOM	AREA in sq. m.
Dining room	225
Lounge & Library with toilet	80
Storage for dining room	65
7 bed rooms with toilets	100
2 toilets x12	24
2 spaces for stair cases x30	60
2 stair cases x16.5	33
5 travel offices	106
Meteorology department	56
Radio room	56
Office	14
Technical library	21
Toilet	10
Rest room	27
Storage room	65
Pilots dormitory with toilet	80
Small waiting room	15
Secretaries room	15
Typists room	19
Accountant room	18
Officer room	18
Chief engineer's office	22
Toilet	8

The second floor comprises the following rooms with their respective areas indicated in front of them.

SECOND FLOOR.

ROOM	AREA in sq. m.
2 stair cases x16.5....................................	33
Operations manager's office...........................	29
Airport manager's office..............................	25
Teletype room...	21
1 stair case x16.5....................................	16.5
Observation room......................................	21
Communication room....................................	25
Air traffic room......................................	29
Waiting room..	26
Analysis room...	20
Technical instruments room............................	18
Files room..	18
Rest room...	20
Typists room..	26
2 toilet rooms x13.5..................................	27

The third floor comprises the following rooms with their respective areas indicated in front of them.

THIRD FLOOR.

ROOM	AREA in sq. m.
1 stair case room x16.5...............................	16.5
Operation room..	32
Control room..	32
Rest room...	18
Phones room...	18

Hangars:

Four hangars are proposed. The overall dimensions of each are 84 by 50 m., the overall height is 20 m. For every hangar there will be one opening having net dimensions of 70 by 13 m. One of these hangars is functioning as a major workshop and it has an extra space of 50 by 10 m. In this hangar repair work and maintenance of both aircraft and engines is done. There will be a private hangar having overall dimensions of 70 by 30 m. and an overall height of 10 m. It has three openings measuring clear dimensions of 18 by 6 m.

Plane fueling:

In order to fuel the planes, there are pumps driven electrically at points along the concrete apron which deliver the gasoline through hoses contained in chambers set flush with the surface of the field. Gasoline is stored in underground tanks of specified capacity.

Drainage system:

The nature of the airfield's soil is clay; the average annual rainfall is 6 in. and the intensity is ¼ in. per hour.

Since we want to get rid of the rain water as soon as possible and since the ground is relatively flat and impervious, a drainage system composed of tile drains is necessary. The herringbone system is used, shown in the accompanying drainage plan. The spacing between the laterals is 12 m. and the length of the laterals is about 200 m. The diameters of the tile drains are shown on the above mentioned plan. The slope of the tile drains is made 3/10 feet per 100 feet, and their depth from the surface of the soil will be 80 cms. There are two mains which collect the water from the submains and these in their turn discharge through 50 cm. concrete pipes to the Mashash river which in turn discharges in-to the Tigris river.

The position of the airway station has been so chosen as to insure a clear visibility and control of the field. Parking areas for cars are available in fromt of the airway station. Traffic to the airway station enters from the main highway through a junction and leaves it from another junction, and so there will be no traffic congestion in the airport area.

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PREFACE.

This thesis is intended to present, in a brief and concise manner, the fundamental principles involved in the planning of a modern airport for Baghdad.

In the attempt to insure accuracy, various professors were consulted and asked to criticize the design.

I am deeply indebted to the following for their help in the preparation of this thesis: Prof. J. R. Osborn (Chairman of the Engineering Department at the American University of Beirut); Profs I. A. Rubinsky, E. J. Romanski , K. K. Yeramian and N. E. Manasseh of the Engineering Department at the American University of Beirut.

Many thanks are also due to the United States Information Service Library for supplying me with valuable references.

I. S. SHINA.

Beirut,
June 1947.

INTRODUCTION.

Not very long ago, aviation was in an experimental stage, nowadays, aviation is undergoing rapid progresses due to the increase in the need for it as a means of express transportation.

A well conceived and a flexible master plan must be drawn up at the very beginning when studying the program of airport construction.

In the past, it was thought that in airport construction, the draining, lighting, and the construction of the buildings and runways were unrelated problems. Now, in order to have the airport function smoothly, all the elements should be interrelated and planned together at the start.

The airport should be a recreation center at the same time when fulfilling its duty as an exchange between surface and air transportation. Observation terraces, a spacious dining room, a nice coffee shop etc., all these offer pleasant times to the passengers or non passengers.

"The two groups who have most to do with the solution of the air terminal problem now and in the future are the airlines, who use the airports, and the cities, who own the facilities." (1)

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(1) "What's wrong with our air terminals" by Mr. Marc Thompson. Architectural Forum . Jan. 1946. Page 123.

"The average air traveller thinks not of the now-acdepted freedom of the blue skies, but of the series of unscheduled waits every plane journey entails: buying a ticket, transportation to the airport, keeping up with luggage, checking in, waiting to take off. He thinks too of the disagreeable standing in line, of crowded taxis and confusing buildings, of dashes through rain or snow to and from the plane, of no place to sit. And he remembers the ugliness of it all: cramped downtown offices, rides through city slums to equally hideous airports, overlapping buildings in every style, dirty interiors badly lighted, badly ventilated and badly designed."(1)

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(1) "What's wrong with our air terminals" by Mr. Marc Thompson. Architectural Forum . Jan. 1946. Page 124.

CHOICE OF THE PROBLEM.

From its geographical position, Iraq forms a good center for world airways. Baghdad -the capital- is situated on the banks of the Tigris river with its major part on the East bank. Two big steel bridges connect both sides of the river. Baghdad has only one civil airport situated on the West bank of the river about two kilometers from the center of the city. Modern planes are not able to land over these present runways because they are not long enough to provide the distance required by these heavy planes to land and take off.

The airway station is a small one with not enough facilities and which becomes very crowded in a rush time.

Nowadays the present Baghdad civil airport is accomodating 15-25 planes daily. This number evidently will increase in the near future due to the increase in the number of the passengers following the decrease of the transportation costs, besides the increase in the number of the planes themselves following the ease of production after the war is over.

The new proposed airport is situated at about three and a half kilometers from the center of the city on the west side of the river. It covers an area of about 800 acres, which is almost flat. To the East of this area run Iraq's two main railway lines: Baghdad-Basrah to the South, and Baghdad-Mosul to the North.

The airport site is located on the highway across the Syrian-Iraqian desert, hence the cars coming from Syria will be inspected in this place too. The future progress of commercial air transportation necessitates Baghdad to have a modern airport with a big airway station and long runways able to cope with the future conditions. Adequate provision to a further expansion of the new airport has been accounted for by using a large area for the airport and by the ease of enlarging the airway station itself.

OUTLINE OF THE PROBLEM.

The following headings comprise the main points which must be studied when developing a plan for an airport.

1- Providing the necessary money.

2- Selecting the airport site.

3- Planning of the airport layout.

The airport construction includes:

a) Clearing of the landing area.

b) Grading of the landing area.

c) Laying the drainage structures.

d) Constructing the runways.

e) Installing the lighting system.

f) Constructing the airway station and the hangars.

g) Installing the instrument landing aids.

The main points which I shall endeavour to take up in my discussion are: The selection of the airport site, the planning of the airport layout, the laying of the drainage structures, the construction of the runways, the hangars and the airway station construction.

The following plans will be presented:

1- Runway plan with the location of hangars and airway station.

2- Drainage plan of the area.

3- Plans of a four-storey airway station.

4- Main facades.

5- Perspective.

6- Section of the concrete runway with details.

GENERAL INDICATIONS
about the
SELECTION OF THE AIRPORT SITE.

When selecting the site for an airport, the following poi - nts should be investigated.

1- SIZE :

Municipal airports at focal points should be 640 acres in area (1 sq. mile) or more providing marginal areas for future expansion. It is always essential to provide landing areas large enough for the operation of the aircraft to be accomodated under the most unfavorable conditions likely to prevail.

2- TOPOGRAPHY AND PHYSICAL SURROUNDINGS :

The airport site should be reasonably level to reduce to a minimum the cost of gradi-ng. The effective length of the landing area available is reduced when vertical obstructions are present in the appro-aches to the airport, and thus it is necessary to provide a larger area than would be necessary if those obstructions did not exist.

3- ALTITUDE OR ELEVATION ABOVE SEA LEVEL :

The altitude of the airport site above sea level influences to a great extent the length of the runways and consequently the area of the air-port site. Airplanes land and take off at higher speeds and climb at flatter angles as the altitude above sea level increases. This is due to the normal decrease in the lifting effect of the air on the wings and the effects on certain type of motor, resulting in a decrease of the horsepower delivered.

"For every 1000 feet above sea level, the runway length is increased 500 feet." (1)

"Owing to the increased rarity of the atmosphere at increasing altitudes, other factors being equal, a plane would need double the take off run which is needed ar sea level to rise from the ground at an altitude of about 7500 feet and proportionately longer or shorter runs at altitudes above or below 7500 feet."(2)

4- METEOROLOGICAL CONDITIONS .

a) Temperature:

A longer run before the take off is required on a very hot day, as a result of decreased air density due to the temperature effect alone and the rate of climb will be decreased.

b) Barometric pressure:

A decrease in barometric pressure necessitates a longer run due to the decrease in density.

5- ORIENTATION :

The longest airport dimension should normally lie in the direction of the prevailing wind and open air approaches.

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(1) "Military Airfields" Construction and design problems. by James H. Stratton, M. A.S.C.E. Transactions A.S.C.E. (1945). Paper No. 2247 Page 692.

(2) "Airports" Some elements of design and future development. by John Walter Wood , Copyright 1940 Page 10.

6- <u>RELATION TO TRANSPORTATION</u> :

The airport site should be situated reasonably close to a focal point of existing and projected systems of air and surface transportation.

7- <u>COMMUNICATION</u> :

The airport should be connected to the city by an express highway.

8- <u>SOIL</u> :

In order to convey the rain water to the underground drainage structures, a porous soil is an important element. The soil should be soft enough to facilitate excavation for the drainage structures and firm enough to form a compact bed for the runways.

9- <u>LOCAL FACILITIES</u> :

The presence of nearby materials of construction (bricks, gravel and sand pits) reduces the cost of construction. The two sources of power - water and electricity - when present and available, together reduce the cost of operation, because water is important to condition the turf or some other kind of grass which is grown in the airfield to avoid dust and to bind the soil, and electricity to light the various lighting systems of the landing areas.

10-<u>EXPANSION</u> :

The airport site should be flexible, that is, it should provide an easy matter for future expansion. However it is an easy problem to account for it beforehand by preparing marginal areas around the airport area which can in the time where they are not yet needed be developed into entertaining areas such as athletic fields or even race course s or the like which may constitute a good source of income for the airport.

11-<u>COST</u> :

"A well conceived plan is worth many times its cost", says a competent architect.[1] It is necessary always to forecast future developments and the way to incàrporate the future expansions with the present installations.

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(1) Mr. Marc Thompson in an article "What's wrong with our air terminals" . Forum , January 1946.

RUNWAYS.

Layout :

The runways are an integral part of the airport in operation. They should be incorporated into the carefully unified airport plan.

Orientation :

The orientation of airport runways depends upon the variation in the local conditions at airports - prevailing winds, force and direction of winds, height, size, position of buildings and other physical obstructions. The runway should be oriented parallel to the prevailing wind of the locality, hence a study of wind conditions at the airport should be based upon a 10-year record of the meteorological station if possible. The airport section of the Civil Aeronautics Board specifies that there should be a sufficient number of runways to permit landings and take offs to be made within 22½ degrees of the true wind direction above 5 miles an hour for 75% of the time for class 1 airports, 80% of the time for class 2 airports, and 90% of the time for class 3 and class 4 airports. Class 3 and class 4 airports are for transport operation.

Length :

The Civil Aeronautics Board recommends the use of the following tentative classification for airports.

Planning classification	Length of landing strip in feet	Glide path approach to ends of runways
1	1800-2500	20 to 1
2	2500-3500	30 to 1
3	3500-4500	30 to 1
4	4500 and over	30 to 1

The four classes include : Small private owner planes; large size private owner types and small transport planes; present day transport planes; the largest planes in use and those planned for the immediate future.

<u>Overshoot of safety strip</u> :

Usually an extra length is added to the runway for the various reasons which may be summarized as follows.

1- Mistake made by the flier in the direction of the wind.

2- Air brakes or wheel brakes may not be functioning well.

3- Mistake in the calculation of the original length of the runway.

4- A big velocity when landing.

5- Approach at big angle.

<u>Runway patterns.</u>:(1)

"The four main runway patterns are :

1- Tangential.

2- Triangular.

3- Unistrip.

4- Multistrip.

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(1) "Aeronautics" April 1946. Vol. 14 No. 3 Page 43.

The basic difference between the tangential, the triangular, and the multistrip patterns is that the airport buildings are centralized in the tangential pattern but are usually to one side in the other patterns.

The tangential pattern : The essential advantage claimed for this type of runway has to do with the traffic movements that can be handled in safety in a given time. The aircraft should be at the greatest possible horizontal separation while they are moving fast and they should only come close together near the loading apron when their speed has been dissipated.

The triangular pattern : If there is a single triangle, only one runway can be used at a time and that for only one aircraft movement, either taking off or landing. In case the main triangle is supplemented by secondary triangular plans, the result is a series of parallel runways. When using this type, there is a difficulty in making a good use of the central area emclosed within the triangle.

The unistrip pattern : This pattern has proved to be an extremely practical one when used. It would not be satisfactory for a major city airport. This is essentially made very wide and intended for the take off or landing of one plane at a time.

The multistrip pattern : This type approaches the tangential pattern. It differs in only minor points from the triangular pattern."

Runway surfaces :

Any of the following materials may be used for the surfacing of the runways.

1- Gravel or cinder, which are both unsatisfactory because the particles become scattered by the wind or by the traction of the plane wheels, and those flying particles may injure the planes or the onlookers.

2- Simple turf ; which has a low first cost and a high maintenance cost.

3- Bituminous concrete similar to that used on highways. Two types may be distinguished:

a) The premixed type.

b) The penetration type.

4- Portland cement concrete. This is usually used on a firm subbase. It is ideal for runways. One of its advantages is that the stresses in a concrete slab may be accurately computed.

CONCRETE PAVEMENT RUNWAY.

Factors affecting the subgrade support :

Several factors influence the bearing value of the subgrade, such as: variations in the soil moisture resulting from fluctuating ground water; deformation of the subgrade due to loading; seepage through joints etc. These influences may be taken care of by compacting the subgrade and using firm base courses.

Military airplane wheel loads for pavement design. (1)

Class	Wheel load lbs.	Contact pressure p.s.i.	Contact area sq.in.
I	60,000	75	800
II	37,000	65	570
III	15,000	55	273
IV	5,000	45	111

Base courses for concrete pavements. (2)

When used in pavement designs for class I and II airfields, wheel loading values of the subgrade moduli commonly assumed in highway practice result in excessively thick pavements (10-15 in.). Such thick slabs obviously are undesirable because of the high temperature stresses that would result. Furthermore, experience has shown that concrete slabs more than 8 in. thick are inferior in the lower portion. This is due to difficulties in vibrating the concrete.

The excessively thick pavements for class I and II airfields required for subgrade of low bearing value are avoided by the use of base courses to improve the support of the pavements.

Airfield concrete sections for pavements used by Corps of Engineers.

Standards of the Corps of Engineers for concrete pavement sections are shown on design drawing handed with the set of plans. Edges are thickened only at free sides and at longitudinal expansion joints. Joint spacing are shown on the design.

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(1) and (2). "Military airfields" Construction and design probs. by James H. Stratton, M. A.S.C.E. Transactions A.S.C.E.(1945). Paper No. 2247,P.670

<u>Factors affecting the design of concrete pavements.</u>

The principle factors affecting the stress condition of concrete pavement slabs are the loads, temperature warping, and subgrade reaction.

<u>Base courses</u>:

Crushed rock, gravelly and sandy soils, varieties of gravels are used alone or mixed together to provide base courses.

<u>Widths and grades of runways</u>.

The normal width is 500 feet of graded area, of which the center 150 feet is paved. Sometimes 75 feet shoulders on either side of the paved strip are allowed.

Maximum allowable grades are as follows: For runways 1.5% longitudinal and transverse; for turfed all over field 3% in any direction. When runways are designed for 120,000 lb. gross load, the maximum allowable longitudinal grade is 1% although 0.5% is preferred.

<u>Pavement thickness</u>:

According to specifications, pavement thickness are not less than 1.5 in. for wheel loads up to [redacted], 15,000 lb.; and not less than 3 in. for wheel loads up to 37,000 lb. For wheel loads exceeding 37,000 lb. the thicknesses are designed in accordance with the requirements in each specific case, but in general do not exceed 6 inches.

<u>Design of concrete pavements:</u>(1)

"For unfavorable subgrade conditions, the use of thicker slabs with steel reinforcement cannot

....

(1) A. Casagrade, M. A.S.C.E. Transactions (1945) Page 687.

be avoided.

Warping stresses might be controlled by a sufficiently small size of the slabs say 12 by 12 feet for a pavement 12 in. thick.

The wire mesh reinforcement will preferably be used in two layers spaced about 3 inches from the top and bottom of the slab. Some additional reinforcement in the top of the pavement should be provided at the corners."

AIRPORT BUILDINGS.

The airport buildings should be centrally located with respect to the entire airport and to the runways and should be in position to:

1- Facilitate a unified airport control.

2- Be within reasonable distances from the other buildings.

3- Provide a free air approach for the planes.

Airway station:

It is necessary in the design of the buildings to obtain the greatest efficiency. It is of prime importance that all traffic approaching the terminal area should be routed to destination in the minimum of time, at the same time cross traffic should be avoided for vehicles and pedestrians.

The airport station should be in key position in regard to runways, the building should be planned for expansion, should be functional and expressive of air transportation.

Hangars:

They should be located so as to provide for a smooth plane traffic circulation and situated on a relatively narrow airport frontage and yet enough spaced from each other to avoid the spread of fire from one to another and also not to limit the free movement of larger planes.

The hangar should also provide for expansion of the plane storage area and for the increase in the clear door heights in order to be able to accomodate for an increase in plane wing span and height.

Apron:

It is an important part in the airport layout. It should be planned to accomodate all the planes which may be berthed at one time. In this place the passengers and cargo finally board or leave the plane.

DRAINAGE FACILITIES.

A drainage system for an airfield serves the three following functions:

1- To remove ground water flow from the airfield area.

2- To collect and divert the surface and ground water flow originating from lands adjacent to the airfield area.

3- To remove the surface runoff from the field.

When designing the airport drainage structures, informations must be obtained about the character of the soil and the subgrade, nature of the future development plan of the airport, existing surface grades, high and low water level, rainfall and snowfall characteristics of the locality, approximate final grades, and various other minor informations.

In the case of a pervious soil, e.g. sand and gravel, the water is readily absorbed into the soil when an adequate subsurface drainage is installed.

In a nonporous soil such as clay, the field should be steep enough to provide a good gradient enough to make the water run off rapidly but not very steep as to cause surface erosion.

Some airports use hundreds of miles of subsurface drainage structures varying in diameter from 3 inches to 10 feet mains.

Tile drainage:

The main difference distinguishing between tile drains and other conduits is that water enters at every joint all along the line (for small tile at 1-ft. intervals.).

a) Slope:(1)

"A fall of 1/10 foot per 100 feet is as flat as tile should, as a general rule, be placed, and it will be found difficult to maintain even this grade, A fall of 3/10 foot per 100 feet is a nice grade to work to, and, of course, for falls greater than this, the tile is correspondingly easier to install.

b) Spacing:

In close dense soils, largely clay, 30 to 40 feet is a good spacing; in sandy soils etc. the spacing is correspondingly larger.

c) Depth:

The depth of tile drains laterals varies from 18 in. to 4 feet."

Of course several other points have to be considered, such as: The total area to be drained, the size of the nonpermeable areas (the runway pavements and aprons) which must be drained, the speed with which drainage must be accomplished, and the compressive loads transmitted to the drainage structures by the weight of plane wheels passing over them.

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(1) "Land drainage and reclamation" by Ayres and Scoates (1928) Page 341.

BAGHDAD AIRPORT.

Baghdad is nearly 35 m. above sea level, its population is something above 500,000 .

Airport:

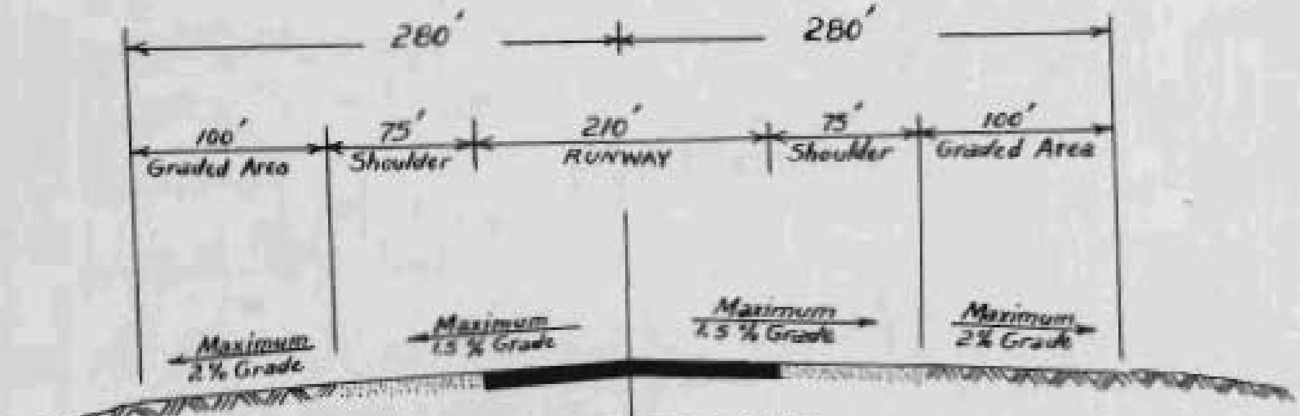
The new proposed airport lies on the west bank of the Tigris river, approximately 3½ Km. from the center of the city.

The 800 acres airfield (about 325 hectares) lies on a relatively flat ground near the old airport actually existing.

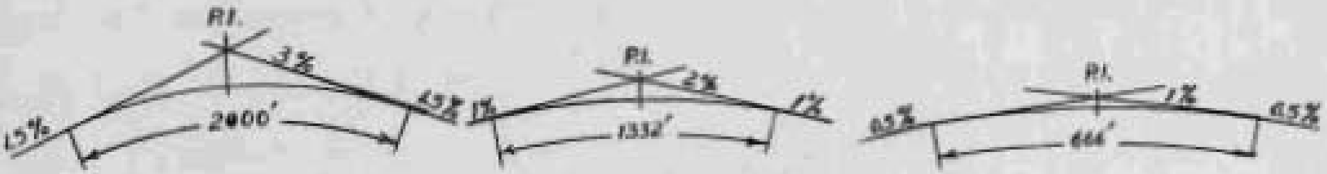
Landing area:

There are three runways which measure respectively 2.000 Km; 1.500 Km; and 1.325 Km. in length. The first one is provided with 250 m. overshoot (safety strip) on both ends to take care of possibilities of accidents. It is of a concrete pavement 65 m. wide with 75 ft. shoulders and 100 ft. of graded area on both sides. The thickness of the concrete pavement is 7 inches. A transverse section and a plan ~~is~~ are shown on the next page indicating the sizes and the maximum grades permissible by the American Corps of Engineers in military airfields.

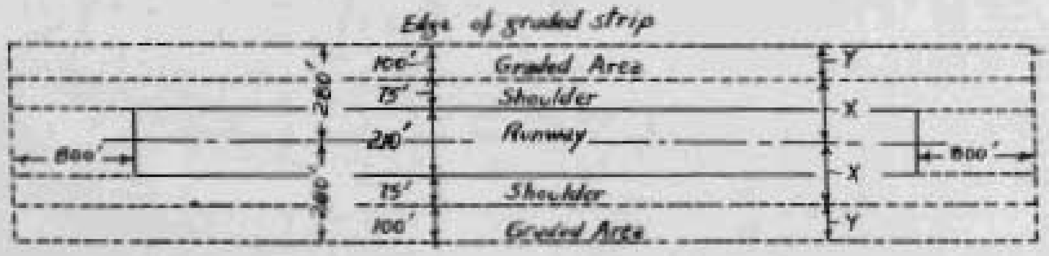
The other two runways are of bituminous concrete pavement 5 cm. thick . They are 50 m. wide with 50 ft. shoulders and 75 ft. of graded area on both sides. The longer runway lies in the ~~d~~ direction of the prevailing wind being north west and having a maximum velocity of 78 M.P.H.



TRANSVERSE SECTION



LONGITUDINAL SECTIONS
Showing three examples of permissible grade changes.



Max. longit. Grade in Area X or Y = 1.5 % (1% for 126,000 # wheel load)

" trans. " " " Y = 2 % ; in Area X = 1.5 %

Longit. grade changes in Area X { Min. dist. between P.I. = 1000'
" vert. curve = 666' per each 1% Algebraic diff.

" " " " " Y at edge of graded strip { Max. Algebraic diff. = 2 %
Min. Curve = 300' (Min. dist. between P.I.s = 300')

No base coutse is provided because there is no necessity for it since the clay is firm enough to support the pavement above it.

The transverse grade will be made as shown on the section being 1½% for the runway and shoulder and 2% for the graded area. The longitudinal grade will be 1% maximum where needed because the ground is almost flat.

Airway station:
The building is a framed structure and the walls are of bricks. Exterior walls are made 35 cm. thick (one brick and a half) ; and interior ones are made 23 cm. thick.

The station measures 120 m. by 42 m. It is a four story high building. It has a total height of 20 m.

According to the informations which I obtained about the region where the building is to be erected, water may be found at a depth of 3 m. from the surface of the soil. Hence it will be very difficult to pour foundations under water especially because the ground is clay which is very detrimental to the concrete. On the other hand, the bearing power of the soil is low and according to the experience prevailing at Baghdad several buildings have failed because of no adequate foundations. Nowadays piles are used more extensively especially for big public buildings, and for this airway station, piles are going to be used. The way in which they are going to be used will be the general one in practice at Baghdad i,e. gxxxxxx xx fxxx 6 in.dia. steel shell piles filled with concrete. These piles are driven with pneumatic hammers. The length of the piles will be 25 ft. which is the common length used in practice there.

The ground floor comprises various services. It has a coffee shop, a mail room, an inspection room, a medical examination room, a storage room, ticket offices, lounge, a fire fighting station and various other utilities. Besides all these, there is a large waiting hall extending two stories in height. It covers an area of 870 sq. m. There are eight columns inside the hall to support the roof above which is of beam, girder and slab construction. The size of the hall is big because it is necessary to accomodate for a great number of passengers especially in a rush time when car convoys coming from Syria bring the over land passengers and at the same time having air passengers arriving or taking off. The ticket offices open to the main hall with counters in front of them.

Passengers enter the airway station from a main large entrance door and there are two other doors for luggage.

All measures pertaining to the comfort of the passengers have been taken. There is an ease in circulation inside the airway station, corridors are 3 m. in width. Doors inside the airway station are wide, their widths differ with the function of the rooms to which they open.

Enough lighting is insured for the rooms by the large openings to the outside.

In order to add to the convenience of the airway station, it will be air conditioned because of the extremely hot weather which prevails in Baghdad in summer.

The concourse is incorporated with the main building. It is about 6 m. in width extending all along the building. It is 2-story high in the middle portion and 1-story high on both sides. It overlooks the field; four doors open to it, two from the waiting hall and the other two from the sides; in turn it opens to the field through four doors. There is a colonnade all along the concourse. These columns support the terrace slab in the upper story. The middle seven columns go up two stories in height while those to the sides go up 1 story in height only. The concourse's wall to the outside is receded from the columns by a short distance and it is made of a 1 m. high masonry wall and the rest is made of glass which goes high up to the roof slab.

The first floor houses a few rooms for the lodging of some passengers, a pilots dormitory, weather bureau offices, a dining room and a large public observation terrace overlooking the field on three sides. The other two stories house the various x airport offices and the control room.

In order to protect from direct sun rays, especially in summer, modern shutters will be installed in the windows.

Bathrooms which do not have an opening to an outside wall will be aerated by ducts. The door opening to the bath will be made a bit higher than the level of the floor, so the air can enter from below the door and be sucked by the duct to the roof.

The ground floor comprises the following rooms with their respective areas indicated in front of them.

GROUND FLOOR.

ROOM	AREA in sq. m.
Waiting hall	870
Passengers luggage examination room	210
Coffee shop	150
Customs office	85
Outbound luggage storage	78
Passport control office	80
Commissary	40
Barber shop	37
Kitchen	27
Pantry	11
Store	9
Post office working room	210
Medical examination & first aid room	54
Lounge	155
Air police station	76
Dormitory	70
Ambulance car & fire fighting station	148
Kitchen	22
Bathroom & W.C	20
4 ticket offices x22	88
2 toilets x12	24
2 stair cases x30	60
Janitor room below the stairs.	
Concourse	675

The first floor comprises the following rooms with their respective areas indicated in front of them.

FIRST FLOOR.

ROOM	AREA in sq. m.
Dining room	225
Lounge & Library with toilet	80
Storage for dining room	65
7 bed rooms with toilets	100
2 toilets x12	24
2 spaces for stair cases x30	60
2 stair cases x16.5	33
5 travel offices	106
Meteorology department	56
Radio room	56
Office	14
Technical library	21
Toilet	10
Rest room	27
Storage room	65
Pilots dormitory with toilet	80
Small waiting room	15
Secretaries room	15
Typists room	19
Accountant room	18
Officer room	18
Chief engineer's office	22
Toilet	8

The second floor comprises the following rooms with their respective areas indicated in front of them.

SECOND FLOOR.

ROOM	AREA in sq. m.
2 stair cases x16.5....................................	33
Operations manager's office............................	29
Airport manager's office...............................	25
Teletype room..	21
1 stair case x16.5.....................................	16.5
Observation room.......................................	21
Communication room.....................................	25
Air traffic room.......................................	29
Waiting room...	26
Analysis room..	20
Technical instruments room.............................	18
Files room...	18
Rest room..	20
Typists room...	26
2 toilet rooms x13.5...................................	27

The third floor comprises the following rooms with their respective areas indicated in front of them.

THIRD FLOOR.

ROOM	AREA in sq. m.
1 stair case room x16.5................................	16.5
Operation room...	32
Control room...	32
Rest room..	18
Phones room..	18

Hangars:

Four hangars are proposed. The overall dimensions of each are 84 by 50 m., the overall height is 20 m. For every hangar there will be one opening having net dimensions of 70 by 13 m. One of these hangars is functioning as a major workshop and it has an extra space of 50 by 10 m. In this hangar repair work and maintenance of both aircraft and engines is done. There will be a private hangar having overall dimensions of 70 by 30 m. and an overall height of 10 m. It has three openings measuring clear dimensions of 18 by 6 m.

Plane fueling:

In order to fuel the planes, there are pumps driven electrically at points along the concrete apron which deliver the gasoline through hoses contained in chambers set flush with the surface of the field. Gasoline is stored in underground tanks of specified capacity.

Drainage system:

The nature of the airfield's soil is clay; the average annual rainfall is 6 in. and the intensity is ¼ in. per hour.

Since we want to get rid of the rain water as soon as possible and since the ground is relatively flat and impervious, a drainage system composed of tile drains is necessary. The herringbone system is used, shown in the accompanying drainage plan. The spacing between the laterals is 12 m. and the length of the laterals is about 200 m. The diameters of the tile drains are shown on the above mentioned plan. The slope of the tile drains is made 3/10 feet per 100 feet, and their depth from the surface of the soil will be 80 cms. There are two mains which collect the water from the submains and these in their turn discharge through 50 cm. concrete pipes to the Mashash river which in turn discharges in-to the Tigris river.

The position of the airway station has been so chosen as to insure a clear visibility and control of the field. Parking areas for cars are available in front of the airway station. Traffic to the airway station enters from the main highway through a junction and leaves it from another junction, and so there will be no traffic congestion in the airport area.