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Continuing Education Course #330  
Railroad Curves Simplified

1. Using the FRA formula and Rail Curve software, find the MAXIMUM train speed in miles per hour for:  
1-degree curve (chord definition)  
6-inches of cant  
3-inches of cant deficiency
  - a. 98-mph
  - b. 110-mph
  - c. 113-mph
  - d. 120-mph
  - e. 123-mph
  
2. Using the FRA formula and Rail Curve software, find the MINIMUM train speed in miles per hour for:  
1-degree curve (chord definition)  
3-inches of cant deficiency  
A maximum train speed of 110-mph
  - a. 59-mph
  - b. 84-mph
  - c. 93-mph
  - d. 110-mph
  - e. 113-mph
  
3. What is the cant in problem 2?
  - a. 3.5-inches
  - b. 4.5-inches
  - c. 5.5-inches
  - d. 6.5-inches
  - e. 7.5-inches
  
4. Using the FRA formula and Rail Curve software, find the radius in feet for:  
3-inches of cant deficiency  
A balanced train speed of 90-mph  
A maximum train speed of 110-mph
  - a. 4896-feet
  - b. 4962-feet
  - c. 5134-feet
  - d. 5263-feet
  - e. 5348-feet
  
5. What is the MINIMUM train speed in question 4?
  - a. 59-mph
  - b. 64-mph

- c. 93-mph
  - d. 110-mph
  - e. 113-mph
6. What is the cant in problem 4?
- a. 3-inches
  - b. 4-inches
  - c. 5-inches
  - d. 6-inches
  - e. 7-inches
7. Using the FRA formula and Rail Curve software, find the MAXIMUM train speed in miles per hour for:  
45-minute curve (chord definition)  
4.5-inches of cant  
A minimum train speed of 60-mph
- a. 98-mph
  - b. 110-mph
  - c. 116-mph
  - d. 120-mph
  - e. 123-mph
8. Using the FRA formula and Rail Curve software, find the cant in inches for:  
3-inches of cant deficiency  
A minimum train speed of 60-mph  
A maximum train speed of 120-mph
- a. 3-inches
  - b. 4-inches
  - c. 5-inches
  - d. 6-inches
  - e. 7-inches
9. What is the radius of a 1-degree curve (chord definition)?
- a. 5729.65-feet
  - b. 5729.58-feet
10. Using the table on page 9 of the course document to compare the 'FRA formula and Rail Curve software' results to the 'Principal of Physics' results for calculating maximum allowable train speed, the results are:
- a. Identical
  - b. Nearly the same (within 0-2 mph)
  - c. drastically different

**Now change Rail-Curve to "Principals of Physics" mode.**

11. Using the Principals of Physics and Rail Curve software, find the radius in feet for:  
59.5-inch rail spacing  
4-inches of cant  
A balanced train speed of 85-mph  
A maximum train speed of 120-mph
- a. 6941-feet
  - b. 7169-feet
  - c. 7208-feet

- d. 7575-feet
- e. 7748-feet

12. What is the cant deficiency in problem 11?

- a. 3.5-inches
- b. 3.7-inches
- c. 3.9-inches
- d. 4.1-inches
- e. 4.3-inches

13. Using the Principals of Physics and Rail Curve software, find the cant in mm for:

1520-mm rail spacing

A 50-minute curve (chord definition)

A balanced train speed of 100-kph

- a. 57-mm
- b. 65-mm
- c. 70-mm
- d. 73-mm
- e. 76-mm

14. Now modify question 13 by adding a cant deficiency of 100-mm. What maximum velocity does this produce?

- a. 111-kph
- b. 129-kph
- c. 136-kph
- d. 143-kph
- e. 166-kph

15. Using the Principals of Physics and Rail Curve software, find the cant in inches for:

59.5-inch rail spacing

2-inches of cant deficiency

A minimum train speed of 45-mph

A balanced train speed of 78-mph

- a. 3-inches
- b. 4-inches
- c. 5-inches
- d. 6-inches
- e. 7-inches

16. What is the curve radius in problem 15?

- a. 7010-feet
- b. 7408-feet
- c. 7936-feet
- d. 8059-feet
- e. 8406-feet

17. What is the maximum train speed in problem 15?

- a. 98-mph
- b. 101-mph
- c. 116-mph
- d. 119-mph
- e. 123-mph

**Note: This question was revised on 21 Dec 2018**

18. Continuing with question 15, make the following entries on the Spiral Transition spreadsheet:

Spiral Length of 500-feet

Delta angle of 35-degrees

What is the total curve length?

- a. 1514-ft
- b. 1948-ft
- c. 5423-ft
- d. 6214-ft

**Note: This question was revised on 21 Dec 2018**

19. Continuing the previous question, now reduce the spiral length to 150-feet. What warning message appears in the footer of the "Spiral Transition" spreadsheet?

- a. Minimum train speed cannot be greater than maximum train speed
- b. Overdetermined - Too many entries
- c. Cant deficiency for min & max speeds will be different values
- d. WARNING! Short spiral length may cause diagonal warping of car bodies

**For the next three questions will perform a "One-at-a-time" Sensitivity analysis of the relationship between cant, curvature and balanced train speed.**

[https://en.wikipedia.org/wiki/Sensitivity\\_analysis#One-at-a-time\\_\(OAT/OFAT\)](https://en.wikipedia.org/wiki/Sensitivity_analysis#One-at-a-time_(OAT/OFAT))

20. Using the Principals of Physics and Rail Curve software, calculate the sensitivity of cant to a doubling of balanced train speed. Start with these variables:

59.5-inch rail spacing

0-inches of cant deficiency

A 1-degree (chord definition) curve

A balanced train speed of 40-mph

the resulting cant is 1.11-inches. Now double the balanced train speed to 80-mph.

Doubling the balanced train speed has the effect of increasing the cant by approximately \_\_\_\_\_ times.

- a. 2-times
- b. 3-times
- c. 4-times
- d. 5-times

21. Using the Principals of Physics and Rail Curve software, calculate the sensitivity of cant to a doubling of the curvature. Start with these variables:

59.5-inch rail spacing

0-inches of cant deficiency

A 1-degree (chord definition) curve

A balanced train speed of 40-mph

the resulting cant is 1.11-inches. Now increase the curvature to 2-degrees.

Doubling the curvature has the effect of increasing the cant by approximately \_\_\_\_\_ times.

- a. 2-times
- b. 3-times
- c. 4-times
- d. 5-times

22. Using the Principals of Physics and Rail Curve software, calculate the sensitivity of balanced train speed to a doubling of the cant. Start with these variables:

59.5-inch rail spacing

0-inches of cant deficiency

A 1-degree (chord definition) curve

A cant of 2-inches

the resulting balanced train speed is 53.69-mph. Now double the cant to 4-inches.

Doubling the cant has the effect of increasing the balanced train speed by approximately \_\_\_\_\_ times.

- a. 1.2-times
- b. 1.4-times
- c. 1.6-times
- d. 2.0-times

23. We use a technique called "Cascading Lookup Tables to find values for "Cant" when inputs include only "Cant Deficiency" and any two of the three train speed variables. While we freely admit that the level of accuracy is unwarranted, the results are accurate to \_\_\_\_ significant digits.

- a. 5
- b. 7
- c. 9
- d. 12
- e. 15

24. Referring to the "Spiral Legend" tab on the "Rail-Curve" software, The green "Unspiraled Portion of the Central Curve" and the dashed "Simple Unspiraled Curve" are concentric (have the same center point).

- a. True
- b. False

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