## RIGID PAVEMENT DESIGN EXAMPLE

## (PROPOSED REVISION TO AASHTO GUIDE APPENDIX I)

A jointed concrete pavement is to be designed to carry 10 million ESALS and the pavement is located in the southeastern United States.

### GENERAL DESIGN INPUTS

Design reliability = 90 percent

Overall standard deviation, $S_0$ = 0.39

Design traffic = 10 million ESALs in the design lane

P1 - P2 = 4.5 - 2.5 = 2.0

Concrete flexural strength, mean 28-day, third-point loading, $S'_c$ = 700 psi [4827 kPa]

Concrete elastic modulus, $E_c$ = 4,100,000 psi [28,270 MPa]

Subgrade soil type: silty clay

k-value = elastic value of subgrade/embankment = 100 psi/in [27 kPa/mm]

Subdrains = 1 (yes)

Climate:
- WIND = mean annual wind speed = 7.9 mph [12.7 km/h]
- TEMP = annual temperature = 58.9°F [14.9°C]
- PREC = annual precipitation = 43 in [1092 mm]

Effective positive temperature differential:

| Slab Thickness | Temperature Differential |
|---|---|
| 9 in [229 mm] | 8.3°F [4.6°C] |
| 10 in [254 mm] | 8.9°F [4.9°C] |
| 11 in [279 mm] | 9.4°F [5.2°C] |

Freezing Index = 0°F [0°C]-days below freezing

Temperature Range = 50°F [27.7°C] (maximum July - minimum January)

## DESIGN ALTERNATIVE A

Undoweled joints

Untreated aggregate base, 6 in [152 mm], $E_b$ = 25,000 psi [172 MPa], friction f = 1.5

Joint spacing = 15 ft [4.6 m]

Conventional lane width = 12 ft [3.7 m]

AC shoulders

### Slab Thickness Design

Assuming an effective temperature differential of about 9°F [5°C], a required slab thickness of 10.2 in [259 mm] is obtained for design ESALs of 10 million, at a design reliability level of 90 percent.

### Joint Faulting Check

The initial design has undoweled joints with a 15-ft [4.6-m] joint spacing. The estimated mean faulting for this design is 0.09 in [2.3 mm]. This value exceeds the recommended limit of 0.06 in [1.5 mm]. Therefore, a joint design modification (e.g., dowels, shorter joint spacing, different base type, tied shoulder) is required to control faulting.

### Joint Load Position Stress Check

The joint load position check is required since the pavement is undoweled. The total negative temperature differential is estimated from the climatic data as -5.6°F [-3.11°C] (use -6°F [-3.33°C]).

Combined moisture gradient and construction differential: -10°F [-5.6°C] (wet climatic zone, conventional concrete cure).

Total negative equivalent temperature differential: -16°F [-8.89°C].

The critical stress for joint loading is determined to be about 145 psi [1000 kPa] for a slab thickness of 10.2 in [259 mm]. This joint loading stress is compared to that obtained for the midslab location with a positive temperature differential of 9°F [5°C], which is found to be 233 psi [1607 kPa]. Therefore, the midslab load design is adequate to control stresses at the joint loading position. A total negative temperature differential of about -30°F [-16.67°C] would be required to produce a stress greater than 233 psi [1607 kPa].

## DESIGN ALTERNATIVE B

Undoweled joints

Permeable asphalt-treated aggregate base, 6 in [152 mm], $E_b$ = 100,000 psi [690 MPa], friction f = 6

Joint spacing = 15 ft [4.6 m]

Widened slab width = 14 ft [4.3 m] (with AC shoulders)

### Slab Thickness Design

Assuming an effective positive temperature differential of about 9°F [5°C], a required slab thickness of 9.4 in [239 mm] is obtained. Note that a stress reduction factor of 0.92 for the widened slab was used in the calculation.

### Joint Faulting Check

The mean faulting estimated for this design is 0.06 in [1.5 mm], which just equals the recommended limit. Therefore, the joint design is acceptable.

### Joint Load Position Stress Check

The joint load position check is required since the pavement is undoweled. The total negative temperature differential is the same as estimated for Alternative A, -16°F [-8.89°C].

The critical stress for joint loading is determined to be 165 psi [1138 kPa] for a slab thickness of 9.4 in [239 mm]. This stress is compared to that obtained for the midslab location with a positive temperature differential of 9°F [5°C], which is found to be 234 psi [1613 kPa]. Therefore, the midslab load design is adequate to control stresses at the joint loading position.

## DESIGN ALTERNATIVE C

Doweled joints, 1.25 in [32 mm] diameter

Untreated aggregate base, 6 in [152 mm], $E_b$ = 25,000 psi [172 MPa], friction f = 1.5

Joint spacing = 17 ft [5.2 m]

Conventional lane width = 12 ft [3.7 m]

Tied concrete shoulder

### Slab Thickness Design

Assuming an effective temperature differential of about 9°F [5.0°C], the required slab thickness is 9.9 in [251 mm]. Note that a stress reduction factor of 0.94 for a tied concrete shoulder was used in the calculation.

Joint Faulting Check

The estimated mean faulting for this design is 0.01 in [0.25 mm], which is well below the 0.06-in [1.5-mm] recommended limit.

Joint Load Position Stress Check

The joint load position check is not required since the pavement is doweled and the joint load position stress will be well below the midslab stress.