Petroleum

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Informal Note 44

YARD GEOMETRIC DESIGN: CONTRIBUTIONS FROM UNION PACIFIC

Mr. M.J. Anderson, Manager of Terminal Planning and Desige, spent a great deal of time documenting his thoughts and experience on yard geometric design for the project. His contribution will ultimately be integrated with other contributions at a later date. However, because his work is already in a good form, we though it should stand alone as a project working note. Consequently, his contribution is attached.

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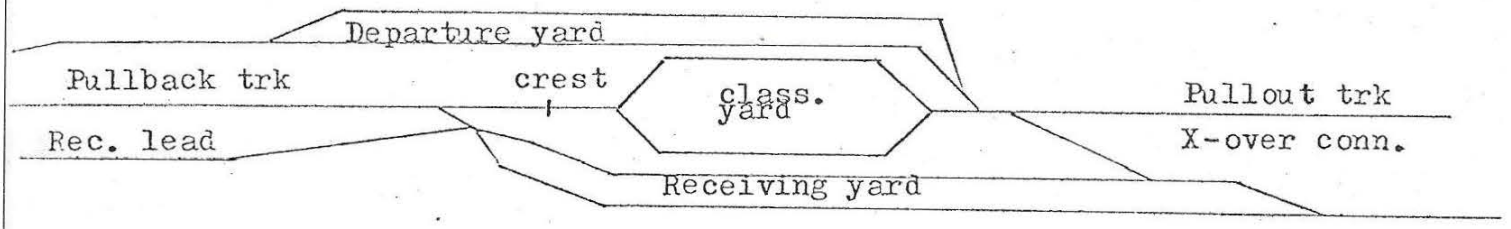
YARD GEOMETRIC DESIGN

The yard configuration should have been determined with site selection as different yard configurations have their own space requirements which may be determined by the site location. The various yard configurations that are most commonly used are:

1. Parallel receiving and parallel departure with classification yard between



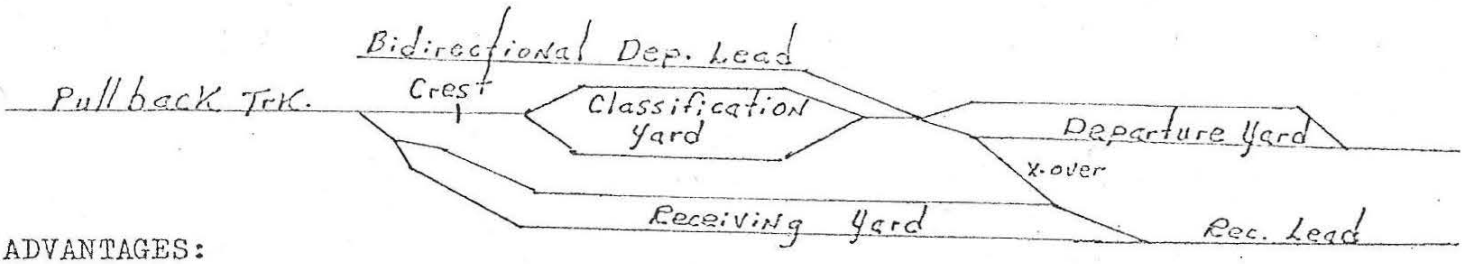
ADVANTAGES:

(a) If one direction of traffic is used such as westbound in the above sketch there are no conflicting moves for arriving and departing trains.
(b) Overflow blocks from classification yard can be set to departure yard and then easily put in their proper location in the train later.
(c) By setting part of your train to departure yard earlier allows carmen to work this portion of the train speeding departurer time when train is completed.
(d) Warms up journals & bearings pulling back train prior to humping; which provides better rolling characteristics on cars during humping. This speeds humping process.
(e) With X-over connection to receiving yard it allows you to fill a train that has bypass blocks. Also, when reducing a train the sluff is in the proper place to go to the hump.
(f) Shortest length requirement from west end of departure yard to east end of receiving yard.
(g) This type of configuration also allows better acess to receiving and departing trains as leads are occupied the least amount of time than other configurations.

DISADVANTAGES:

(a) Requires the widest area at classification yard location than any other configuration.
(b) Moving power from receiving and departure yards requires crossing pullback leads; which if volume is great enough it may require a power overpass or underpass to move power from receiving yard to diesel shop and back to departure yard.

2. Parallel receiving and in line departure.



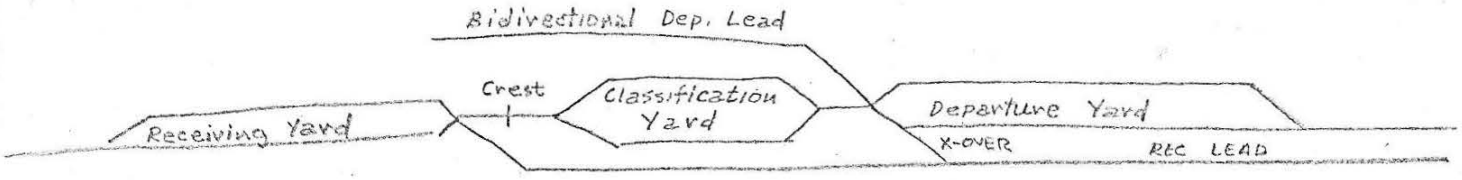
ADVANTAGES:

(a) If bidirectional traffic is run thru this configuaration westbound traffic should run out of the north ½ of departure yard to avoid conflict.
(b) Warms up journals and bearings pulling back trains prior to humping which provides better rolling characteristics on cars during humping. This speed up humping process. This configuration with the parallel receiving yard has the same advantages as items d & e in the preceding configuration.
(c) With X-over connection to receiving yard it allows you to fill a train that has bypass blocks. Also, to reduce a train, the sluff is in the proper place to go to the hump.
(d) Requires less width at the center of classification yard than the parrallel receiving and parallel departure.

DISADVANTAGES:

(a) Requires same distance from west end of pullback track to east end of departure yard as in line receiving and in line departure yard.
(b) Requires all blocks to be in bowl at time train is to be made up.
(c) Slows the trimming process by reuiring switch engine to make bidirectional moves with a large number of cars on last moves to make up train.
(d) Taking power from diesel shop on south side to departure yard requires conflicting moves.

3. In line receving and in line departure.



ADVANTAGES:

(a) This requires the least width of any classification configuration.
(b) This configuration usually works best with one direction of traffic to minimize the conflict at the hump end of receiving yard and the trim end of departure yard.

DISADVANTAGES:

(a) This configuration requires the most length from west end of receiving yard to east end of departure yard.
(b) Requires all blocks to be in bowl at time train is to be made up.
(c) Slows the trimming process by requiring switch engine to make bi-directional moves with a large number of cars on last moves to make up train.

After yard configuration has been determined the Geometric design begins with listing of size of turnouts to be used in the different areas of the yard and maximum curvature to be allowed in the different parts of the yards.

CURVES:

Curves that are used in railroad design are of the chord definition. In railroad curves the degree of curve is the central angle subtended by a 100 ft. chord.

D= Degree of curve
V= Vertex or point of intersection (=P.I.)
I= Deflection angle between the tangents
P.C.= The beginning of the curve (point of curve)
P.T.= The end of curve (=Point of tangent)
T= The tangent distance
E= The external distance
R= The radius of the curve
L= The length of the curve (P.C. to P.T. along curve)
L.C.= The long chord (P.C. to P.T. on chord line)
M= The middle orinate. (K to the mid point of L.C.)

Formulas related to simple curves:

T= R tan I/2

E=

$$L = \frac{I \times 100}{D}$$

$$R = \frac{50}{\text{Sin } \frac{1}{2}D}$$

While different railroads may apply different standards the following guidlines are recommended inthe different parts of the yard.

RECEIVING AND DEPARTURE YARD

The maximum of 4 degree curves should be utilized throughout the body of the tracks after the turnouts to enable the coupling of cars without passing drawbars.

The approaches to the receiving yard and exits to the departure yard, on their leads, a maximum of 2° curves with at least 40 M.P.H. spirals should be maintained to speed the process of arriving and departing trains.

CLASSIFICATION YARD:

While there are many yards designed with 14 degree curves on the outside tracks and even some with as high as 16 degree curves, it is best to limit the entrance curves to $12^{\circ}30'$ if possible. There should be no curves in the body tracks if at all possible.

TURNOUTS:

The various number of turnouts are shown in the turnout data sheet shown in figure . For design information the most critical data is Frog angle, length of turnout, theoretical point of curve thru the turnout, location of joint behind point of switch, (where bent stock rail begins), distance from point of frog to heel of frog, distance from point of switch to end of switch ties. This information allows the designer to designate the proper turnout and make the necessary calculations to construct the trackage for its particular use.

The type of turnouts normally used in the various locations of the yard are as follows:

Receiving yard: No 14; or No 10's. Preferably No. 14's inbound Departure yard & Departure Yard: No 7 or No. 8's (dependant on R.R. Standard).

In receiving or departure leads where corssovers or connections to main line power operated No.20 turnouts should be utilized.

There are also numerous variations of how these turnouts may be used. The following list of most common uses and where they will appear.

Equilateral turnout - One half of the frog angle and degree of curve is split each way. This enables double the speed through the turnout. They are most commonly found as first 3 switches starting a throat design, usually on the hump end of a receiving yard or going into a group of bowl tracks.

Lap turnouts: This type of turnout requires the use of 3 frogs and one switch islayed right after the other. They are often used to start the leads into the hump end of the bowl. They are used to fan out to outside tracks as soon as possible.

These turnouts lead us into the different ways they may be used in rd design such as ladder tracks, Tandem ladder, Throat design, the ree most common uses.

STANDARD LADDER TRACK:

This is basically a ladder track on the frog angle with the point of intersection at each track being calculated by using the track centers and the frog angle. When track centers are increased the frog angle may be increased based on the properties of the turnout. This type of ladder is generally used in the receiving and departing ends of the receiving and departure yards

TANDEM LADDER:

A tandem ladder is based on twice the frog angle and switches are located as shown in sketch. This type of ladder is generally always found on the trim end of bowl andsometimes on receiving and departing ends of receiving and departure yards.

THROAT DESIGN:

The throat design splits a group of tracks generally with one half the frog angle on each side. It is started most frequently by a equilateral turnout and the second turnout on each side is equilateral which generates a standard ladder from that point on. However; a throat design may also start with a lap turnout and this is most common in the design of groups of bowl tracks. The other locations for this design would be the hump end of the receiving yard or the trim end of an in line departure yard.

GRADES:

The vertical curves connecting all grades are different than the horizontal curves explained previously in that they have the properties of a parabola. The following is the manner in which they are calculated and table provides offsets for standard distances.

HUMP GEOMETRIC DESIGN:

The hump geometry should be designed in such a manner that the distance from the hump crest to the tangent, points of the classification tracks becomes as short as possible. The detailed design of hump profile is done by using a computer hump profile evaluator, such as PROFILE, as a design evaluating tool.

General Rules:

Ascending grade to hump - usually the assending grade is somewhere between 0% (flat) to 3%. However; it is best to have at least 150 feet of positive grade approximately 0.5% to eleminate slack action enabling a better pin pulling operation.

. Desending grade from the hump - The maximum grade is considered to be approximately 6%. The grade should usually be less than the limit. .The length of the vertical curve at the hump crest is dependent on the approach and descending grades. If the maximum grades are used it should be at least 100 feet. However; if a .5% approach grade is used this vertical curve may be 80'.

CLASSIFICATION YARD:

Classification yards are generally designed with .08 to .11% of grade descending away from hump. These are considered non accelerating grades and generally .08% grade is used unless humping is done into the prevailing winds or the traffic is primarily emptys and then these grades may be increased to .10 or .11%. At the trim end of the classification yard a prevent rollout grade should be installed 300 feet from the clearance point. This is generally 300 feet of .4% grade. An inert retarder is installed at beginning of this grade change to assist in the stoppage of cars .

RECEIVING AND DEPARTURE YARDS:

The preferred grade in these yards is 0%; however, they may reach a grade of approximately .15% before consideration should be given to installing inert retarders to prevent roll outs without setting air insome of the cars.

Both ends of receiving and departure yards should have 300 feet of .4% grade to prevent rollouts.

HUMP PULLOUT LEAD:

In the pullback style yard, a positive grade of .1 - .6% is preferred in the pull direction. This is allows the slack to run out of the cars as switch engine changes directions to push to hump. This grade should be maintained as low as possible to allow quick and high speeds in pullback operation.

PULLOUT LEAD:

The preferred grade is between 0 and .2%. This grade should be positive toward the spur end of the drill track. Its purpose is the same as on the hump pullout track in that it allows the slack to run out of the cars as the switch engine starts toward the departure yard.

To assist the designer in laying out his yard it is recommended that templates be made of the throats and ladder designs with the number of tracks that each yard will require. These should be drawn on a scale of 1"=100 foot and with the proper track centers that are to be utilized. It is recommended at 14ft. track centers be used in classification yards and 22 to 25 ft track centers be used in receiving and departure yards for inspection roads.