(13)

B. Sc. Engg. (CEE)/ 6th Sem. 16 May, 2023 (Group B: Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination **Summer Semester: 2021-2022**
Course No.: CEE 4653 **Full Marks: 150**
Course Title: Pavement Design & Railway Engineering **Time: 3.0 Hours**

There are 8 (Eight) questions. Question No. 4, 5, 6 are compulsory. Answer any 2 (Two) questions from Question No. 1, 2 and 3. Answer any 1 (One) question from Question No. 7 and 8.

No marks will be assigned if the student fails to write appropriate question number on the answer script in a distinct and clearly visible manner or does not follow specific question selection process as mentioned above.

Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning. Assume reasonable values for any missing data.

1(a) Discuss about train breaks including types, relative advantages and disadvantages. Differentiate between the usage of sheep foot roller and pneumatic tire roller. (4 + 3) (CO1-PO1)

(b) Differentiate between Semaphore Signals and Color-light signals. Classify and describe signals according to locations and with a sketch show their positions on two main lines. (5+10) (CO2-PO2)

2(a) Discuss the characteristics of good ballast. Discuss different types of rail defects. (3 + 4) (CO1-PO1)

(b) Differentiate between the following: (15) (CO2-PO2)

(i) Reception sidings and sorting sidings.
(ii) Flag Stations and block stations.
(iii) Station and yard.
(iv) Points and Crossings.
(v) Repeating signals and Co-acting signals.

3(a) What are the resisting forces that are related to the speed of train? Discuss briefly along with equations for their measurement. What is the hauling power of a 4-6-2 locomotive with 20 ton axle load on driving wheels and coefficient of friction 0.15? (3+4) (CO1-PO1)

(b) Explain the following: (i) Throw of switch (ii) Facing points or facing turnout (iii) Interlaced sleepers. A 7 degrees curve branches off from a 4 degrees main curve in an opposite direction in the layout of a B. G. yard. If the speed restriction on main line is 57 kn p. h., what would be the speed restriction on branch line? Assume permissible cant deficiency as 75 mm. (7.5+7.5) (CO2-PO2)

4(a) Briefly state the function, requirement and procedure for a transverse longitudinal joint. Draw a diagram of a transverse longitudinal joint. What are differences between Water- bound macadam and Bituminous macadam? (8+5) (CO3-PO2)

(b) It is desired to combine material A, which is the soil existing in the roadbed, with material B, which may be obtained from nearby borrow sources at low costs, to form a stabilized (15) (CO4-PO3)

soil- aggregate surface course conforming to the specification recommended by the AASHTO grading. The sieve analysis of materials A and B and AASHTO grading are shown in the following tabulation. Determine approximately the limiting proportions of A and B that should be used to produce a mixture of the desired gradation. That is, determine the greatest proportion of A that can be used in a mixture and still meets the specifications, and then the smallest proportions of A that will meet the same objective.

Percentage Retained(by weight)			
Sieve Designation	Material A	Material B	AASHTO Grading(Based on % passing)
2 in(50 mm)	0	-	100
1 in(25 mm)	11	0	75- 95
3/8 in(9.5 mm)	21	55	40- 75
No. 4(4.75 mm)	26	17	30- 60
No. 10(2.0 mm)	12	11	20-45
No. 40(0.425 mm)	2	10	15-30
No. 200(0.075 mm)	17	4	5-20
Pan	11	3	0

5(a) When does pumping through joint occur? How can this problem be handled? Explain "Pavement Serviceability Concept". Describe AASHO road test. (4+4+3) (CO3-PO

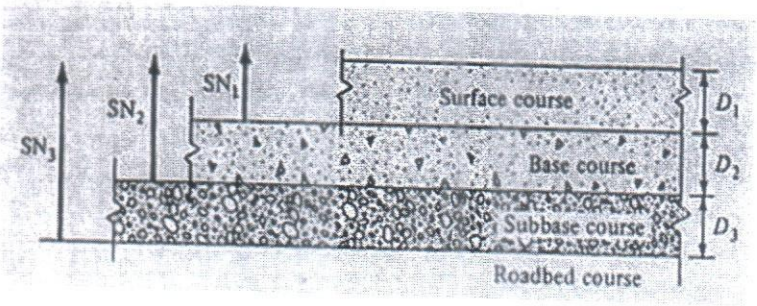
(b) Define a flexible and rigid pavement. In sketches show the components of typical road pavements of each type. What are the functions of each component? List the types and qualities of materials commonly used in different layers of a flexible road pavement. (10+5) (CO4-PO

The following information are available for the design of a flexible pavement by AASHTO method.

Design ESAL=12.5 x 10^6, Reliability Level=85 percent, Standard deviation=0.45, Serviceability loss, ΔPSI=2.0

The structural numbers, layer co-efficient and drainage modifying factors are given as follows: a_1=0.42, SN_1= 2.05, a_2=0.13, SN_2= 3.3, m_2=0.95, a_3=0.075, SN_3=6.5, m_3=0.90

Find the layer thickness. Assume reasonable value of missing data, if any.



$$D_1^* \geq \frac{SN_1}{a_1}$$

$$SN_1^* = a_1 D_1^* \geq SN_1$$

$$D_2^* \geq \frac{SN_2 - SN_1^*}{a_2 m_2}$$

$$SN_1^* + SN_2^* \geq SN_2$$

$$D_3^* \geq \frac{SN_3 - (SN_1^* + SN_2^*)}{a_3 m_3}$$

6(a) Where is stabilization necessary? Explain the material requirement and construction steps for soil cement stabilization? What is lime stabilization? How does it work? (11) (CO3-PO2

(b) As a consultant, you are requested to troubleshoot several types of asphalt mixes, each showing one or more issues. Provide preliminary solution for following mix issues: (15) (CO4-PO3)

i. High Flow and high stability
ii. Low flow value but high void
iii. Low voids and good stability
iv. High void and low density
v. High flow and low stability

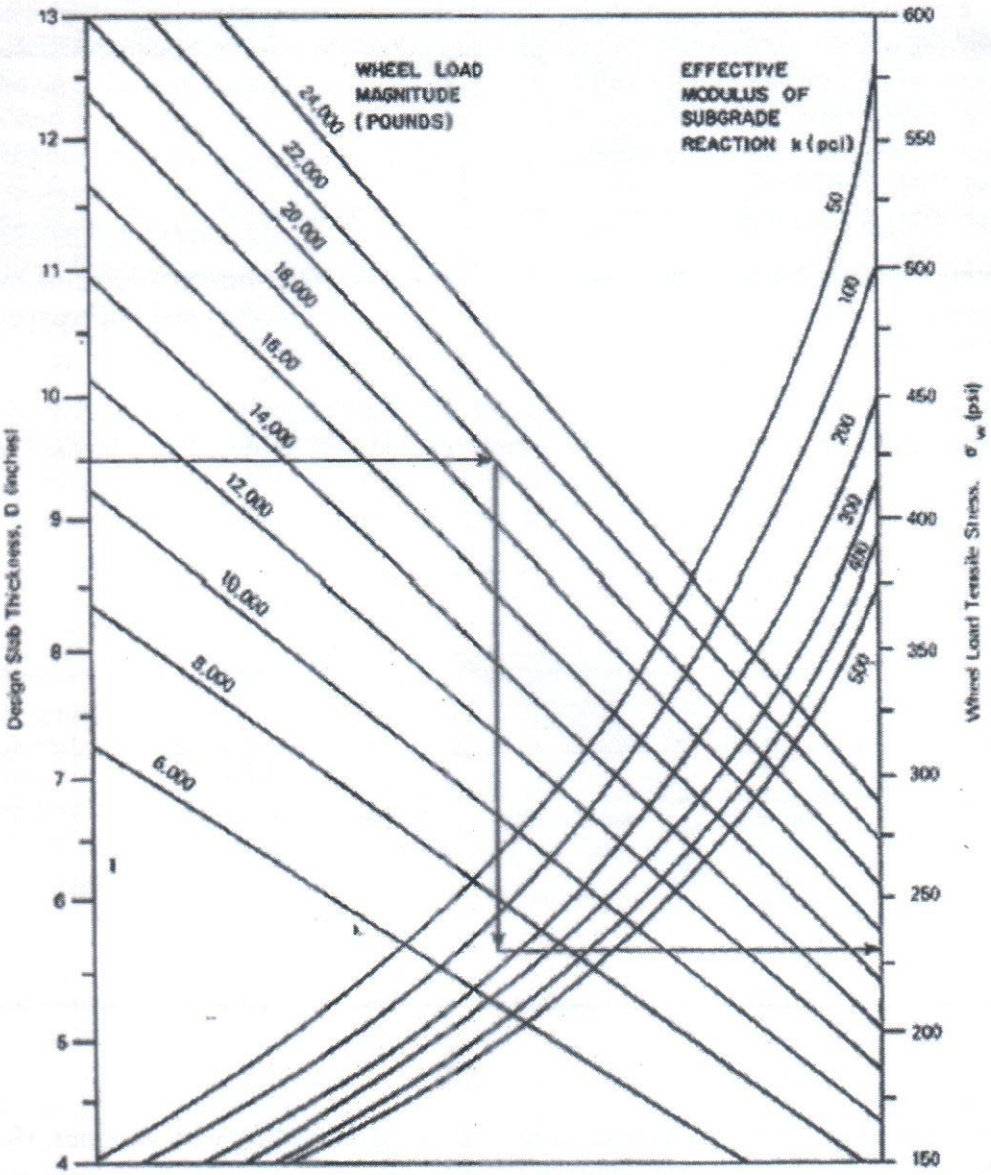
7(a) Discuss the relative advantages and disadvantages of (i) Performance Grading over Penetration Grading and ii) Marshall sample preparation method and Superpave sample preparation method. (11) (CO3-PO2)

(b) An asphalt mix is being optimized using Marshall method. Using a given job mix composition, several lab specimens were prepared and tested using Marshall method. Determine optimum bitumen content, VMA, air voids for the mixes with different bitumen content for mix design purpose and comment on the values obtained. (15) (CO4-PO3)

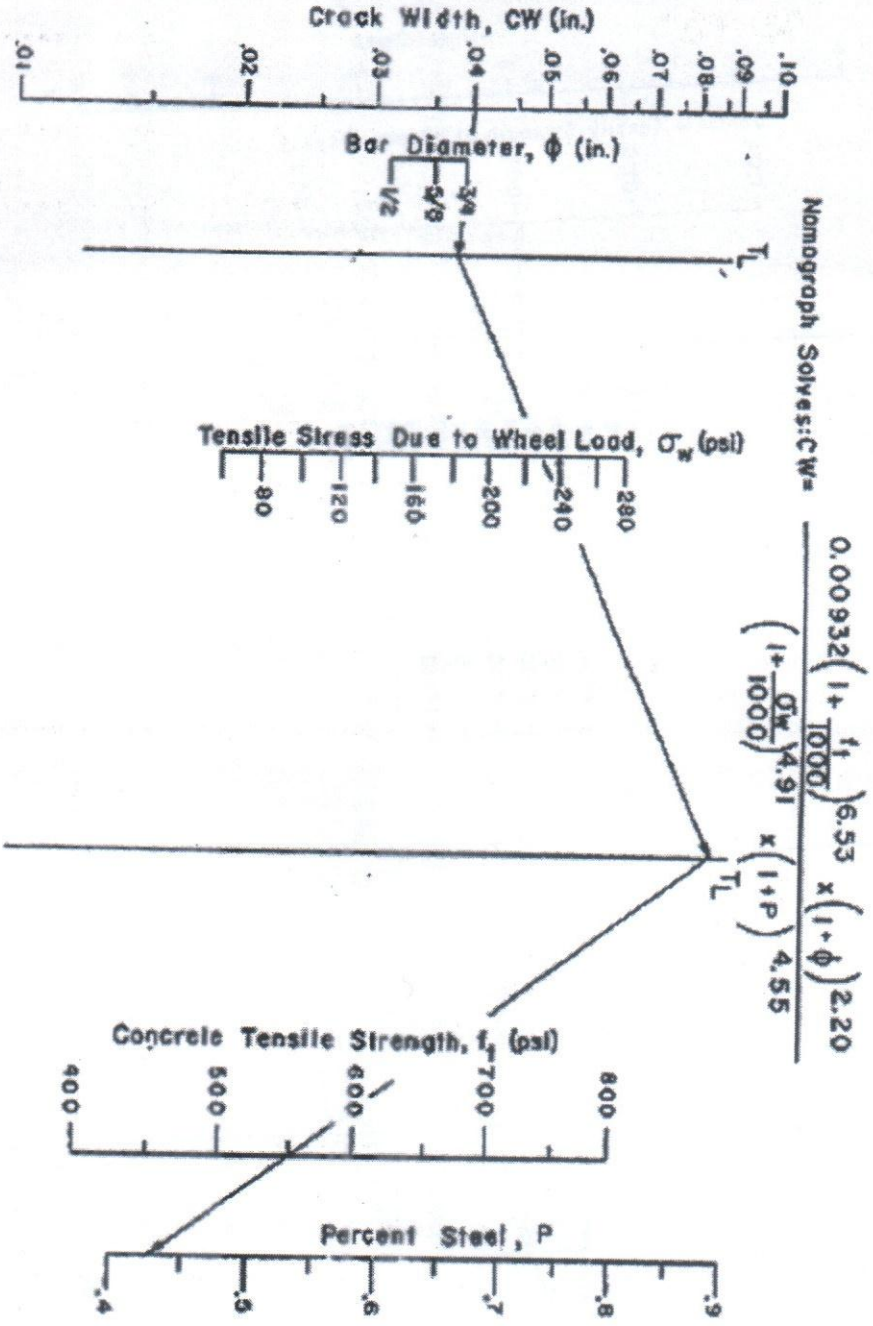
Aggregate type	%Weight in mix	Bulk specific gravity		
Course	50%	2.66		
Fine	39%	2.78		
Filler	11%	2.75		
Bitumen Content	**Bulk Density (Kg/cu.m.)**	**Stability (kN)**	**Flow (mm)**	**Gmm**
4.5%	2350	7.44	2.6	2.54
5%	2380	7.78	2.8	2.58
5.5%	2410	7.65	3.1	2.59
6%	2390	7.49	3.3	2.59

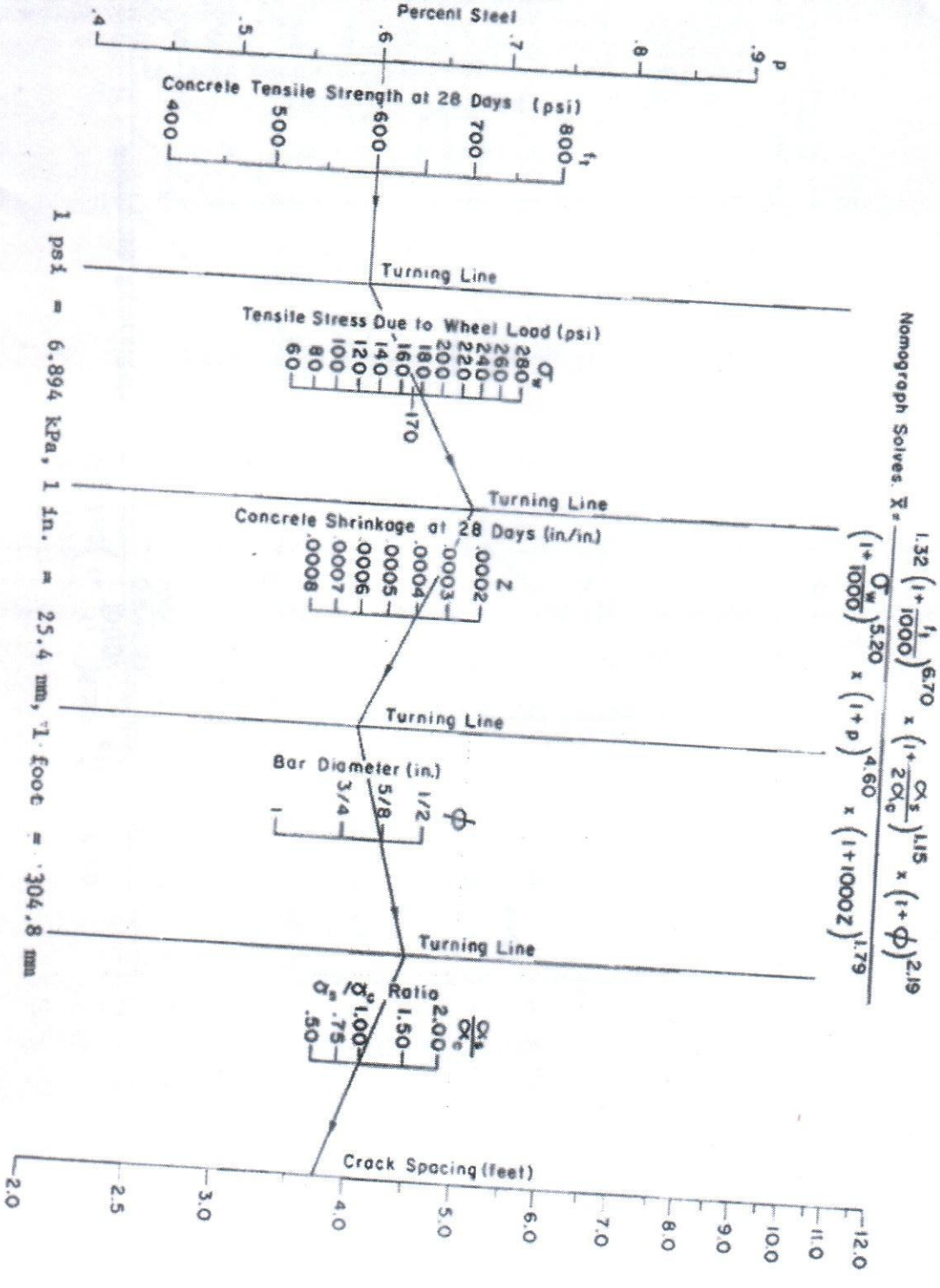
8(a) Discuss the Marshall sample preparation and testing procedure with sketches. How does Marshall test differ from Indirect Tensile Test? (11) (CO3-PO2)

(b) Design longitudinal reinforcement for a CRCP pavement with 8-inch slab thickness and 14,000 lb wheel load. Subgrade modulus is 300 pci. Allow maximum 1-mm crack width at 8-ft (max) and 3.5-ft (min) spacing, 3/4 -inch dia rebar, 50°F temperature drop, 60 ksi allowable steel stress and 600 psi tensile strength of concrete. Concrete shrinkage = 0.0005 in/in and ratio of thermal expansion coefficient of steel and concrete is 1.00. Use attached graphs if required. (15) (CO4-PO3)

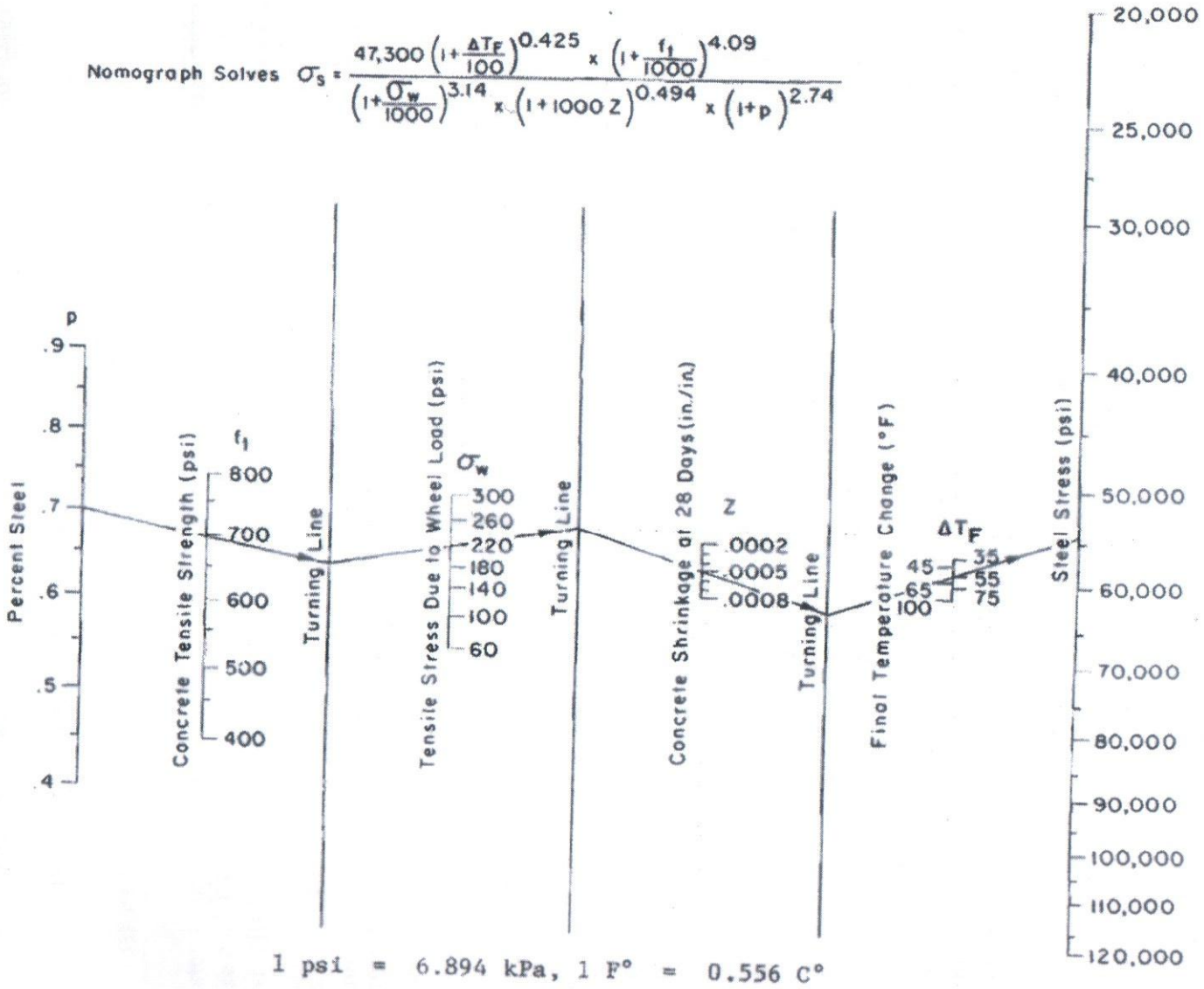


(1 in = 25.4 mm, 1 psi = 6.98 KPa, 1 pci = 0.271 MPa/m)


Crack Width, CW (in.)
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
Bar Diameter, ϕ (in.)
#4
#5
#6
Tensile Stress Due to Wheel Load, σw (psi)
80
120
160
200
240
280
Concrete Tensile Strength, ft (psi)
400
500
600
700
800
Percent Steel, P
.4
.5
.6
.7
.8
.9
TL
TL
Nomograph Solves: CW = 0.00932 (1 + ft/1000)^6.53 x (1 + P)^4.55 x (1 + ϕ)^2.20 / (1 + σw/1000)^4.91 x TL


Percent Steel
.4
.5
.6
.7
.8
.9
p
Concrete Tensile Strength at 28 Days (psi)
400
500
600
700
800
f_t
Turning Line
Tensile Stress Due to Wheel Load (psi)
60
80
100
120
140
160
180
200
220
240
260
280
σ_w
170
Turning Line
Concrete Shrinkage at 28 Days (in./in.)
.0008
.0007
.0006
.0005
.0004
.0003
.0002
Z
Turning Line
Bar Diameter (in.)
1
3/4
5/8
1/2
ϕ
Turning Line
σ_s/σ_s' Ratio
.50
.75
1.00
1.50
2.00
$\frac{\alpha_s}{\alpha_c}$
Crack Spacing (feet)
2.0
2.5
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
Nomograph Solves. $\bar{x} = \frac{1.32\left(1+\frac{f_t}{1000}\right)^{6.70} \times \left(1+\frac{\alpha_s}{2\alpha_c}\right)^{1.15} \times \left(1+\phi\right)^{2.19}}{\left(1+\frac{\sigma_w}{1000}\right)^{5.20} \times \left(1+p\right)^{4.60} \times \left(1+10002\right)^{1.79}}$
1 psi = 6.894 kPa, 1 in. = 25.4 mm, 1 foot = 304.8 mm

Nomograph Solves $\sigma_s = \dfrac{47{,}300\left(1+\frac{\Delta T_F}{100}\right)^{0.425} \times \left(1+\frac{f_1}{1000}\right)^{4.09}}{\left(1+\frac{\sigma_w}{1000}\right)^{3.14} \times \left(1+1000\,Z\right)^{0.494} \times \left(1+p\right)^{2.74}}$



1 psi = 6.894 kPa, 1 F° = 0.556 C°