CE 5830: Pavement Analysis & Design

Course Description:

Analysis, behavior, performance, and structural design of pavement systems. Topics include climate factors, rehabilitation, life cycle design economics, material and system response, pavement foundations and traffic loadings. Development of models for and analysis of pavement systems. Use of transfer functions relating pavement response to pavement performance. Evaluation and application of current and evolving pavement design practices and procedures. Mechanistic-based pavement design techniques and concepts. Analysis of the effects of maintenance activities on pavement performance and economic evaluation of pavement systems.

Course objectives (course designed to provide students with):

This course covers the structural and functional design of pavement structures for highway and airport situations with an emphasis on highways. Structural design examines the direct influence of the vehicles on material and thickness requirements to provide a pavement with suitable design life and good performance. Design considerations include climatic conditions, traffic loadings, life cycle design economics, and rehabilitation. The functional design examines the user aspects, which are primarily smoothness and safety considerations.

Course Outcomes (students should be able to):

1. Pavement Performance:
    - Explain the difference between structural performance of a pavement and functional performance.
    - Identify distress types common to flexible and rigid pavements.
    - List several means for evaluating the functional performance of pavements.
2. Material Characterization:
    - Characterize fine and coarse grain soils in terms of their physical and mechanical properties.
    - Apply measured soil properties to pavement design examples.
    - Explain the behavior of granular materials under loading and list factors affecting their performance.
    - Identify base types used for pavements and their properties.
    - Determine the elastic property inputs required for asphalt concrete and Portland cement concrete pavements.

Course Outcomes, continued:

3. Traffic Analysis:
    - List the types and axle configurations of typical highway trucks and their corresponding standard loads.
    - List the various types of aircraft gears, wheel load magnitudes, and wheel and axle spacing.
    - Convert mixed traffic into an equivalent single axle load for flexible and rigid pavement systems.
4. Pavement Analysis:
    - Calculate stresses, strains, and deflections in flexible pavements using Boussinesq solutions and layered elastic analysis.
    - Calculate wheel load and temperature stresses in concrete pavements using Westergaard equations.
5. Pavement Design:
    - Design new and overlays for flexible highway pavements using the AASHTO Mechanistic-Empirical design methodologies, the Asphalt Institute method, and DOT based design procedures.
    - Design new and overlays for rigid pavements using the AASHTO Mechanistic-Empirical design methodologies, PCA method, and DOT based design procedures.
    - Design a continuously reinforced concrete pavement. List the processes required to construct a flexible and rigid pavement system.
6. Transfer Function Application:
    - Apply asphalt concrete fatigue algorithms and unbound layer rutting equations to the design of flexible pavements.
    - Utilize existing concrete fatigue transfer functions to relate load repetitions to fatigue cracking of rigid pavement systems.
7. Life Cycle Cost Analysis:
    - Conduct present worth and annual series calculations to compare different pavement design alternatives.
8. Sustainability in Pavement Systems:
    - Explain the role and importance of sustainability in pavement design, construction, and maintenance and rehabilitation.
    - Describe some of the products, processes, principles that would enhance the sustainability of flexible and rigid pavements and pavement foundations.