



MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 401: HIGHWAY ENGINEERING I

DATE: 17/8/2021

TIME: 2.00-4.00 PM

INSTRUCTIONS

- This paper comprises of five questions. Answer **three** questions
- Question one is **compulsory** and carry 30 marks
- Answer any other **two** questions

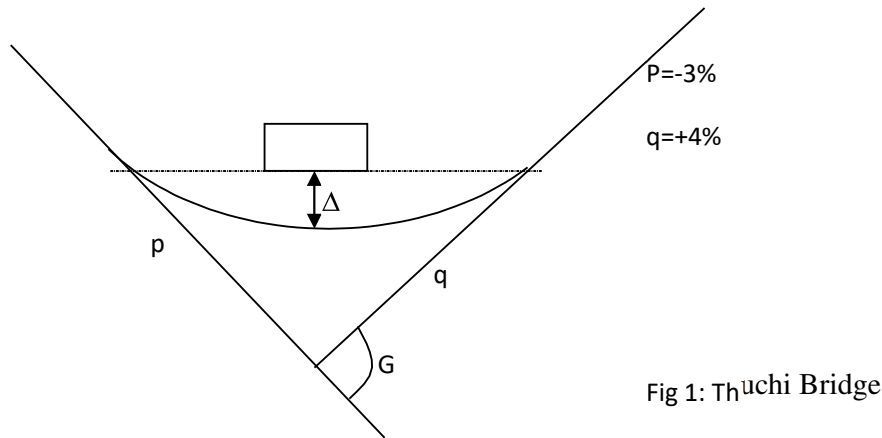
QUESTION ONE (COMPULSORY) (30 MARKS)

- a) A horizontal curve whose diameter is 900m balances 45% centrifugal force,
- Calculate super elevation for a velocity of 85km/h. (2 marks)
 - If the above super elevation and curve radius balances the hand off speed, estimate the design speed. (2 marks)
 - Briefly discuss FIVE fractional classifications of roads. (10 marks)
- b) i With illustrative diagram(s), differentiate between acceleration and deceleration lanes. (6 marks)
- ii. The Nithi bridge vertical curve alignment in Tharaka-Nithi County has the first tangent as +4% and second tangent as +1%. if the elevation of the point of intersection is 203.25m, the chainage of end of vertical curve (EVC) is 1024.05m and desirable stopping sight distance is 225m, estimate the elevation of
- Beginning of curve (4 marks)
 - Point of chainage 898m (3 marks)
 - EVC (3 marks)

(Use $h_1 = 1.05$ and $h_2 = 0.26$ m)

QUESTION TWO (20 MARKS)

- a) The Thuchi bridge has a 4.5m Vertical clearance to edge of structure of obstruction as shown in figure 1 below. Given that the absolute and desirable stopping distance for design speed of 85km/h is 160m and 215m respectively, determine the length of the sag curve for the absolute and desirable cases. (10 marks)



- b) i) Define super elevation and state its advantages on road design. (4 marks)
- ii. Calculate the speed at which a vehicle should traverse a circular curve of radius 750m having maximum super elevation of 5% such that no steering effort is required to balance the forces acting on the vehicle. What is this speed called? (6 marks)

QUESTION THREE (20 MARKS)

- a) i. A -3% grade is being joined to a -5% grade by means of a parabolic curve of length 1200m. Calculate the vertical offset at the point of intersection of the tangent. (6 marks)
- ii. State any four widely accepted criteria for determining the minimum length of vertical sagculves (4 marks)
- b) i Calculate the down slope and upslope braking distance for a 1.5 tonne vehicle moving at 80km/h on a road with coefficient of 0.4 and friction grade of 1:40 for a perception time of 2.5 sec. (6 marks)
- ii. The horizontal curve in Athiriver is designed for a two-axled truck for extra width w of 0.6, lateral width between the wheels of 1.3m and length between front and rear axles of 7m. Estimate the radius of the inner rear wheel in the curve. (4 marks)

QUESTION FOUR (20 MARKS)

- a) For a two-lane single carriage with lane width of 5.65m, cross fall on tangent of 2.5 percent and super elevation on circular curve of 6 percent, determine
- Length of the transition curve and
 - Radius of the circular curve
- Take speed=85km/h and rate of gain of radial acceleration = 0.45m/s^3 . (10 marks)

Speed	Max Slope (Longitudinal)
50	0.66%
85	0.50%
100	0.40%
140	0.36%

- b) i With illustrative diagram(s), define Passing Sight Distance (PSD), safe PSD, Preliminary delay distance, Overtaking distance and Safety distance. (5 marks)
- ii Briefly discuss five factors affecting the traffic speed. (5 marks)

QUESTION FIVE (20 MARKS)

- a) A horizontal alignment in kitui road is as shown in figure 1. It consists of a circular curve of radius 850 m and spirals on either end. The tangents meet at an angle of 38° . If the length of the circular curve is 76.5m and the chainage at the end of the alignment is 1185.45m, estimate the
- Length of spiral curve. (3 marks)
 - Chainage of beginning of curve (3 marks)
 - Tangent length (3 marks)
 - Chainage of point of intersection (3 marks)

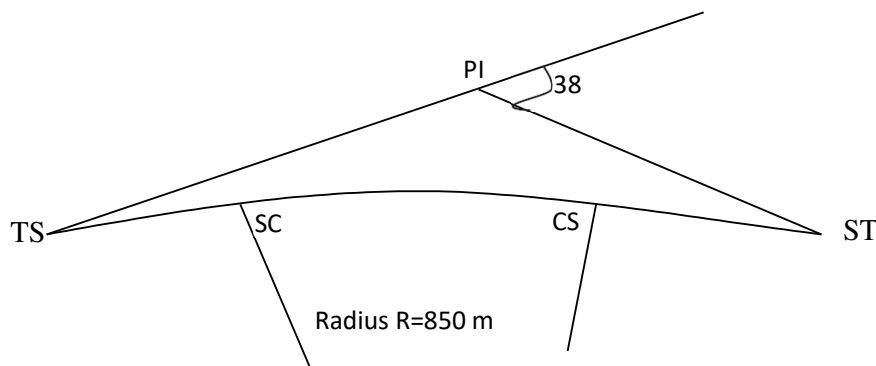


Figure 1

- b) i State four advantage of a super elevation on a horizontal curve (4 marks)
- ii State four factors that determine the Maximum super elevation to be used on a horizontalcurve (4 marks)