SIMPLIFIED PAVEMENT PERFORMANCE MODELS

I-A	I-B	I-C
II-A	II-B	II-C
III-A	III-B	III-C

OBJECTIVES

To develop improved PSR prediction models for use in the Highway Performance Monitoring System (HPMS) analytical process

IDENTIFICATION OF PAVEMENT "GROUPS"

- Five major pavement types:
  - FLEX, COMP, JPCP, JRCP, and CRCP
- Nine climatic zones:
  - Wet/Intermediate/Dry,
  - Freeze/Freeze-Thaw/Non-Freeze
- Two functional groups:
  - Interstate & Principal Arterials
  - Minor Arterials & Collectors

DATA FOR INITIAL MODEL DEVELOPMENT

FLEX: AASHO Road Test (522)

COMP: Illinois Pavement Feedback (509)

JPCP: AASHO Road Test/Extended (117)

JRCP: AASHO Road Test/Illinois Pavement Feedback (254)

CRCP: Illinois Pavement Feedback (1204)

DATA USED TO EXTEND INITIAL MODELS

HPMS nationwide database (85,533):

1984, 1986, 1988, 1989

REGRESSION TECHNIQUES USED

- Alternating Conditional Expectations (ACE):
  - Model form selection
- Least Median Squared (LMS):
  - Outlier (error) detection
- Least Square (LS) Regression:
  - Final model coefficients

PROPOSED MODEL FORM

$$PSR = PSR_i - a * STR^b * AGE^c * CESAL^d$$

$$\log(PSR_i - PSR) = \log(a) + b * \log(STR) + c * \log(AGE) + d * \log(CESAL)$$

PSR_i = initial value of PSR (4.5 assumed)

STR = structural parameter (structural number, overlay thickness, or slab thickness)

FLEX MODEL

$$PSR = 4.5 - 14.3 * STR^{-1.87} * AGE^{0.35} * CESAL^{0.34}$$

Statistics:

$R^2 = 0.52$, SEE = 0.45, N = 522

SUMMARY STATISTICS OF MODELS

Model	R^2	SEE	N
FLEX	0.52	0.45	522
COMP	0.58	0.38	509
JPCP	0.79	0.26	117
JRCP	0.57	0.40	254
CRCP	0.37	0.31	1204

APPLICATION OF THE PROPOSED MODELS

- These five PSR models are useful for a variety of pavement management uses, but not for pavement design

- For prediction of future PSR of an existing pavement, the models must be calibrated to that pavement condition without knowing pavement age and cumulated ESALs.

CALIBRATION TO EXISTING PAVEMENTS

$$\textit{Assuming that:} \quad CESAL = AGE * ESALPYR$$

$$C_1 = AGE = \left[\frac{4.5 - PSR1}{a * STR^b * ESALPYR^d} \right]^{\frac{1}{c + d}}$$

$$C_2 = CESAL = C_1 * ESALPYR$$

CALIBRATION TO EXISTING PAVEMENTS (CONTINUED)

$$PSR = 4.5 - a * STR^{b} * (C_1 + \Delta YEAR)^{c} * (C_2 + \Delta ESAL)^{d}$$

ADJUSTMENT FACTORS

- To adjust the rate of deterioration of PSR of the proposed predictive models for pavements in different climatic zones and functional groups of the HPMS database.

- Adjustment factors are defined as follows:

$$AF = \frac{\Delta PSR_a}{\Delta PSR_m} = \frac{4.5 - PSR_a}{4.5 - PSR_m}$$

ADJUSTMENT FACTOR EXAMPLE

Flexible pavement
Interstate highway
Wet-Freeze climatic zone

Mean AF = 0.59, N = 5,685

Result: HPMS data shows slower rate of deterioration than model predicts.

RECOMMENDED AF(S)

1. FLEX, Interstate & Principal Arterials:

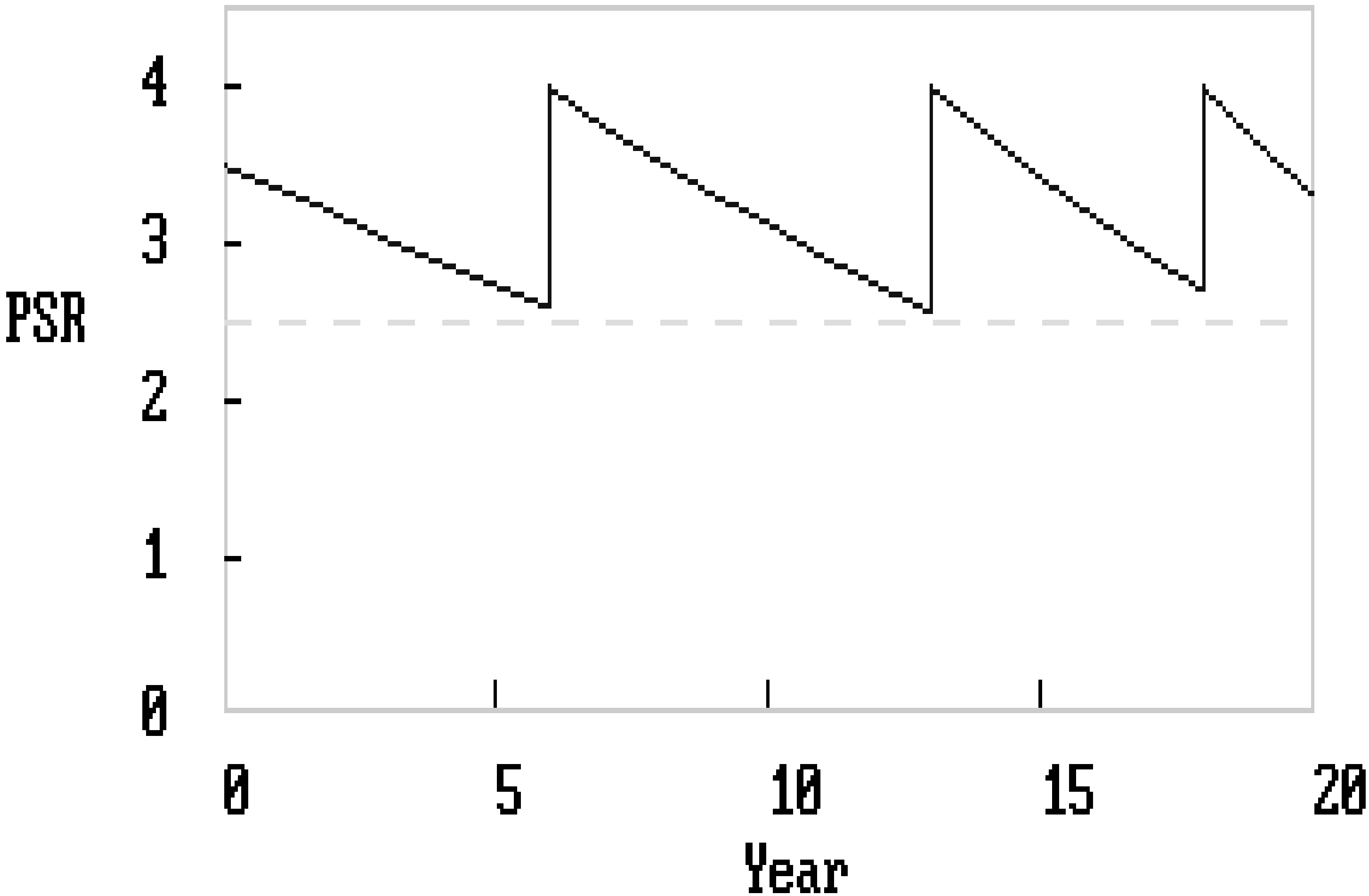
Climatic Zones	Freeze	Freeze-Thaw	No Freeze
Wet	0.59	0.40	0.44
Inter-mediate	0.40	0.52	0.43
Dry	0.40	0.40	0.40

RECOMMENDED AF(S)

2. FLEX, Minor Arterials & Collectors:

Climatic Zones	Freeze	Freeze-Thaw	No Freeze
Wet	0.81	0.85	0.69
Inter-mediate	0.49	0.71	0.65
Dry	0.43	0.40	0.79

PERFORMANCE SIMULATION (SIMPERF)



CONCLUSIONS

- Developed five simplified predictive models (FLEX, COMP, JPCP, JRCP, and CRCP)
- Calibration to existing pavements
- Recommended adjustment factors for each climatic zone and functional group
- Models implemented in the SIMPERF program for performance simulation