

# 九、 Design of Overlays for Concrete Pavements

## 參考資料：

1. Darter, M. I. “ Techniques for Pavement Rehabilitation,” Training Course, FHWA, 1987. (Block 5, Module 5A - 5B)
2. AASHTO, “AASHTO Guide for Design of Pavement Structures,” Volume I, 1993. (Chapter 5)

## Introduction (Objectives)

### Approaches

1. Engineering Judgement
2. Structural Deficiency:  
AASHTO structural number approach
3. Mechanistic Fatigue Damage Approach:
  - (a) characteristic of pavements,  $E$ 's
  - (b) past damage
  - (c) remaining life
  - (d) required overlay thicknessNot widely utilized
4. Others, e.g., deflection approach

## Types of Overlays over Rigid Pavements

AC, PCC (same as before)

## AASHTO Overlay Design Methodology

1. Based on serviceability-performance relationships
2. Implicit remaining life concept

### 3. Strongly recommends NDT testing

#### Basic AASHTO Design Procedure:

Figure 1 Relationship between serviceability-capacity condition factor and traffic

$$SC_{xeff} = C_x SC_0$$

$$SC_{OL}^n = SC_y^n - F_{RL} (SC_{xeff})^n$$

$C_x$  = overall pavement condition factor

$SC_{xeff}$  = effective structural capacity

$F_{RL}$  = remaining life factor  $\leq 1.0$

### AASHTO AC Overlay Design Over Rigid Pavements

#### Major Seven Steps:

1. Analysis unit delineation
2. Traffic analysis
3. Material and environmental study
4. Effective structural capacity analysis ( $SC_{xeff}$ )
5. Future overlay structural capacity analysis ( $SC_y$ )
6. Remaining life factor determination ( $F_{RL}$ )
7. Overlay design analysis

#### Analysis Unit Delineation

1. determine boundaries along the project
2. accurate historic data available / unavailable

#### Traffic Analysis (ESAL)

#### Material and Environmental Study

1. existing pavement layer properties
  - (a) NDT backcalculation techniques
  - (b) Use “interior” loading position
  - (c) cracked / non-cracked slabs
2. existing subgrade properties
 

Figure 2 Composite subgrade modulus
3. design properties of overlay layers

### Effective Structural Capacity Analysis ( $SC_{xeff}$ )

1. NDT Method (Figure 3)
2. Non-NDT Approximate Procedure
  - (a) Visual condition factor (Figure 4)
  - (b) Nominal size of PCC slab fragments (Figure 5)
  - (c) Remaining life (Figure 6)

$$D_{xeff} = C_x D_0$$

### Future overlay structural capacity analysis ( $SC_y$ )

$SN_y$  (AC) or  $D_y$  (PCC)

Simply a new pavement design

### Remaining life factor determination ( $F_{RL}$ )

1. Approaches:
 

NDT, Traffic Approach, Time Approach (Figure 7), Serviceability Approach (Figure 8), Visual Condition Survey Approach (Figure 9)
2. Use  $R_{Lx}$  and  $R_{Ly}$  to determine  $F_{RL}$  (Figure 10)
 

The procedure is very confusing and was removed in the new AASHTO Guide (1993).

## AC overlay thickness determination

(Figure 11 - Equations used)

1. Normal AC structural overlay approach

$$h_{ol} = SN/a_{ol}$$

2. Use of thick overlays to minimize reflective cracking
3. Crack and seat approach to minimize reflective cracking

## AASHTO PCC Overlays Over Rigid Pavements

Major Seven Steps: (Same as before)

1. Analysis unit delineation
2. Traffic analysis
3. Material and environmental study
4. Effective structural capacity analysis ( $SC_{xeff}$ )
5. Future overlay structural capacity analysis ( $SC_y$ )
6. Remaining life factor determination ( $F_{RL}$ )
7. Overlay design analysis

Figure 16 unbonded, partially bonded, or fully bonded (by cold milling or shot blasting)

$$D_{OL}^n = D_y^n - F_{RL} (D_{xeff})^n$$

## Example Problems

### Major Steps

- Step 1 – Collect basic information and design criteria
- Step 2 – Determine the structural number for a new pavement to support the future traffic
- Step 3 – Determine the effective SC of the existing pavement
- Step 4 – Determine the remaining life factor
- Step 5 – Computation of final overlay design thickness
- Step 6 – Reflection crack control

Design of flexible overlays over rigid pavements

(Figure 23 ~ Figure 25)

Design of flexible overlays over cracked and seated rigid pavements

Design of rigid overlays over rigid pavements

(Figure 26)

## Overlay design analysis

1993 年 AASHTO Guide 各類加鋪組合之加鋪厚度計算公式如下表所示：

表一 加鋪厚度計算公式

加鋪材料	現存鋪面	加鋪設計公式
AC	AC	$h_{ol} = SN_{ol} / a$ $= (S_{nf} - S_{Neff}) / a$
AC	Break/PCC	$h_{ol} = SN_{ol} / a$ $= (S_{nf} - S_{Neff}) / a$
AC	PCC	$D_{ol} = A(D_f - D_{eff})$
AC	AC/PCC	$D_{ol} = A(D_f - D_{eff})$
Bonded PCC	PCC	$D_{ol} = D_f - D_{eff}$
Unbonded PCC	PCC	$D_{ol}^2 = D_f^2 - D_{eff}^2$
PCC	AC	$D_{ol} = D_f$