



## Transportation Engineering II: Highway Design & Railways

### Lecture 10 POINTS & CROSSINGS SUPERELEVATION

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## Superelevation (Cant)



- Difference in height between the inner and outer rail on a curve

- Provided by gradually lifting the outer rail above the level of the inner rail

- Superelevation

$$e = \frac{GV^2}{gR}$$

$G = \text{gauge}, V = \text{velocity}, R = \text{radius of the curve}$

- If  $V$  is in kmph and  $e$  is in cm,

$$e = \frac{GV^2}{127R}$$

## Superelevation



### ▪ Superelevation for different gauges:

$$\text{For BG, SE (e)} = \frac{v^2 \times 1.676}{1.27 \times R} = 1.315 \frac{v^2}{R}$$

$$\text{For MG, SE (e)} = \frac{v^2 \times 1.00}{1.27 \times R} = 0.80 \frac{v^2}{R}$$

$$\text{For NG, SE (e)} = \frac{v^2 \times 0.762}{1.27 \times R} = 0.60 \frac{v^2}{R}$$

### ▪ Maximum superelevation:

- UK: 19cm
- USA: 15.2cm
- Bangladesh: 16.5cm (BG), 10.2cm (MG), 7.6cm (NG)

## Optimum Speed



### ▪ Factors to consider:

- Depends not only on the maximum speed of the fastest train, but also on the heavier trains that move at a slower pace
- Compromise: fast trains run smoothly without causing discomfort to the passengers, slow trains run safely without derailment/overturning

### ▪ Speed used in equation is equilibrium speed

## Terms Related to Superelevation

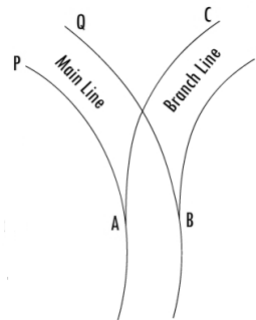


- Equilibrium cant
  - Value of superelevation derived from the equation using equilibrium speed
- Cant deficiency (Cd)
  - Occurs when a train travels around a curve at a speed higher than the equilibrium speed
  - Difference between cant required at travel speed and actual cant
  - Maximum permissible Cd: 7.6cm (BG), 5.1cm (MG), 3.8cm (NG)
- Cant excess (Ce)
  - Occurs when a train travels around a curve at a speed lower than the equilibrium speed
  - Difference between actual cant and cant required at travel speed

## Negative Superelevation



- Mainline: B higher than A
- Branchline: A higher than B



# Negative Superelevation



Procedure for finding respective speeds on main and branch lines will be as follows:

- The equilibrium cant on branch line is calculated by usual formula by assuming suitable speed on branch line.
- The permissible cant deficiency is deducted from the equilibrium cant.
- The result thus obtained will represent the negative super-elevation to be given on the branch line.
- Evidently, the negative cant on branch line will be equal to the maximum cant permitted on the main line.
- Permissible cant deficiency is added to the maximum cant permitted on the main line and correspondingly, the restricted speed on main line is worked out.

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## CE 353 Transportation Engineering II: Railways



### Problem 1

A 6 degrees curve branches off from a 3 degrees main curve in an opposite direction in the layout of a B.G. yard. If the speed on the branch line is restricted to 35 kmph, determine the speed restriction on the main line. Assume permissible deficiency in cant as 76 mm.

### Solution:

$$\text{S.E. for branch line} = 1.315 \frac{v^2}{R} = 1.315 \frac{35^2}{1750/6} = 5.523 \text{ cm}$$

$$\text{Negative super-elevation} = 5.523 - 7.60 = -2.077 \text{ cm}$$

$$\text{Maximum S.E. that can be given on main line} = 2.077 \text{ cm}$$

$$\text{Theoretical S.E. on main line} = 2.066 + 7.60 = 9.677 \text{ cm}$$

$$\text{Hence, } 9.677 = 1.315 \frac{v^2}{1750/3}$$

$$V = 65.92 \text{ kmph speed on main line}$$



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## Points and Crossing

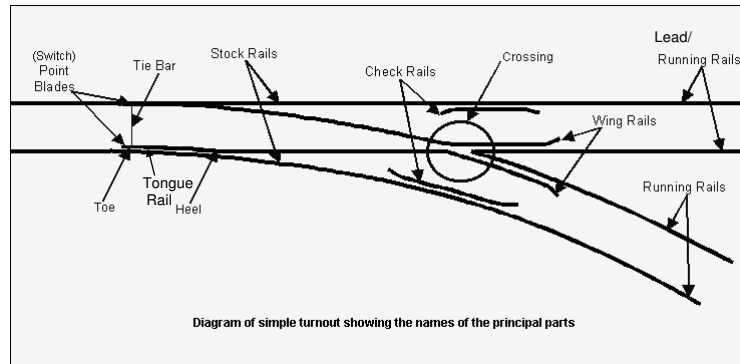


- Points and crossings are provided to transfer trains from one track to another
  - Point (Switch): the device that is use to divert the wheels
  - Crossing: gaps in the rail that enables the actual diversion
  - Turnout: Complete set of points and crossing including the main (lead) rail
    - Left hand turnout
    - Right hand turnout

## A Railway Turnout



## Parts of a Right Hand Turnout

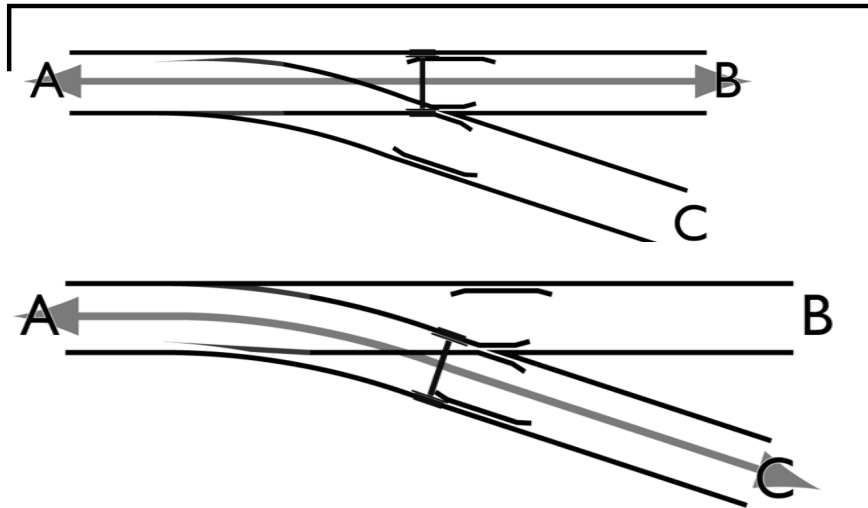


## Parts of a Turnout



- Turnout** : It is an arrangement of points and crossings with lead rails by means of which rolling stock may be diverted from one track to another track.
- Tongue rail** : It is a tapered movable rail made of high carbon or manganese steel to withstand wear. It is attached at its thicker end to a running rail. A tongue rail is also called sometimes a switch rail.
- Stock rail** : It is the running rail against which a tongue rail operates.
- Switch** : A pair of tongue and stock rails with necessary connections and fittings forms a switch.
- Points** : A pair of tongue rails with their stock rails is termed as 'Points'.
- Crossing** : A crossing is a device introduced at the junction where two rails cross to permit the wheel flange of a railway vehicle to pass from one track to another track.

## How Switches Work:



Animation Link: [http://en.wikipedia.org/wiki/File:20080202-EMDX\\_AiguillageAnime.gif](http://en.wikipedia.org/wiki/File:20080202-EMDX_AiguillageAnime.gif)

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## Types of Crossing



- V Crossing: Meets at acute angle



- Diamond Crossing: Meets at obtuse angle

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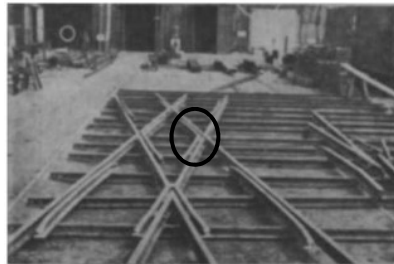
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## Types of Crossing



- V Crossing: Meets at acute angle
- Diamond Crossing: Meets at obtuse angle

AT EAST TOWN WORKSHOPS.



First Diamond Crossing turned out of new Points and Crossing Shop at East Town.