STATION YARD & BUILDING

BY

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The candidate wishes to express his gratitude in these few words to Professor Manasah for his helpful advice in the preparation of this project.

CONTENTS

PREFACE

Railroad transportation has become a source of happiness and prosperity to all countries and communities.

Through the aid of different services which the railroad has rendered, the standard of living has been advanced beyond local boundaries, making possible exchange between communities and contact with other countries, such contact without which no country or community can prosper or exist.

Thus it goes without saying that railroads are of tremendous importance in the life and advance of humanity. This importance naturally embraces all aspects of human life; economical, social, and political.

When I worked during my training in Kirkuk Railway Station, the pressing need of experts became quite obvious to me. At the time, the Iraqi Government facing such obstacles was obliged to bring experts from India. I have also noticed a great tendency for railway expansion in order to meet the situation of modern Iraq. This tendency will be brought into noticeable action in the near future in the joining of Arbil with Mosul by a railroad. Having realized the importance of railroad, and having seen the serious lack of railway technicians, I was moved to write on this subject so as to augment my knowledge in this field. Accordingly, I decided to plan a thorough railway station on this proposed line.

INTRODUCTION

The Iraq State Railways became the property of the Iraqi government by agreement with the British Authority in April, 1936. The system at present consists of three main sections, the meter guage line connecting the port of Basra with Baghdad, the meter guage line connecting Baghdad with Arbil, and the section of standard guage connecting with Tel Kotchek.

The Erbil-Mosul line will be the completion of the single meter guage connecting Baghdad with Arbil via Kirkuk. The importance of the construction of this line is first seen in the connection of this part of the country with Baghdad and Mosul. Its importance appears in the existance of the oil wells in Kirkuk and the transportation of animals and agricultural products which reach tremendous quantities in this section of Iraq.

The topography of the district through which the proposed line will pass may be divided into two parts; the first is a wide level plain, while the second is characterized by many hills which rise as high as 50 yards. Here the line is forced to cross the Zah River. This district is intensively populated in relation to other parts of Iraq, and the inhabitants are intellectually fanatic. Thus the construction of the station must be in accordance with what was mentioned before.

Any project whatsoever must have for its purpose the satisfaction and the desires and wishes of those for whom it is to be made. Though sometimes neglected when it comes in conflict with the social habit and deeply rooted customs of the inhabitants, the economic aspect must be taken into consideration.

On this basis the facilities must be constructed so as to separate between the sexes and also between the different classes. Building of the station must be in accordance to the desires of the people. For example, arches and pillars are well accepted and must be present. A good restaurant should be built near the station building for the people of that district have the habit of making reception parties directly after a passengers' arrival.

Moreover, one of the important aims of this line should be the transportation of local produce; suitable facilities for these should be constructed in the station.

As it was mentioned before, any project must based on two fundamental facts, the first is the perfectional attainments of the project , and secondly, its construction should be at the least possible cost. Thus to realize the second point, the material which is to be used in the buildings should be of the cheapest suitable kind which can be found locally. In this particular case the Juss as mortar and the abandoned old rails (I-beams) can be utilized andused with the local bricks. The cost of the land is not important, as the government expropriates the land which is to be used for public utility and thus purchased at a comparatively low rate.

Stations in the world are usually divided into two kinds, passenger stations and freight stations. In districts like Erbil, where the traffic is light and there are no great varieties of products in comparision with other countries, it is economically preferable to have both constructed in one station. Moreover, the inhabitants have the habit of accompanying their products and commodities;all of which makes the combined type of station more suitable for them. Stationsare built and constructed near the centers ofthe cities, especially in the industrial centers and towns which receive a great number of passengers, so as to make cartage as low as possible and also in the necessity that passengers reach their destinations as directly as possible. However, the case in thisproposed line is different especially from the point of view of utilizing this railroad. It is preferable that the station be constructed far far from the center of the towns for the following reasons. The products which are to be loaded are brought by the farmers from the surrounding villages. So there is no need to construct the station in the center of the town which would make it necessary that all the farmers with their animals be crowded in the town and cause a lot of congestion, moreover, most of the passengers are farmers having nothing to do with the town and once leaving the station go directly to their respective homes. Secondly, most of the towns are expanding, and the population is increasing and crowding around the centers of the towns. Thus the construction of the station in the suburb will attract the attention of the people, and make them build their homes around it. Within a few years all of the congestion will simply be found to have been diverted to the site of the new station. If any local manufacturing center is established and makes it necessary, a spur can be laid to join the station with that place.

An important point not mentioned above should be considered, that is, that since all the locomotives work by fuel oil, there is no need to construct storage facilities for handling bulky coal.

PART I

LOCAL MATERIAL FOR CONSTRUCTION

Apart from the materials to be used for the construction of the yard and which are brought from outside the country, the main materials which can be found locally and utilized for the construction of the buildings in the station are,

1- The Juss
2- bricks
3- abandoned rails
4- limestone

THE JUSS

The juss is a basic material for building construction in Iraq. About 80% of the buildings are constructed with this material. It is manufactured locally by heating a mixture of ruble resulting from the demolishing of old buildings, and gypsum stones. The method by which the heat is applied is not technically finished, and the temperature is not uniform in all the stones to which the heat is applied. Some of them melt while the temperature of others remains low.

From the procedure it is clear that the juss is a mixture of hard wall plaster and quick lime mixed with impurities which cause the product to set more slowly than plaster of paris. Moreover, the rocks which are supposed to be gypsum contain some alum in their constituents which with the application of heat results in a hard finished plaster as a by product. Accordingly, the juss is a combination of hard wall plaster, quick lime, and hard finished plaster. The mortar of the juss is workable, and sets in a short time. When solidified it stands the heat, but for a lower temperature than the concrete. It stands the atmospheric changes and rain for a very long time. A weakness of the juss is that it can't stand dampness for a long period. To offset this characteristic, the juss should be used for roofs and walls, built on cement foundation raised to about one foo above the ground, and it would be much better if some kind of moisture-proofness or preventive is placed between the cement foundation and the juss wall.

RAILS USED AS I- BEAMS

Through long use the rail loses some of its metallic properties and reaches a stage where it becomes no longer useful as a part of the railway, and therefore must be removed and changed by new ones. These old rails, instead of being stored in corners to rust and deteriorate as is usually done, may be utilized as I-beams for roof construction, or encased in cement as concrete columns, or even used as lintels.

The section modulus of a 75 lb. rail is 9.I; using an allowable stress of 30,000 p.s.i., although it is sometimes higher. The moment which it can bear while used as an I-beam is:

$$M = 30{,}000 \times 9.1$$
$$= 273{,}000 \text{ in. lb.}$$
$$= 22{,}750 \text{ ft. lb.}$$

accordingly, if the span is 20 feet long, the weight for unit length which it could carry would be:

$$W = \frac{8M}{L2} = \frac{8 \times 22750}{20 \times 20}$$
$$= 455 \text{ lb/linear foot}$$

as the juss and bricks are more or less pervious material and absorb the water readily, the rails should be smeared by asphalt before it is used in the construction with the aforamentioned two materials.

LIMESTONE

Limestone found in this locality is usually quite hard. Its crushing pressure is about IO,000 +/O, low water absorbent usually 2%, and its color is rather grey which matches with the color of the juss. It can easily be worked to a good finish, so blocks of 8 x 8 x 4 inches willmake great use as floor tiles.

PART II

BUILDINGS

STATION BUILDINGS

The main factors which control the design and planning of such a building are, the site and locality, the purpose of the building, and the methods of construction. The location of the site is discussed in the introduction and has been shown that it should be in the outskirts of the town. The building serves both as an office building for the officials of the station, and as a waiting room and general station to meet the needs of the passengers. Such a building should satisfy all health conditions, easy circulation of the public, and maintain a saving in time.

It is designed as a one story building for the following reasons, the price of the land is cheap, and generally one story buildings are cheaper on the basis of floor area owing to lighter construction and larger centers of support, and that on multistoried buildings, the floors which are above the ground level are rather hot in summer time.

Being a station, the units of the building should be easily reached, and should function perfectly in accordance with the purpose for which it is built. Two halls are planned to accommodate from 80 to 100 persons each, giving about 14 square feet of floor space per person. They are planned to lie beside each other, so that the essential offices which are needed by the passengers, i.e., the booking office and the luggage facilities will be common to both. Moreover, the third class section must be able to be reached easily by the responsible personnel of the station whose offices are planned for the first and second hall. The third class is generally planned to be simply a large waiting room for this class of passengers, so no room is constructed to open directly into it. The first and second class hall functions to extent as a symbol of civic dignity to the station and as a nuclei to the whole building. However, it is not essential to the first-second class passengers because special waiting rooms are planned for them. Areas allotted for the rooms depend upon the need for ample space required for large numbers of visitors who frequent the personnel offices. Thus the corridors are made eight feet wide so as to be comfortable and allow good circulation. Eight feet is sufficient for two persons standing while being passed by a third carrying a suitcase. When the entrances or exits to the station building are limited, the main doors of the buildings and the two inside doors of the corridors can be closed along with those of the waiting room which open to the corridor.

The roof is 15 feet high, (although some specifications allow the height to be only 12 or 13 feet).

The minimum area of the windows is approximately 1/10 of of the floor area; 1/10 is satisfactory under normal conditions in hot weather. To attain good ventilation, flight-windows are designed in all the rooms which opens to the corridors. These windows are to be on the side of the room which abut the corridors.

The booking office is made large so as to be occupied by the ticket, information, and reserve officers. Only one cloak room is planned, and it is in the first-second class hall, as the third class passengers usually carry their luggage with them. No cloak room at all is planned for them. A small fountain for drinking water is in the third class hall, this is necessary to keep the passengers away from the tops of the gardens and other units of the building.

Clearly, the station does not need large stores. Three small stores are planned in the building and distributed in different sections. The three waiting rooms are each planned to allow an occupancy of 30 persons, with 14 square feet per person. The waiting rooms each have two doors from which they can be reached from the corridors and platform. The luggage facilities consist of the cloak room for the first-second class, as well as another room with a space in front of it serving as a place for the scales, and by removing the counter placed in this space, the two halls are joined together.

The restaurant is planned to be at the most distal side of the station, so as to be as quiet as possible from the ordinary station noises. It can be reached from the platform as well as from the corridor, and is designed for 50 persons, allowing a space of about 14 square feet per person. The circular part of the restaurant can be separated by a curtain and used for women. A scullary, a store, and a toilet room are planned to join the restaurant and form a complete unit. The kitchen occupies about 30% of the area which is allotted to the restaurant. Toilets in the building are distributed approximately according to the following specifications:

Persons	W.C.	Persons	Urinals
1-15	1	10-20	1
16-30	2	21-45	2
31-65	3	46-70	3
66-100	4	71-100	4

All the lavatories are to be of the oriental type, to use others in such public buildings would be hazardous to health.

Since the weight of the building is distributed nearly uniformly, the construction is to be continuous as far as the foundation is concerned. Width of the footing is to be dependent upon the bearing power of the soil at chosen site; depth is to be six feet deep.

As it was mentioned, the juss can not stand dampness for a long time, thus, a belt of concrete reinforced with four-lo mm. bars is needed.The thickness of the belt is to be one foot, with half of it to be above the floor level so as to keep the dampness away from the juss wall. All the walls are to be built with juss and limestone. Thickness of the wall is to be I5 inches for those on which the beams of the roof are supported and I2 inches for the partitioning walls. The floor is to be of 4 inches of crushed stone, on top ofwhich will be one inch of sand, then a layer of concrete mortar and finally concrete tiles for the rooms. The tile for the halls and corridors will be of limestone blocks, IO x IO x 4 inches.

The roof is to be 9 inches thick, built of 75lb. rails, bricks 4,5 inches thick, on top of which a layer of concrete is poured, then a layer of asphalt which will function as a water-proofing compound. Since the asphalt is a good absorber of heat, it will be covered by a layer of mud mixed with straw which will keep the heat away. The roof of the halls are to be supported by columns arranged as shown in the sketch.The beams of the roof are fixed on a wide flange as a girder, which in turn is supported on the columns.

THE FREIGHT HOUSE

The freight house with the pens and barn form a complete unit for the freight transportation to which half of the station's function id devoted. They are constructed in a place for from the station building, and on the side fo the yard which is designed for the freight cars, so that the main line will be left open for the arrival and departure of other trains. Moreover, congestion will be eliminated, and animals are kept away from the passengers. The capacity of the freight house is enough for about 15 freight cars. Two stores open to the inside of the freight house are planned especially for valuable goods, and for merchandise which must be kept in cool places, such as during summer time. The construction is in general to be similar to that of the station building, except for the floor and the roof. Due to a large space of the house and the need for a space free of columns, the roofs will be of corrugated sheet iron supported by roof trusses. The trusses are to be six panels, each rising 15 feet, and supported along the length of the house so as to make a good facade along with other parts of the building. The supports of the trusses are columns constructed of 75 lb. rail encased in concrete, similar to those used in the station building.

Because the apexes of the two triangular walls are 32 feet high, the walls will require buttresses to support them against inclination tendencies. The floor should be rigid enough to support varied weights upto 250 lbs. per square foot. Accordingly, it will be constructed of a 6 inch layer of crushed gravel on which lies 6 inches of concrete. To protect its surface against the wear by hand trucks, a layer of asphalt is to be placed on the concrete floor which will make it damp moisture-proof as well. The platform is 25 feet wide which is sufficient for two cars to stand side by side. The construction of the platform is similar to the floor of the freight house. The entrance to the freight house and the approach to the platform are to be ramped to facilitate an easy ascent or descent. The barns as well as the pens are planned to side with the freight house. Both are a Platform, covered by a mill bent, roofed with corrugated iron sheets. The support of the mill bents are to rest on a concrete foundation. The supports which are along the track side recede three feet from the edge of the platform. The approach to the barn and to the entrance of the pens is ramped 1:6. The barn is planned to accommodate 2000 bags of cereals; thepens, one for 500 sheep, the other for 20 horses. Both pens have a long manger built along one side, and a channel for drinking water on the opposite side. Two drains are to be made all along the pens, one to the longitudinal center line, and the other parallel to it and running along the base of the wall which is away from the track. The floors of the pens slope toward the entrance. The pens are surrounded by a wall of juss one foot thick and four feet high for the sheep pens, and seven feet high for the horses .

ROUND HOUSE

Usually a rectangular house is enough for a small station, but expecting future enlargement with increasing traffic, a round house is planned.

The round house, the repair shop, and an oil house are to be near to each other, and constructed far from the station buildings and freight house so as to keep the noises, smell and grime which originates from these shops, away from the passengers. The round house is planned for four engines which is the maximum number that is expected to be present at once.

In planning the house, the length of the engine is assumed to be 60 feet. Allowing a space behind the tender and in front of the pilot for a man with a hand truck to move, the length of the house is made 80 feet. The height is enough for the stack of the locomotive to pass under the smoke jack. The height specified for the locomotive is 16 feet, and the length of the smoke jack is 10 feet, making the total height of the roof 26 feet.

As the engines are cleaned and attended inside, pits are to be constructed for the locomotive. The rail is to be placed on a trestle formed by a wide flange beam supported on reinforced concrete posts spaced 6 feet apart, and embedded in the bottom of the pit. The pit is 60 feet long, 10 feet wide, and 2 feet 8 inches deep. As the level of the rail is one feet four inches above the floor, the level of the pit will be 3 feet below the level of the rail. At the bottom of every pit is a drain of 9 inches in width by 2 inches deep which slopes toward the other end, where it becomes 9 inches wide and 6 inches deep. As the gases which the locomotive emitsaffect the steel, a minimum amount of iron should be used in the construction of the house. Accordingly, the roof is to be of the same type which is used in the station building. The floor is exposed to grease, oil, and sometimes heavy loads, so itis to be constructed of a 6 inch layer of crushed stone, and 6 inches of concrete. Doors are 16 feet high with concrete frames. The rails pass through into grooved in the sill deep enough to permit the top of the rail to be flush with the surface of the sill. The roof is supported on columns similar to those used in the halls of the station building. As the span of the beams which are nearer to the outer circular wall of the building increases, the distance between the beams are to be decreased to 2 feet, so as to decrease the weight carried by each on account of the large amount of smoke from the engines in the house, a smoke jack is placed in each stall, located so that the locomotive will come directly underneath the jack. The jack is made of asbestos and has a rectangular base 10 feet long by 4 feet wide, and slopes to a funnel of 30 inches in diameter. It is to be supported in the roof by a collar of concrete casted on the top of the roof and connected to the nearest two rails.

REPAIR SHOP

Every station should be provided with a repair shop, proportional to the importance and capacity of the station. For a station as this one, a small repair shop is needed which is sufficient to answer the local requirements. It includes a black smith shop, a store room, and a power room, along with a space for the track on which the broken cars can rest. The layout may be of two kinds, either cross-track or longitudinal track. Since the number of cars that need repairs at once are expected to be about 4, a longitudinal track is more suitable. The house is planned to accommodate two parallel tracks. One is to cross the house longitudinally with a capacity of four cars. The other is a dead end track leading to *an examining pit 30 feet in length, IO feet wide, and 2 feet 2 inches deep. Accordingly, the level of the rail must be 3 feet 6 inches above the hollow of the pit. The rail is to be placed on reinforced concrete posts similar to those used in the round house. The room with the two tracks is to have a roof of trusses covered with corrugated iron sheets. To assure proper ventilation, a monelair is to made on the top of the roof as shown in the sketch. Rooms for the employees and the enginemen are planned with the house, so as to be in the close proximity of the repair shop. The trusses are supported on a column of 75 Ib. rail built especially for this purpose. The floor of the house is to be similar to that of the round house, the level of the sills are four feet above the floor, so as to be opposite to the cars.

OIL HOUSE

A special isolated building is planned as a store for the

~~for the~~

different kinds of oils which are used as fuel for the locomotives, or for other purposes needed in the station.

There are two basements, three rooms, and a platform. The basements are for the storage of the oils. Each has a capacity of about 5000 cubic feet, which is sufficient for 8 tenders. Three Openings for ventilation are provided for in the basements, each being 2 feet in length and 1 foot in width, which will be covered bywire netting whose openings are fine , and uniformly spaced. A series of pipes, one for each kind of oil passes through the outer vertical face of the platform for the convience of emptying tank cars into the storage tank. Each basement has a door 6 feet wide with a ramped landing. The pumps willbe placed in the larger room, which will contain a series of inlet pipes in the floor leading to tanks in the basements. The sand for locomotives is to be placed in one of the remaining two rooms of the house. Since dry sand can be obtained easily at any time, there is no need for installing drying equipment. The third room is an office for the the employees in charge of the house. The construction of the basement is in concrete. The ceiling of which is in reinforced concrete necessary to stand the vibration of the pumps.

<u>TURNTABLE</u>

The turntable is an important structure required of every station. It is usually controlled at the entrance to the round house, or is at a point to which many tracks are directed, on which a locomotive and tender may be runand then turned horizontally through any portion of a circle as to be transferred to any other track inclined to the first one. The turntable which is to be used in this station belongs to the "three point support type". In this type the locomotive does not need to be balanced on the platform of the turntable. It may stop at any position. The pit in which the turntable is supported is a circular pit having its circumference lined with reinforced concrete. The bottom of the pit is a concave surface, and the wall is made with steps which supports the rail on which the end rollers. The diameter of the pit is 2 ~~feet~~ inches greater than the length of the turntable. Depth of the pit depends upon the kind and manufacture of the turntable and varies at the center of the pit between 4 to 11 feet. The length of the turntable is 75 feet long. This length is suitable for the length of the locomotive with the tender, and to permit the motion of the engine a few feet in either direction.[2]

WATER TANK

A storage tank for water is to be of the steel type with a capacity of 100,000 gallons of water which is sufficient to supply ten tenders, each of which have a capacity of 10,000 gallons. The tank will be supported on 12 X 12 inch posts, arranged in a double cross, four posts in each line. Each post resting on a concrete foundation.[1] The height of the bottom of of the tank will be 25 feet above rail level, and the diameter for piping from tank to the standpipe will be 6 inches.[2]

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1. Walterloring Webb, C. E., Railroad Construction, p.380
2. Standard Dimensions of Iraq State Railways.

PART II

THE YARD

The most important points that are to be considered in designing a yard are; maintenance of the tracks; safety and ease in the movement of cars; and economy in time. Moreover it should be remembered that the yard is not just arrangement of tracks for storing cars. It is a sorting arrangement on which trains are to be received, broken up, reorganized, and dispatched. The cars received by the station, are either cars to go through the full length of the road, empty cars to be stored, or those needing repairs.

All these movements depend on the arrangement of the tracks which should be in such a way that meet the required aforementioned purposes.

Before starting the design of the yard, one should decide about the system of yard switching and know the following points:

1- the maximum length of incoming and outgoing trains,

2- maximum number of cars which are needed daily,

3- the maximum number of cars to be stored or crippled cars.

The method of switching which is assumed to be used in this station is by means of tail switching. The procedure of this method is that the engine is attached at the rear of the train, the cars of which are to be stored. The switch engine pushes the train ahead and suddenly stops. One or more cars at the forward end, destined to some particular track, have been previously uncoupled, and when the train stops, continue on their way . The switchman rides the car and stops it at the proper place. After the first cut is sent ahead, the train is withdrawn, and the same procedure followed.

The maximum legth of the incoming or outgoing train is assumed in the designing of this yard to be 1100 feet long. The different cars which make up this supposed train are five for the third class, three for the first and second class, ten freight cars, one for the guards, one military car, and the locomotive.

The maximum number of cars which are expected to be at the station at a time is 60. The abovementioned points must be considered in designing the yard, and can be attained by considering the following points: (1) Curves should not be used, unless absolutely necessary. Curves are the cause of many derailments, as well as warping of the rails. Velocity of trains within the yard is generally limited to about 10 miles per hour, and the separation is designed according to this estimation. Thus with many curves, a precarious engineer, driving at a velocity exceeding this will be more prone to derailment and accidents, than if there were less curves. Due to the centrifugal force, the wheels of the locomotive or cars, grinds against the rails and causes the wear of both the rails and the wheels.

(2) Frogs used should not be of such small number, so that the danger of derailment is not great, which requires the switching to be accomplished more slowly and carefully than is economical. Sharp frogs give easy riding and less danger of derailment, but the length of the lead for each turnout is greater and the space for storing the cars is reduced. The best number to be used averages one, No. 7 is preferable and is used in the design of this yard.

(3) Rails and ties are not to be laid directly on the surface of the ground.

(4) Switches used, should be "point switch", which are safer than the stub switch, and depreciate less.

(5) Slip switch should be as less as possible.

(6) Long storing tracks are undesirable because of the high speed needed to send cars the full length and the time required for

the men to return from riding a cut to the end of the track.

(7) Switches should be arranged in groups to provide for easy handling from a tower, if desired.

(8) The switch-light stand should be near the ground and furnished with two lights showing the setsfor riding or lead tracks.

(9) Any storage or classification of parallel tracks should be arranged so as to conform with the lead track in a parallelogram shape, and the entering end should be wedge-shaped. This arrangement, concentrates the switches and saves wear of them and of frogs.

(10) Ladders and through tracks must always be kept open for the passage of trains. Thus no car should be left standing even for a short time.

(11) Running tracks should be provided for the engine to cross the yard.

(12) Buildings should not appear between the tracks, this avoids crossing of the tracks by passangers or vehicles.

(13) Cross overs should be located at convenient places where they do not interfere with regular movements.

(14) Distances, center to center, between tracks should be made so ~~that~~ as to allow a space suitable to the function of the track. Distances between tracks are specified in most reference books and are as follows: Baby tracks 13 to 14 feet; distance between ladder and nearest parallel track 15 feet; repair tracks 16 to 14 feet.

The design was carried on according to the abovementioned points, to the capacity of such a station in Erbil, Mousel, and to the number of inbound and outbound trains estimated.

The general lay out of the station is as follows:

All the buildings are planned outside the tracks so as to facilitate a free movement of the cars and locomotives.

The tracks are arranged to form three small yards with few tracks for the crippled cars. The first group is the main yard which includes the main track for the passanger train. The main track is kept clear of any switch or cross-over except at the ends. Next to the main track is the departure track on which the assembled cars are placed in trains ready to be taken by an engine. The second track is a receiving one, which is ready to receive any train that arrives while there is a train standing onthe main track next to the station. The third one is a reserve to be used for urgent needs. The fourth track, is a through track, which crosses the yard longitudinally, and from which the ladders of the local orders tracks and storage tracks are turned out. Each of these four tracks are more than a train -- length long, and each one is joined to the one next to it by a cross-over. Through these cross-over tracks, any train, can cross from one of the main five tracks which are mentioned above, to any other of them by simple movement to the right; it clears the switch point, and after settng the switch for the cross-track the train returns to cross to the next parallel track. The second yard is the freight yard which is formed by seven parallel tracks each having a capacity of 10 cars. The track which serves the freight house, the barn and pens is a siding parallel to the ladder of the freight yard, and is joined with it by a cross-over track which crosses the platform, that separates the ladder of the freight yard and the siding. This cross-over is designed to enable the cars which are standing on the siding next to either the pens and the barn or the freight house from blocking each other. The cars can be drawn out of the freight yard from either end, or from one of its tracks which is planned purposely for this reason to join the other yard as shown in the plan. The second yard which is next to this is for the passanger's cars, it has six tracks, each track has a capacity of either 3 first class cars or 5 passangers cars.

Both yards are to be used as storage, classification, and local order tracks. The remainder of the tracks are those which serve the round house and the repair shop as shown in the plan. A running track is planned to join between the main track of the passanger train with the through track and the turn table so as to enable the engines of the station to pass freely from one side of the station ~~to pass freely from one side of the station~~ to the other; also to enable road and station engines to pass to and from the engine house and other points. The body tracks in the three yards make the same angles with the ladders and are connected by switches that have the same frog number. Accordingly, there are no connecting curves beyond the frog, and the body tracks run out in the direction of the frog rail.

SWITCHES

There are two main kinds of switches, the stub switch, and the point switch. The stub switch, although it was universally used, is now abandoned, and is not recommended for the following reasons:

I. The two switch rails are the ends of the main track, which are kept loose and not tied to the sleeper.

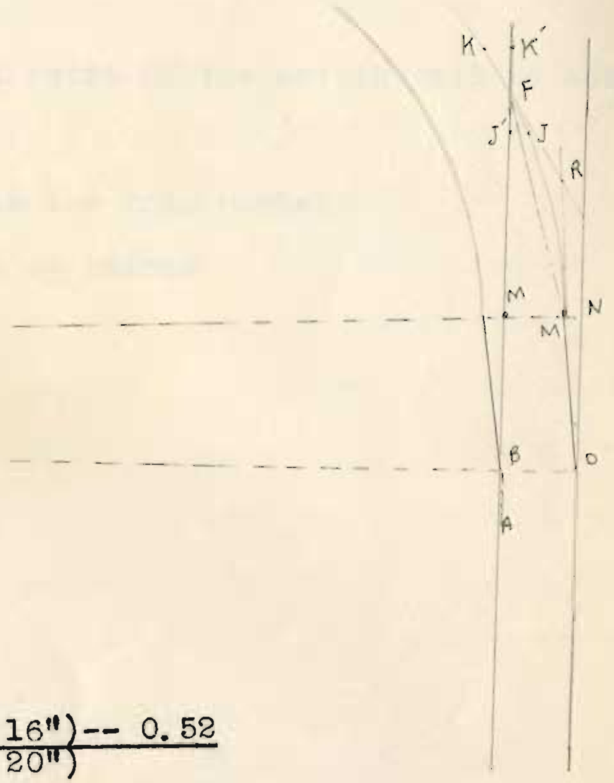
2. Derailments occur when the switch is not set properly.

3. The open joint at the head blocks causes a heavy jerk to the train and injures the wheels.

The point switch is the one which is recommended and is used in the design of the station. In the ordinary forms one main-line rail and one turn-out rail are continous. All the disadvantages of the stub switch which are mentioned aboveare not found in this kind of switch. All the parts of the switch are fixed to the sleepers except the switch-rails which are I5 feet long as an average. Clearance at heel of switch and at the toe differ according to the kind of rail. Wider clearances are needed for heavier sections because the heavier sections have a wider .

Due to light traffic and absence of sharp curves in the yards of the station, the frogs will be stiff plate frogs which can be made locally of rails of the same weight and cross-section as the rails of the main track.

DESIGN OF THE SWITCH



MN = H = $6\frac{1}{4}$" = 0.52'

FJ = W = 4-5/12' = 4.416'

guage = g = 3' 3 3/8" = 3.27

switch rail = S = 15'

$$JM = \frac{g--W\sin F--H}{\sin\frac{1}{2}(F+@)}$$

where;

F = frog angle

= 8° 10' 16"

@ = arc tan H/S = $6\frac{1}{4}$/15 X 12

= 1° 59' 20"

$$JM = \frac{3.27--4.416\ (\sin 8^\circ\ 10'\ 16")--\ 0.52}{\sin\frac{1}{2}\ (8^\circ\ 10'\ 16"+1^\circ\ 59'\ 20")}$$

= 23.93 feet

$$R+\tfrac{1}{2}g = \frac{JM}{2\sin\frac{1}{2}(F-@)}$$

where R= radius

$$= \frac{23.93}{2\sin\frac{1}{2}(8^\circ\ 10'\ 16"--1^\circ\ 59'\ 20")}$$

:. $R+\frac{1}{2}g$ = 221.82

R= 221.82--$\frac{1}{2}$(3.27)

=220.19 feet

DS = Scos @

= 15cos(1° 59'20")

= 14.99

The lead, L =

$(R+\frac{1}{2}g)(\sin F--\sin @)$ + Wcos F + S cos@

= 221.82(sin8° 10' 16"--sin 1° 59' 20") + 4.416 cos 8°10' 16" +

15 cos 1° 59' 20" = 43.09 feet

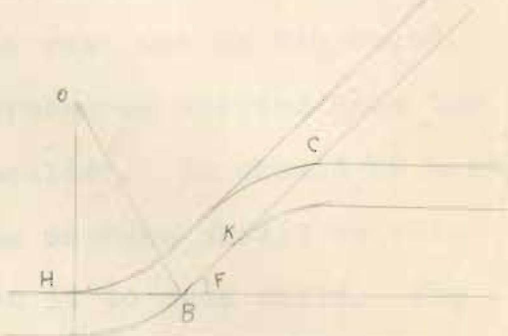
If L = distance from actual point of the switch to the theoretical point of the frog,

and, L' = distance from actual point of the switch rail to actual point of the frog,

then $L' = L + \frac{1}{2} \times 7$; where 7 is the frog number

$\therefore L' = 43.09 + 3\frac{1}{2} = 43$ feet $4\frac{1}{2}$ inches

DESIGN OF LADDER



HB = KC

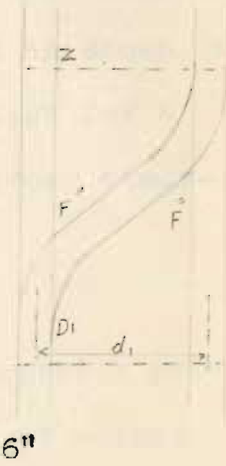
BC = a/ sinF
if N is equal to the frog number then,

BC = a(N+1/4N)

= 15.5 X (7+1/4X7) = 109.06

BK = 109.06 -- 43.37 = 65.69

DESIGN OF CROSS OVER



F' = F" = frog number 7

F'T =(d-g/sinF')--g cot F'

D'Z = 2D'F' + (d--g) cot F' --g/sin F"

where D' F' is the theoretical lead,

F' T = (15.5--3.27/sin 8° 10' 16")--3.27 cot 8° 10' 16"

= 63.24 feet

D' Z = 2 X 43.09 + (15.5--3.27) cot 8° 10' 16"--3.27/sin 8° 10' 16"

= 148.38 feet

BALLAST

Ballast is a great deal more than just something to be found between, around, and underneath the ties. The object of the ballast is to transform the applied load over a large surface, to keep the ties in place horziontally and laterally, to give elasticity to the road bed, and to carry the rainwater away. The material chosen for ballast must therefore fulfil these conditions and must be tough, sufficiently so to stand up under the load placed upon them . Then too, it must behave equally well under either wet or dry conditions. It must not be too round, else it will give way to the lateral pressures exerted upon the ballast between the ties and on the shoulder. It should be hard, yet not too rough on the surface. The surface should be relatively free from dust which may cause it to pack solid. The best material to suit all of these conditions is crushed granite, but this kind of stone is rarely found in the Erbil locality, so good quality limestone can be used. It is found by experience in Iraq ~~that if~~ the top of the ballast between the rails and ~~half on~~ the shoulders which are covered and packed as shown in the sketch, the ties are kept in tiptop shape and last for a much longer time, than if they are exposed to the gross atmospheric changes.

TIES

Treated ties will be used, since treatment generally preserves the wood against adverse conditions. The best method to treat the wood is by treating the seasoned timber with light doses of cresote. Other kinds of treatment such as steaming will weaken the wood, and the use of solutions of zinc, chlorides, will create a brittle property in the wood. Dimensions used will be se those specified by the Iraq State Railway; 6' x 8" x 4,5. The ties should be sound, reasonably straight grained, and they should be laid at right angles to the rails. The surface fo the tie should not be warped so that both rails may get a full bearing across the entire width of the rail.

RAILS

The most frequently used rail is either of the bull-headed variety, or of the T-rail type. Bull-headed rails are more expensive since they require the use of cast iron chairs to support it on the ties. It is used for heavy and fast traffic, but these requirements are not characteristic for Iraq. The important consideration of a rail is in its strength and stiffness.

"The stiffness of a rail or any beam may be said to vary directly with the moment of inertia of its cross section which in turn in beams of similar cross section is proportional to the square of the area of that cross section, since the weight per unit of length is proportional to the area cross section.The stiffness is propotional to the square of the weight. Rails of one type but of varying weights are not of exactly similar cross section, but are so nerarly so as to make the foregoing statement practically true. In rails of equivalent section, the stiffness varies with the cube of the height, and the first power of the breadth. Since the stiffer the track, the less the work of maintenance, and the less the power necessary to haul trains, there is economy in heavy rails."[I] According to the preceding analysis, the rail which is used in the yard is 90 lb. Rail which is in excess to that commonly used in Iraq. Usually the 75 lb. rail of 33 feet length is found in use. By using long rails, the number of joints is reduced. Since

I. Sadler, R., Elements of Railroad Engineering, p. 99

ant pressure of the wheels on the rails while the train is in motion is not vertical, but inclined outward, canting plates will be used so as to reduce the effect of this inclined pressure which are widening the guage and cutting the tie under the outer edge.

JOINTS

The joint of the rail will be supported by angle-bars of 24 inches length, with 4 bolt splices 3 spaces apart at 5 inches, and the nut locked by a nut-lock which prevents the nuts from turning. To decrease the shock due to the expansion gaps at the joint, and to avoid bending both rail joints simultaneously, the joints should be staggered, as well as having the ends of the rails (at the joints) kept in line both vertically and laterally. To keep the ties in good condition, reduce rail-cutting and spike-killing, tie plates of plain bottom will be used.

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II. Webb, Walter Lorring. Railroad Construction.

III. Iraq State Railroad. Standard Railway Dimension.

IV. Raymond, Riggs, and Saddler, Elements of Railroad Engineering.

V . Percy Thomas (Editor) , Modern Building Practice