Design of a Gravity Railroad Switching Yard

Civil Engineering
B. S.
1908
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DESIGN OF A GRAVITY RAILROAD SWITCHING YARD

BY

BYRON KEMP COGHLAN

THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

PRESENTED, JUNE, 1908
UNIVERSITY OF ILLINOIS

June 1, 1908

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

BYRON KEAP COGHLAN

ENTITLED DESIGN OF A GRAVITY RAILROAD SWITCHING YARD

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Civil Engineering

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SYLLABUS.

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Importance of good design.
Factors to be considered.

General plan of a hump gravity yard.
Theory.
Receiving yard.
The hump track.
Classification yard.
Grades.
Storage, repair tracks, etc.

Condition of yards and traffic at Champaign.
Yards.
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Main tracks.
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   Receiving yard.
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Cost.

Will it pay?
THE DESIGN
of a
GRAVITY RAILROAD SWITCHING YARD
for the
ILLINOIS CENTRAL RAILROAD
at
CHAMPAIGN, ILLINOIS.

INTRODUCTION

Yards and Sidings compose a large part of any modern railroad system, and the speed at which traffic can be handled is in direct ratio to the effectiveness of their design and operation. A car when on the road travels at an average rate of ten miles per hour; but, when time detained in yards is added, this speed is reduced to four miles per hour, which fact alone demonstrates the inefficiency of the average switching yard, and also the vast room for improvement.

In the design of switching yards there are several factors to be considered:

1st, The relation of the yard to the working scheme of the whole system;

2nd, Making up of trains so as to move the maximum distance without switching;

3rd, Reducing to a maximum the reverse movement of cars.

4th, Keeping fast and slow movements separate;

5th, Disposal of bad order cars;

6th, Location of scales, water tank, coal chute, etc.;

7th, Non-interference of traffic in opposite directions;
8th, Increase in volume of traffic;
9th, Modification in design due to yards already in place.

The last item is often given undue weight, and the fact is often lost sight of that, if by re-design one engine and crew can be dispensed with, the saving is $20 per day, or $6000 per year, or the interest at 4% on $150,000. Again if each car can be moved forward one hour sooner, and 2000 cars are switched daily, 83 more cars are available for use at $600 each, or a total of $49,800, and if overtime paid because road engines are "held out" can be saved to the extent of ten hours a day, the amount saved would pay the interest on $100,000.

Based on the above mentioned principles several types of yards have been developed, namely: the bunting, poling, gravity, and hump-gravity yards. It is the purpose of this thesis to outline the general scheme of a hump or summit yard, and the application of this type of design to the south yards of the Illinois Central Railroad at Champaign, Ill., where the trains running on the Chicago and Centralia divisions are switched.

**GENERAL PLAN OF SUMMIT YARDS.**

**THEORY.**

A hump or summit yard is one in which the switching of cars is accomplished by pushing them slowly over a summit, beyond which they run by gravity; it consists of receiving tracks, then the hump or summit track, followed by the
classification and the departure tracks, in the order named. The location of repair tracks, storage tracks, coaling plant, water tank, ash pit, etc., may quite properly vary with each individual design.

RECEIVING YARD.

All inbound trains enter the receiving yard, which should be long enough to accommodate the longest expected train. The engines are then cut off, and the cars pushed by the yard engines to the hump. Minor repairs may be made in the receiving yard, and it is of the utmost importance that all brakes be examined and found to work properly. Lack of proper inspection in this matter has cost the lives of many men in gravity yards now in use. A ladder track with slip switches near the center of the yard will facilitate the handling of short trains and the "breaking up" of long ones.

THE HUMP TRACK.

The hump track is a single track passing over a summit and connecting by ladder tracks with the receiving and classification yards. The cars are brought from the receiving yard and slowly pushed over the summit. The cars then move forward, by gravity alone, to their proper place in the classification yard, where they are stopped by the riders in charge. The passage of the cars through the ladder tracks and switches is controlled from a switch tower, which should be located near the summit.
CLASSIFICATION YARD.

The classification yard consists of a number of tracks generally parallel, by means of which cars may be classified by commodity or destination. The number of tracks depends on the number of classifications, so that one passage over the hump will suffice, thus eliminating reverse movement. The length of the yard should be equal to the average train generally sent out.

GRADES.

As a matter of economy the grades of the receiving yard and of the track leading to the summit should be as flat as possible. The grades from the summit and through the ladder tracks and "gridiron" are dependent on the curvature of the yard, number and curvature of turn-outs, directions of prevailing winds, kind of traffic (i.e., loads or empties), and climatic conditions. The Engineering News of March 22, 1905, published the following table of grades for yards of this class:
TABLE 1.

<table>
<thead>
<tr>
<th></th>
<th>NORTHERN CLIMATE</th>
<th>SOUTHERN CLIMATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Bunching Grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Momentum Grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale on Hump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Loads</td>
<td>75' of 1.5%</td>
<td>75' of 1.5%</td>
</tr>
<tr>
<td>B. Empties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale on Hump</td>
<td>200' of 3.0%</td>
<td>200' of 2.5%</td>
</tr>
<tr>
<td>(3) Momentum Grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale on Hump</td>
<td>25' 4%, then scales on 1%, then vertical curve for 50', then 200' of 3% for loads or 4% for empties.</td>
<td></td>
</tr>
<tr>
<td>(4) Ladder Track</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loads</td>
<td>0.9%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Empties</td>
<td>1.2%</td>
<td>1.0%</td>
</tr>
<tr>
<td>When both are handled</td>
<td>1.2%</td>
<td>1.0%</td>
</tr>
<tr>
<td>(5) Continued Grade for Yard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For Loads</td>
<td>0.3%</td>
<td>0.2%</td>
</tr>
<tr>
<td>For Empties</td>
<td>0.4%</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

STORAGE, REPAIR TRACKS, ETC.

Tracks should be provided in which cars awaiting billing or re-consignment may be stored. The size and importance of a storage yard varies with the kind of traffic handled.

Repair tracks should be located so that repairs can be made with dispatch.

The round house should be as accessible from all
parts of the yard as it is possible to make it.

The coal chute, ash-pit, oil house, sand tower and water tank should be placed so that locomotives coming in or going out of the round house can get supplies with the least possible delay.

CONDITION OF YARDS AND TRAFFIC AT CHAMPAIGN.

YARDS.

The present yards at Champaign are the result of the increase of traffic on the Illinois Central. The first tracks were near the site of the present depot, (see Plate 1), and, consequently the round house and shops were built close by. With the growth of traffic these yards proved inadequate, and a new yard was built south of Green Street, and at this yard all trains are now made up, the tracks near the depot being used only for the unloading and loading of freight at Champaign. The present location of the round house and shops is neither convenient nor economical, and it is the intention of the company to move them to a new location south of Green Street. A further extension of the Green Street yards is also contemplated.

TRAFFIC.

The tables below give the amount and kind of traffic handled at Champaign.
Number of cars received and forwarded daily:

North Bound, Average 600, Maximum 1000.
South Bound, "  400;  "  700.

North Bound, Average 500, Maximum 800.
South Bound, " all;  " all.

Classification by destination (daily average):

North Bound-

Wabash 2.
Big Four 20.
Decatur Branch 25.
Local 25.
Local on Chicago Division 50.
Chicago Balance.

South Bound-

Local 10.
Local on Centralia Div. 25.
Mattoon 60.
Centralia (for south) Balance.

Classification by commodities:

North Bound-

Coal 40%.
Grain 20%.
Perishable 5%.
Merchandise 5%.
Mixed & Empties 30%.

South Bound-

Empties 30%.
Merchandise and High Class Freight 15%.
Mixed 5%.

Number of cars in train:

Average 50.
Maximum
Winter 65.
Summer 85.

Number of trains:

North Bound Daily Average 10, Maximum 17.
South " 8, " 17.
Maximum (hourly), either direction 6.

Switching Crews:

Two switching crews are working night and day in
the Green Street yards, and for approximately three months in
the winter, when the maximum amount of business is handled,
a third engine is used.

THE DESIGN.

LOCATION.

The hump yard designed in this thesis, (Plate 2),
would lie somewhat to the south of the present Green Street
tyard. It has a total length of 7100 feet, with its north
end about 750 feet north of milepost 129. This location
permits the use of a large hill, with crest near Sta. 103, for
the gravity tracks. There is a fill between Sta. 110 and
136, the material for which is to come from the land to be
occupied by the round-house and shops, said land lying to the
west of the present right of way between Stations 94 and 108,
(Plate 2). This location is desirable (1) because it is
near the center of the yards and therefore convenient, (2)
because the land is high and, by cutting down, material may
be obtained for the fill south of Sta. 110, thus saving the
cost of borrow pits, and (3) because it permits of easy
drainage.

MAIN TRACKS.

The two main tracks run through the center of the
proposed yard at the same grade and elevation as at present.

EAST YARD.

The east yard, (Plate 2), handles the north bound
business, and consists of receiving tracks, the hump track,
and the classification and departure tracks. The receiving yard has a total length of 2970 feet from extreme ends of ladder tracks and consists of six tracks spaced 14 feet center to center. At the south end there is a ladder track, and at the north end there are two, running at an angle of $6^\circ 22'$ with the receiving tracks, thus permitting the use of #9 frogs. At 1000 feet from the south end of these tracks is an auxiliary ladder track with #7 slip switches to facilitate the switching and "breaking up" of trains. The grade from Sta. 136 to Sta. 110 is plus 5.0 per cent, from Sta. 110 to Sta. 106 + 30 is plus 1.0 per cent.

HUMP TRACK.

This track connects the receiving and classification tracks, is 550 feet long, and has a summit at Sta. 101. From Sta. 106 + 30 to Sta. 106 the grade is plus 1.0 per cent, from Sta. 106 to Sta. 101, plus 2.0 per cent, from Sta. 101 to Sta. 99, minus 3.0 per cent, from Sta. 99 to 98 + 30, minus 1.0 per cent.

CLASSIFICATION AND FORWARDING TRACKS.

Owing to the small number of classifications required, (see article on traffic conditions), the classification and forwarding tracks are included in one yard of six tracks, each 3000 feet long. The ladder tracks make the same angle with the body tracks as in the receiving yard. At a point 1000 feet from the south end of the yard is a ladder track with slip switches to facilitate the grouping of cars into trains. The grades are: from Sta. 98 + 20 to Sta. 95,
minus 1.0 per cent, from Sta. 95 to Sta. 70, minus 0.5 per cent, north of Sta. 70, 0.0.

WEST YARD.

The west yard is practically a duplicate of the east yard in both length of tracks and relative grades, as can be seen from Plate 2.

CROSS OVERS.

There are cross overs between the main tracks at both ends of the yards, and also at a point near Sta. 102. There are also cross overs as follows: near Sta. 108, between the north bound main and the west track of the north bound receiving yard, and at Sta. 104 between the south bound main and the east track of the south bound receiving yard. The last two cross overs are required to permit the road engines to go from the receiving yards to the round house, and also to allow trains which require no switching to proceed directly upon the main tracks without going over the hump and through the classification tracks.

ROUND HOUSE, SHOPS, ETC.

As before stated, it is planned to buy a forty acre plot to the west of the present right of way for shops. (See Plate 2). There are to be two leads from the south bound receiving, and one lead from the south bound classification tracks to the round house, and from these main leads sidings will run to the coal chute (F), oil house (H), machine shop (L), water tank (N), sand tower (V), ash pit (W), pump house (M), repair
tracks (G), and storage track (C). The tracks in the repair yard are to be spaced 20 feet center to center, all other tracks 14 feet centers. A switch tower (M), located at Sta. 103, being thus between the two humps, controls the switching in the entire yard.

COST.

The following table gives the estimated quantities and cost of construction:

(1). EARTHWORK.

Fill Sta. 110 to Sta. 136, 116300 cu. yds.
Cut Sta. 98 to Sta. 110, 31900 " "
Fill Sta. 70 to Sta. 98, 48500 " "
Cut in Yard 132500 " "
Total 164000 cu. yds. cut and fill @ 20¢ $ 32800.

(2). RETAINING WALL, (concrete), 600 cu. yds. @ 6.00 3600.

(3). GRAVEL BALLAST, 33400 cu. yds. @ 30¢ 10020.

(4). TRACK.

Per Mile.
Rails, 80# per yd., 132 tons @ $28. $3696.
Ties, (#2), 2640 @ 70¢ 1848.
Angle bars, 352 pr @ 40# 14080#
Spikes, 4 to each tie 5600
Track Bolts, 6 to each jt. 2112

\[
\text{Total laying and surfacing } 436. 
\text{Total track laying and surfacing } 1000. 
\text{Total } 14\frac{1}{2} \text{ miles of track } @ 3980 101210. 
\]

(5). LAND, 40 acres @ $200 8000.

(6). WATER TANK and PUMPING STATION (N & M, Plate 2) 7500.

(7). SAND TOWER (V, Plate 2) 3000.

(8). OIL HOUSE (H, Plate 2) 1000.

(9). COAL CHUTE (F, Plate 2) 20000.

(10). ASH PIT (W, Plate 2) 3400.

(11). SWITCH TOWER & SWITCHING SYSTEM (A, Plate 2) 15000.

(12). MACHINE SHOP (L, Plate 2) 25000.

(13). ROUND HOUSE (E, Plate 2) 30000.

(14). STORAGE (Y, Plate 2) 5000.

(15). FROGS & SWITCHES, 106 @ $200 21200.

\[
\text{TOTAL } 286740. 
\]
WILL IT PAY?

Should the yard be built as shown, two switching crews would still be required, one for the north bound yard, the other for the south bound business, but a third crew would not be needed at any season of the year, thus saving $1500 or 4% on $37500. (See Introduction). Again, cars can be switched one half hour quicker, making 20 more cars available on the system, a saving of $30000, which with the amount before mentioned, makes a capitalized saving of $67500. From the estimated cost should be deducted items 5, 6, 7, 8, 9, 10, 12, 13, and 14, 20% of item 15, and 10% of item 4, or a total of $117261, since it will be necessary to move the round house and shops in the near future to a point nearer the Green Street yards. The actual cost of remodeling the yards alone would then be $169479, which is far in excess of the capitalized saving of $67500, and consequently, while the cost of running the present yards is greater than that which would be required to operate the proposed yard, the first cost of the improvement makes it prohibitive. Not until the business at Champaign yards is approximately three times what it is at present can switching by the hump gravity method be given consideration.