طرق ومطارات

Mansoura University
Faculty of Engineering
Public Works Dept.

Highway and Airport Engineering

Final Exam -- الامتحان في (٤) صفحات

4th Year Civil
Time: 3 Hours
3 January 2009

Closed Books and Notes Exam & Assume Reasonably Any Missing Data & Total Mark = 110 Pts.

First Question (20 points)

Answer The Following Questions and be specific (each question 2 pts).

a- What is the main difference between the function of the base layer in Flexible and Rigid Pavements?
b- What is unique about the softening point of an asphalt?
c- What is the function of the steel reinforcement in the JRCP?
d- In the Superpave grading system for AC, what test(s) associated with HMA rutting, fatigue cracking, and thermal cracking.
e- What are the three major types of asphalt materials? State how each type achieve viscosity for use in pavement construction.
f- What is the effect of the stress on the resilient modulus of both coarse and fine grained materials?
g- Which soil has better strength A-4(5) or A-4(9)? Explain why?
h- What is the design criterion of the AASHTO design method for flexible pavements?
i- What is wander? Why wander is more important when designing runways and taxiways compared to highways?
j- A coarse aggregate has a bulk saturated surface dry specific gravity of 2.640. If the absorption of the aggregate is 2%, determine the bulk dry specific gravity of the aggregate.

Second Question (20 points)

a- **(3 pts)** What is the significance of each of the following tests:
1) Soundness test 2) Los Angles test 3) RTFO test

b- **(2 pts)** On one plot show a well graded aggregate, open graded aggregate, gap graded aggregate and a uniform graded aggregate.

c- **(3 pts)** Draw the 6 plots used to design the HMA using Marshall Method and explain how the optimum asphalt content is determined from these plots.

d- **(12 pts)** A compacted asphalt mix is comprised of the following properties:
AC (Gb = 1.022, P_b = 5% by total weight of mix), Coarse Aggregate (G_b = 2.61, P_{ca}= 53%), Fine Aggregate (G_b = 2.65, P_{fa}= 35%), and Mineral filler (G_b = 2.70, P_{mf}= 7%). The bulk density of the compacted specimen (G_{mb} = 2.360) and maximum theoretical density is (G_{mm} = 2.450).
Determine: **a) %Va b) %VMA c) %VFA d) %Effective asphalt e) %Absorbed asphalt**

Third Question (20 points)

a- The truck axels **in the design lane** were weighed for one day on a 4-lane highway. The results are shown below.

Vehicle Type	Axle Load (lb)	Percentage	LEF
Passenger Cars	1000	50	0.00002
2-Axle single unit truck	5000	30	0.005
3-Axle single unit trucks	7000	15	0.0196
4-Axle single unit trucks	14000	5	0.360

If the Average Annual Daily Traffic is 11000; answer the following questions:

1. **(6 pts)** Estimate the 10-year cumulative ESAL in the design lane (assume no growth).
2. **(2 pts)** Calculate the average truck factor for this highway.

b- **(3 pts)** Determine the AC and Base layer thicknesses for the pavement system shown in the given figure if $SN_1 = 3.2$ and $SN_2 = 4.5$.

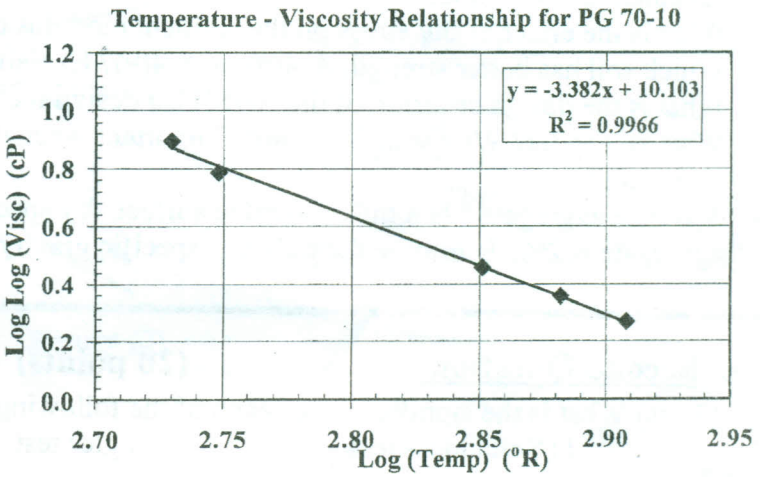
Surface, $E_1 = 400{,}000$ psi , $a_1 = 0.44$
Base, $E_2 = 40{,}000$ psi , $a_2 = 0.14$, $m_2 = 1.1$
Subgrade, CBR = 8%

c- **(3 pts)** In the AASHTO 1993 flexible design method, the equation relating the relative subgrade damage to a given modulus is given by: $U_f = 1.18*10^8*Mr^{-2.32}$ For the seasonal subgrade modulus values shown below, compute the effective subgrade modulus that would be used in the pavement design.

Season	Winter	Autumn	Spring	Summer
Mr, psi	15000	7000	8000	5000

d- The temperature viscosity relationship for a PG 70-10 binder is shown in the given figure. Based on this figure, answer the following questions:

1. **(2 pts)** What is meant by PG 70-10?
2. **(2 pts)** Determine the Ai and VTSi for this binder.
3. **(2 pts)** A HMA using this binder was used in the construction of a highway project and the mix delivered at the site was at 125 °C. After Mix laydown and compaction the field density was found to be 2.26 t/m^3. If the required density was 2.45 t/m^3. Why do you think the required density was not achieved?



Hint: °R = °F + 459.7
°C = (°F – 32)*(5/9)

Fourth Question : (20 points)

1. **Write short notes about the following:**
   - **a) (2 pts)** Importance of Medians and Curbs for highways.
   - **b) (1 pt)** Degree of curvature of horizontal curves.
   - **c) (1 pt)** Overturning effect of centrifugal forces on horizontal curves.
   - **d) (2 pts)** Widening of pavement on horizontal curves.
2. a) **(2 pts)** List the various geometric elements to be considered in highway design.
   b) **(2 pts)** State the various considerations in deciding the ruling gradients of highway.
   c) **(2 pts)** State the factors that govern the length of vertical curves.
3. **(2 pts)** **Figure (1)** shows a plan and profile for a highway, there are 2 problems with this alignment. What are they?
4. **(6 pts)** Given a 2-lane highway with 12 ft lane width. There is a horizontal curve with radius = 600 ft and the superelevation was attained as shown in **Figure (2),** what is the speed limit on the curve.

Fifth Question : (20 points)

A 4-lane divided highway is to be designed. The following are the relevant data for the design process:

- Design Speed = 70mph
- Lane width = 12ft
- Shoulder width = 10ft
- Side slopes (3:2) in fill sections & (4:1) in cut sections
- Maximum superelevation = 0.02 (the normal cross slop)
- Median width = 12ft
- Coefficient of friction (f) = 0.29

It is required to:

a) **(3 pts)** Draw a complete cross-section of this highway in a cut area showing all elements.

b) **(6 pts)** Find out the safe operating speed that should be maintained along the shown section of the highway in **Figure (3),** assume that sight distance is larger than the curve length.

c) **(3 pts)** Determine the location and elevation of the highest point for the crest curve.

d) **(4 pts)** For the sag vertical curve shown in **Figure (3),** suppose that the length of the sag vertical curve (L) =150 ft If a car is entering the sag vertical curve where a tree has fallen across the road at approximately the PVT of this curve. The speed of the car was 30 mph on a wet road condition (f = 0.35). Assuming the driver cannot see the tree until it is lit by his headlights, is it reasonable to expect the driver to be able to stop before hitting the tree?

e) **(4 pts)** Draw a half plan of a 90 'at-grade intersection, if another highway having the same characteristics crosses the given highway at certain point. (Take the acceleration lane length = 625ft with taper length of 230ft & deceleration lane length = 475 ft with taper length of 230ft & The radius and width of turning roadway are 100 and 20 ft respectively, do not use deceleration lanes for left turn movements) (Use a reasonable scale).

Sixth Question : (Airport Engineering) (25 points)

a) **(2 pts)** Explain the advantages and disadvantages of air transport in general and in particular during the Nature / Human disasters like earthquakes and tusnami and bombing in Ghaza (Palestine) resulting from the criminal Israeli air force in December 2008.

b) **(4 pts)** As a part of the development plans of the Egyptian airports network, recently in December 2008, President Mubarak opened the third building in Cairo international airport, Explain briefly these plans and the benefits to the Egyptian economy, (Show your answer with a map).

c) **(9 pts)** Explain in details the factors and surveys required for airport site selection.

d) **(2 pts)** Draw a typical layout of an airport.

e) **(4 pts)** Draw the imaginary surfaces; determine the limiting heights of structures for landing and take off and horizontal surfaces. If the structures located at a distance of 5000 m from the middle of the airport and runway length is 3800 m.

f) **(4 pts)** Determine the corrected length of a runway, the following data are given:

- **The basic length** = 2600 m
- **Maximum ground level** =124 m
- **Minimum ground level** =120 m
- **Average ground level** = 122.5 m
- **Mean of the maximum daily temperature** = 39 ° C
- **Mean of the average daily temperature** = 26 ° C

Best Wishes

Examiners: **1- Prof. Dr. Mohamed El-Shabrawy** **2- Dr. El-Metwally El-Sekaily**
3- Dr. Sherief El-Badawy **4-Dr. Moustafa Kamel**

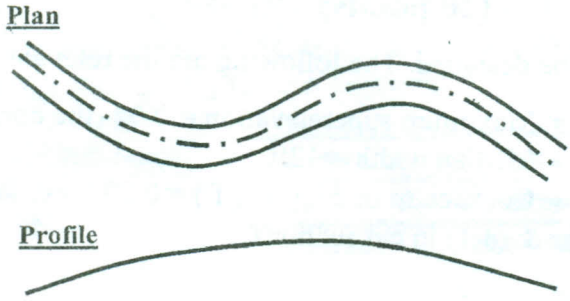


Figure (1)

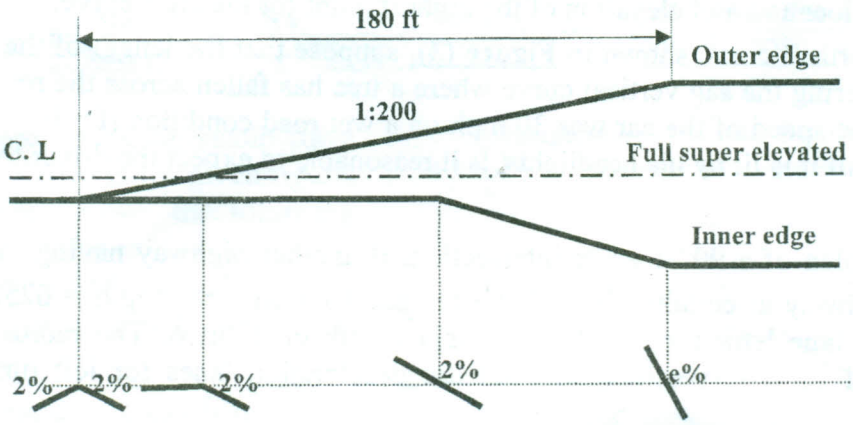


Figure (2)

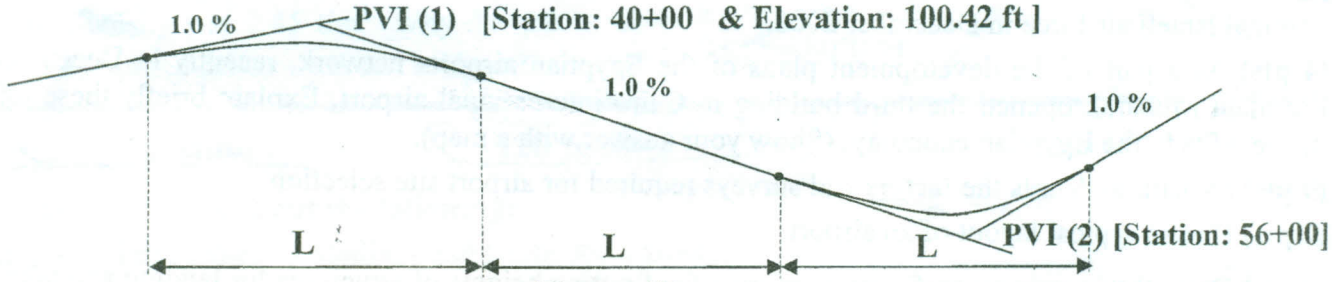


Figure (3)

**** For: S < L**

$$L_{\min} = \frac{AS^2}{1329} \quad \text{(Crest Curve)}$$

$$L_{\min} = \frac{AS^2}{400 + 3.5S} \quad \text{(Sag Curve)}$$

**** For: S > L**

$$L_{\min} = 2S - \frac{1329}{A} \quad \text{(Crest Curve)}$$

$$L_{\min} = 2S - \frac{(400 + 3.5S)}{A} \quad \text{(Sag Curve)}$$