Lecture #6:

◎ Pavement Management Process
(Haas, Chapter 4-5)
- Pavement Management Levels and Functions
- Using PMS as a Research Planning and Technology Improvement Tool

◎ Pavement Management Levels & Functions

※Influence Levels of PMS Compenents
Network-level Needs: Selecting "Candidate" Projects, "Not Enough Funding" as Always

※Project Level, Project Selection Level, Program Level (Network): Detail of Information, Complexity of Models

※PMS Functions: Historical Data Base, Information Flows (i.e., Information, Analysis, Implementation Subsystems)

※Information Flows

1. Network Level: Information (Periodic Updates), Network Analysis (Program Decision Criteria & Budget Constraints), Implementation, Interface Between

Network Level & Overall Transportation System Management

2. Project Level: Porjects Coming On-Line from Network Implementation, Information, Analysis (Decision Criteria & Selection), Detailed Quantities & Costs & Plans, Implementation, Data Files & Research Programs

※Key Considerations in Application of a Total PMS Concept (Precise, Flexibility, People, Effective in Technical & Economic & Others, Interface, Maintenance Management)

※Function of Pavement Evaluation

Major Types of Outputs: Structural Adequacy, Performance, Surface Distress, Safety, (and Maintenance Cost & User Cost for Economic Analysis)

※Distress vs. Performance

Distress => Limiting Response or Damage

Performance => Serviceability History, Time-Related Accumulation of Data

※User-Related vs. Engineering Evaluation

1. Functional Behavior => e.g., PSR
2. Structural Behavior => e.g., PCI

※Pavement Evaluation w.r.t. User Costs

◎ Using PMS as a Research Planning and Technology Improvement Tool

※Identifying Research Needs

※System Parameters & State of the Art: Model Used, Past Experience, Quality of Measuring Techniques and Available Data, Inherent Variability (==> Cyclic Improvements)

※Future Advances In PMS: Continuing Incremental Improvements, More Widespread Use, Use of New Equipments & Technologies (SHRP/LTPP, 20-yr Study => FHWA)

※Establishing Priorities

※Implementing Research Results

◎ Linear Regression (PSI Eq.)
(Fitting a Straight Line by Least Squares)

Handouts:

1. Draper, N. R., and H. Smith, ***Applied Regression Analysis***, Second Edition, John Wiley & Sons, Inc., 1981, pp.8-23.

2. Two Pages of S-PLUS Example Outputs

Assume a True Model: $Y = \beta_0 + \beta_1 X + \varepsilon$

$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$ (*for* $i = 1, 2, \ldots, n$)

Minimize $S = \sum_{i=1}^{n} \varepsilon_i^2 = \sum_{i=1}^{n} (Y_i - \beta_0 - \beta_1 X_i)^2$

$$\frac{\partial S}{\partial \beta_0} = -2 \sum_{i=1}^{n} (Y_i - \beta_0 - \beta_1 X_i) = 0$$

$$\frac{\partial S}{\partial \beta_1} = -2 \sum_{i=1}^{n} X_i (Y_i - \beta_0 - \beta_1 X_i) = 0$$

Normal Equations:

$$\begin{cases} b_0 n + b_1 \sum_{i=1}^{n} X_i = \sum_{i=1}^{n} Y_i \\ b_0 \sum_{i=1}^{n} X_i + b_1 \sum_{i=1}^{n} X_i^2 = \sum_{i=1}^{n} X_i Y_i \end{cases}$$

$$b_1 = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sum (X_i - \bar{X})^2} = \frac{SXY}{SXX}$$

$$b_0 = \bar{Y} - b_1 \bar{X}$$

$$SXX = \sum (X_i - \bar{X})^2 = \sum X_i^2 - n\bar{X}^2$$

$$SYY = \sum (Y_i - \bar{Y})^2 = \sum Y_i^2 - n\bar{Y}^2$$

$$SXY = \sum (X_i - \bar{X})(Y_i - \bar{Y}) = \sum X_i Y_i - n\bar{X}\bar{Y}$$

$\sum X_i^2$ = *Uncorrected Sum of Squares of the x's*

$\sum Y_i^2$ = *Uncorrected Sum of Squares of the* y's

$\sum X_i Y_i$ = *Uncorrected Sum of* Pr*oducts of x and y*

SXX, *SYY*, *SXY* = *Corrected* ... (*Same as above*)

$$(Y_i - \bar{Y}) = (\hat{Y}_i - \bar{Y}) + (Y_i - \hat{Y}_i)$$

$$\sum (Y_i - \bar{Y})^2 = \sum (\hat{Y}_i - \bar{Y})^2 + \sum (Y_i - \hat{Y}_i)^2$$

SS about the mean = *SS due to regression* + *SS about regression*

$$R^2 = \frac{SS\ due\ to\ regression}{SS\ about\ mean}$$

Figure 1.6 *Geometrical Meaning*

Table 1.3 *Analysis of Variance* (*ANOVA*) *Table*

※Linear Regression in Matrix Format

$$Y = X\beta + \varepsilon$$

$$\hat{\beta} = (X'X)^{-1} X'Y$$

$$\hat{Y} = X(X'X)^{-1} X'Y = HY$$

H is called “Hat Matrix”

◎ Use EXCEL Add-in and S-Plus Program

作業二：請利用EXCEL軟體之Add-in功能，建立柔性與剛性鋪面之PSI公式。