Public Works Eng. Dept.	**Final Exam**	4th Year Civil
Faculty of Engineering	**Selective Course (3)**	Saturday, 6 June 2009
Mansoura University	**Highway & Airport Eng. Project**	Time Allowed: 3hrs.

Please Try All Questions.   *This is a closed book closed notes exam.*
Any missing data may be reasonably assumed.   *Total exam grade: 55 points.*
The Exam in 2 pages (4 faces)

Q1. True or False (10 points):

In your answer sheet just write the question number and __True__ or __False__

1. HMA layer is a permeable layer.

2. JPCP have fewer joints compared to JRCP.

3. Transverse Joints in rigid pavements are always constructed perpendicular to the centerline.

4. Spacing between contraction joints is usually larger than spacing between expansion joints.

5. Deflection due to corner loading is more severe than both edge and interior loadings.

6. The superposition principle can not be applied to the horizontal stresses.

7. In actual field condition, the contact pressure is not uniformly distributed throughout the contact area.

8. About 75% to 85% of the required AC compaction is achieved by the paver.

9. Longitudinal fatigue cracking always initiates at the top and propagates downward.

10. Curling stresses are usually not considered in thickness design of rigid pavements.

Q2. (15 points);

1. *(2pts)* What are the sources of water that affect the pavement layers?

2. *(2pts)* How can water affect the following pavement layers of a flexible pavement system:

     a) HMA   b) Subgrade

3. *(3pts)* Name the main components of a batch plant and state the function of each.

4. *(2pts)* What is the difference between tie bars and dowel bars?

5. *(4pts)* What are the possible reasons for the following pavement distresses?

     a) Bleeding of asphalt surface   b) Alligator fatigue cracking

     c) Transverse cracking   d) Corrugations

6. *(2pts)* Draw sketches for typical longitudinal and expansion joints in rigid pavements.
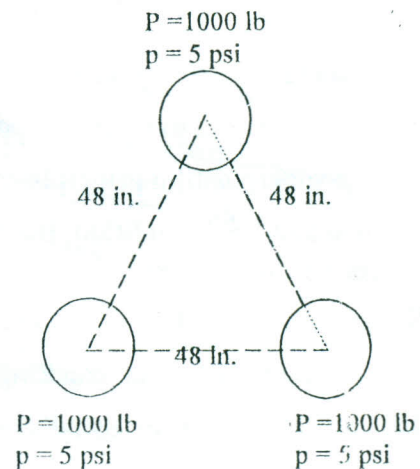
Q3. (15 points):

1. *(5pts)* A low-volume road is required to be constructed which consists of a layer of asphalt-treated stone on top of compacted subgrade. Assume that the design single wheel load is 6000 lb and the tire pressure is 80 psi. It is required that the deflection at the surface of the stone layer not to exceed 0.1 in. What is the minimum thickness of the stone layer in order to satisfy this requirement? The moduli of elasticity of the stone layer and the subgrade material are 30,000 and 3,000 psi, respectively.

2. *(5pts)* Determine the vertical stress at point A, which is located 10 in below the center of circle, due to the two circular loads shown in the following figure.
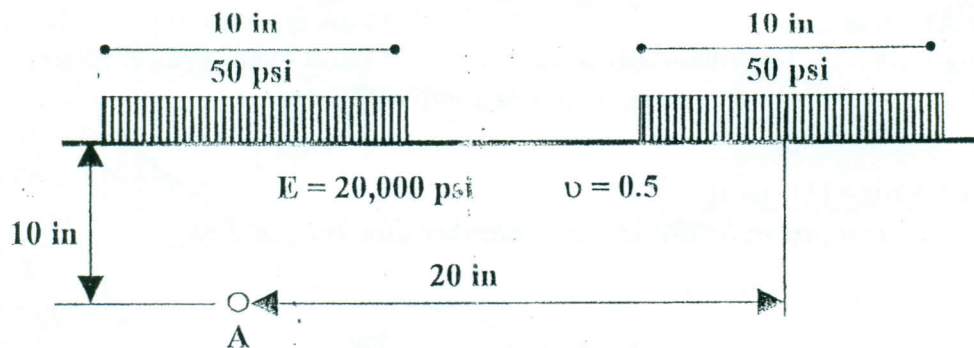

3. *(5pts)* Consider a small airoplane loading applied directely to the top on an unpaved homogenous subgrade ($E = 15,000$ psi, $\upsilon = 0.5$). The airpolane has a tricycle wheel arrangement with the wheels aranged in an equilateral triangle as shown in the figure. The load for each wheel is 1000 lb at a tire presure of 5 psi.

Determine the combined vertical stress at a depth of 24 inches belwo the center of one of the wheels.

Q4. (15 points):

1. *(5pts)* The cross section of a concrete pavement at a transverse expansion joint is as shown below. The radius of relative stiffness is 46.667 inch and the dowels are spaced 1 ft center to center .
   a) What is the load carried by dowel number 3.
   b) If the diameter of each dowel is 1.5 inch, what is the shear stress on dowel number 3.
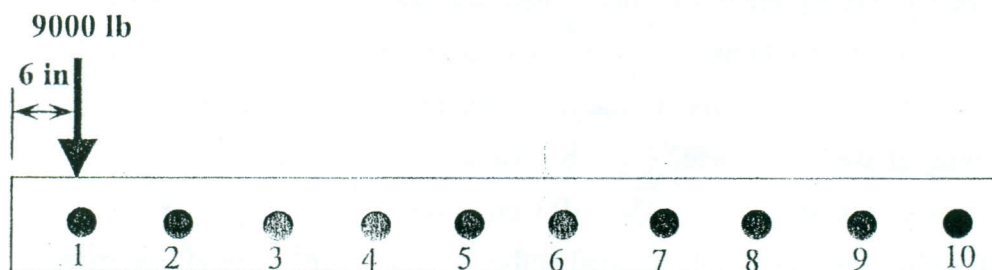
2. *(5pts)* Determine the maximum allowable joint spacing for a jointed plain concrete pavement with the following properties:

   Allowable joint opening = 1.5 mm   Concrete coefficient of thermal expansion = 9.9×10^{-6} /°C
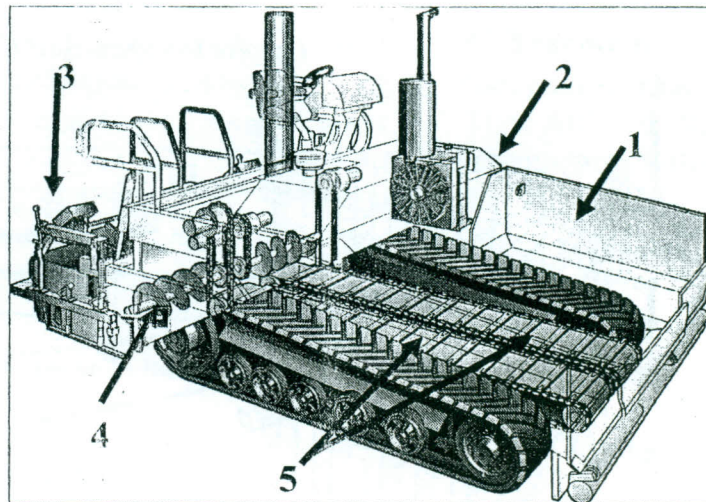
   Temperature change = 35 °C   Drying shrinkage coefficient of concrete = 1.0×10^{-4}

   Adjustment factor for slab-subbase friction = 0.65

   Hint: $\Delta L = C L (\alpha_t \Delta T + \varepsilon)$

gure on the right shows one of the
.t important equipments used in
.ghway construction.

a) *(2pts)* What is the name of this equipment?

b) *(3pts)* State the name and function of the parts 1 to 5.



Bonus Question (8 points):

1. *(3pt)* Paving is a constant balancing act. Explain this statement with a sketch.

2. *(5pts)* The two adjacent PCC pavement slabs shown in the figure below are to be tied together with tie bars spaced at 48 inch center to center. Determine the tie bar size and length. ($f_a = 1.5$, $u = 350$ psi, $f_s = 27,000$ psi).
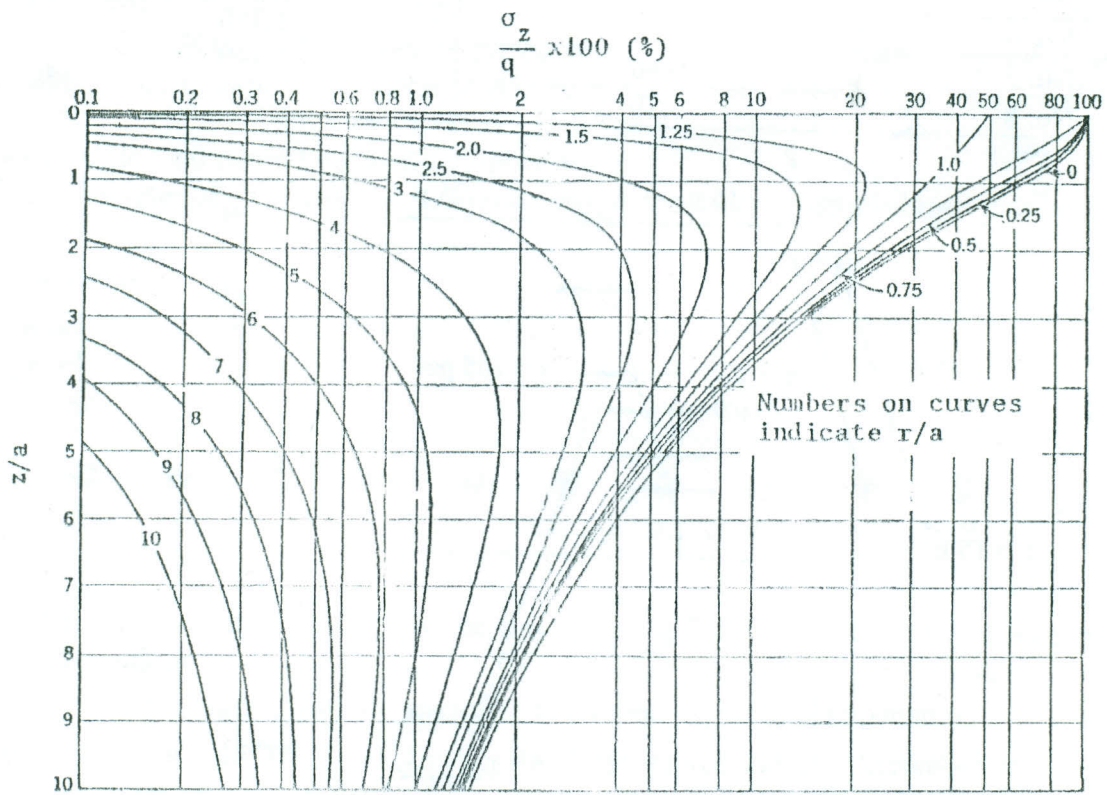
Hint: $t = 2\dfrac{A_1 f_s}{u\Sigma o} + 3"$

Bar Size	Cross-Sectional Area	Perimeter (in.)
No. 5	0.31	1.963
No. 6	0.44	2.356
No. 7	0.60	2.749
No. 8	0.79	3.142

Tie bars

$$w_o = \frac{1.5qa}{E_2} F_2$$
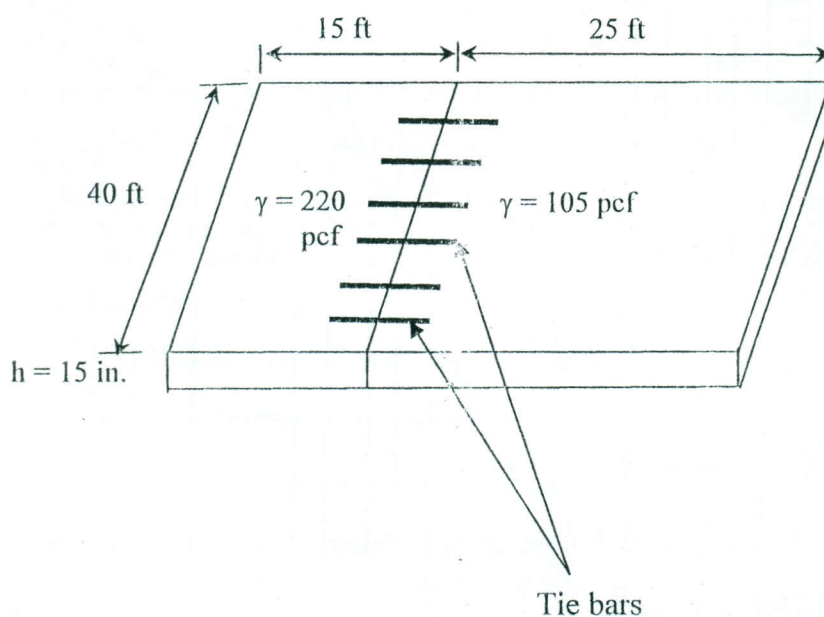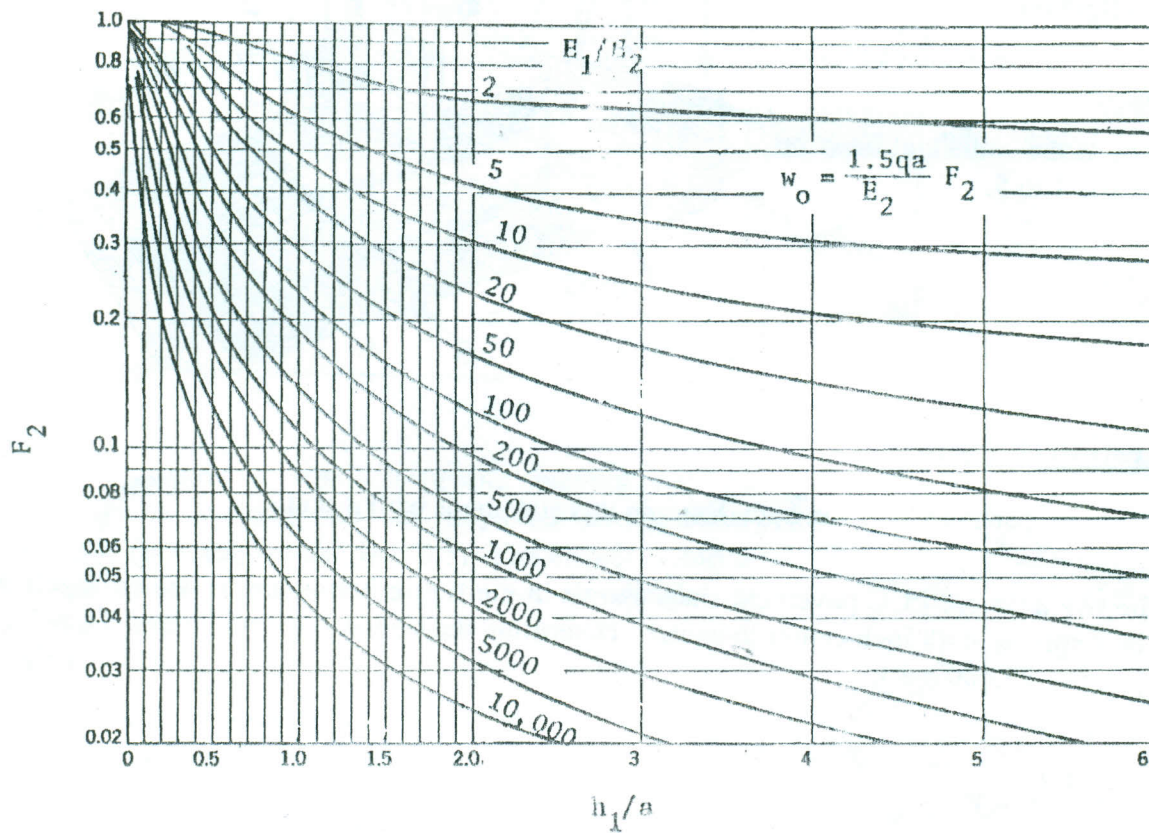
Surface Centerline Deflections

$$\frac{\sigma_z}{q} \times 100 \ (\%)$$

Numbers on curves indicate r/a

Vertical Stresses due to Circular Loading