King Fahd University of Petroleum & Minerals

كل عام وأنتم بخير

Construction Equipment
And Methods

CEM 530

FLEXIBAL PAVEMENT DESIGN

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Introduction

•In 1991,the federal-aid highway system comprised more than 850,000 miles of pavements of various designs .

•It has been estimated that$20 billion is spent annually in united state for pavement construction,maintenance,and rehabilitation.

•The monetary implication of even a minor improvement in pavement performance could conservatively described as substantial so that, the highway community has proven to be the catalyst for research and experimentation all phases of pavement technology.

•The objective of this synthesis is to provide a snapshot of current practice and an indication of trends in the design of new pavements and overlays for the following elements:

- Procedure to determine thickness.
- Layer composition and configuration
- Drainage treatment
- Traffic characterization
- Material characterization
- Miscellaneous design features

Flexible Pavement Design

Background

- The earliest written reference to a flexible pavement as we define it today is an inscription on a brick in ancient Babylon which refer to a "road glistening with asphalt and burnt bricks"
- flexible pavement ***thickness design*** is new and rapidly changing technology. 1
- 50 years ago ,most flexible pavements were designed on the basis of experience and "engineering judgment". 2
- A number of empirical flexible pavement design procedures based on ***soil strength test*** were introduced after world war II. 3

Flexible pavement design

Background (cont.)

- The American association of state highway officials (AASHO) made a comprehensive and costly pavement research programs(1958-60)
- The objective of this program is to develop a relationship between the number of repetition of specific axle loads of different magnitude and arrangement and the performance of different thickness of uniformly designed and constructed asphaltic concrete,plain Portland cement when on a basement soil of known characteristics.
- The road test involved two years of massive effort and the expenditure of $27 million .
- Analysis of the data led to the publication ,in 1961, of the AASHO interim guide for design of rigid and flexible pavement.

Flexible Pavement Design

Background(cont.)

- This empirical design procedure had a number of basic deficiencies including;
  - The short duration of two years did not allow an evaluation of the effect on pavement performance of surface aging.
  - The road test was limited to a single sub-grade condition and environment.
  - The road test did not incorporate the pavement features and materials which become standards.
- The pace of change in pavement design practice since the AASHO road test was reflected by the 1986 revision(*guide for the design of pavement structures*) *included* drainage design criteria, reliability factors ,replacement of soil support,an overlay design, section on lifecycle cost analysis,and an overview of the mechanistic pavement design.

Agency Practice

Design Procedures

- Empirical design procedures ,including the 1972 and 1986 AASHO procedures, were used by 51agincies.
- Ten agencies have developed their own ,usually empirically based.
- Four agencies employ mechanistic models for flexible pavement design.
- Five agencies use the asphalt institute procedures which is mechanistically based.

Internal Drainage of Flexible Pavement

- Agency questioner response revealed a diffident movement toward rapid positive internal drainage of flexible pavement in united states .
- Twenty agencies employ collector and outlet pipes for removal of water collected in the permeable layer while, seven extend the permeable layers “daylight” for this purpose
- A typical flexible pavement section with an internal drainage system consisting of treated permeable base with collector and outlet pipes is shown in the figure

Shoulder Design

- Twenty three agencies reported using standard shoulder design
- 22 agencies construct shoulders with the same structural section as the pavement I.e "full depth "
- Twelve agencies base shoulder design on a percentage of the traffic loading assumed for pavement design.

Anticipated Modification in Flexible Pavement Design

- Twenty two agencies indicated an eventual shift to the use of mechanistic models.
- Twelve agencies resilient modulus testing for materials characterization.
- Ten agencies will adopt the 1986 AASHO pavement design guide line .
- Six agencies indicated their intention to incorporate permeable into flexible pavement.
- Others anticipated modification cited by four agencies each included life cycle cost analysis.

Flexible Pavement Overlay Design

Background

- The warrants for overlaying of the flexible pavement includes:
  - Poor ride quality
  - Low skid resistance
  - Excessive rutting within the AC surfacing
  - Extensive pavement distress due to inadequate structural capacity
- Flexible pavement overlay design procedure presently fall into the following basic categories :
  - Engineering judgment
  - Standard thickness
  - Component analysis
  - Deflection analysis
  - Mechanistic models

•The engineering judgement based on experience ,environmental conditions,traffic loading ,and surgrade soil type .

• A *standard overlay thickness* is prescribed for a given pavement type ,thickness ,and traffic loading

• The *component analysis* procedure involve a comparison of the structural capacity of the existing pavement with that required to carry the traffic loading estimated for the design life of the overlay.

• The deflection analysis based on premise that the fatigue life of the pavement is a function of deflection level as measured by NDT device.

• Mechanistic overlay design procedures are based on the assumption that the pavement structure will respond to load layer elastic solid

Reflective Crack Control

Reflective cracking of AC overlays of flexible pavements has been addressed by number of treatments with widely varying degrees of success .this include :

- Paving fabrics
- Stress absorbing membrane interlayer
- Increased overlay thickness
- Crack sealing,sphaltadditives,fiberreinforcement and etc.

THANK YOU