Characterization of "STAR" Structures

Periods are 2.5 hours with a 10 minute break; one class period per week. Work performed during Fall '04 semester.

Class No. 1 (Friday, September 3, 2004)

Hand out course syllabus, the review of Statics and Mechanics of Materials (Appendix I from MAE/CE 477/577), and the basics equations governing Mechanics of Materials (Appendix II from MAE/CE 477/577). Outline the requirements of the course (syllabus) and discuss the STARS concept (use transparencies of the flow chart to show overall approach and the photoelastic bending specimens to demonstrate stress transfer). Review Appendix I. Assign a shear and moment diagram, and a deflection problem as Homework No. 1 and outline these problems as necessary.

Class No. 2 (Friday, September 10, 2004)

Collect Homework No. 1 and review Appendix II; basic formulas for Mechanics of Materials including, but not limited to: loadings, torsion, pure bending, Mohr's Circle, shear and moments, deflection, buckling, and design codes.

Reinforce that stress transfer is the key to STARS technology. Hand out Chapter 5 from MAE/CE 477/577, demonstrate photoelasticity using the demonstration polariscope, and review the transform section theory from Mechanics of Materials.

Class No. 3 (Friday, September 17, 2004)

Cover Chapter 5 from MAE/CE 477/577 on photoelasticity and hand out Kirk Biszick's paper entitled, "Designing thin-walled, reinforced concrete panels for reverse bending."

Biszick, K.R., Gilbert, J.A., "Designing thin-walled, reinforced concrete panels for reverse bending," Proc. of the 1999 SEM Spring Conference on Theoretical, Experimental and Computational Mechanics, Cincinnati, Ohio, June 7-9, 1999, pp. 431-434.

Show slide (Power Point) presentation of Kirk's thesis. Mention that Kirk's approach fell short when it was used to describe multi-layered composite sections that were comprised of materials that had stiffness ratios greater than 20. This led to the development of Bob Vaughn's modified transform section theory. Have students analyze the photoelastic bending specimens and the simplified section used to model the concrete canoe built in 1999 as Homework No. 2.

Class No. 4 (Friday, September 24, 2004)

Outline problems in Homework No. 2 as necessary and ask students to introduce themselves.

Stress that STARS are very resilient and that deflections are large. Hand out the pre-proposal submitted to Gary Anderson regarding the moire patterns that appeared in photos taken of the World

Trade Center while under attack and review this material with the class. Hand out Chapter 8 from MAE/CE 477/577 on Moire Methods and cover this material.

Class No. 5 (Friday, October 1, 2004)

Collect Homework No. 2. Hand out a copy of the NCCC Rules and Regulations and discuss the requirements for the 2005 NCCC design report. Hand out the 2004 NCCC design report and have the students read and critique it for homework.

Hand out Bob Vaughan's paper entitled, "Analysis of graphite reinforced cementitious composites," and outline it briefly.

Vaughan, R.E., Gilbert, J.A., "Analysis of graphite reinforced cementitious composites," Proc. of the 2001 SEM Annual Conference and Exposition, Portland, Oregon, June 4-6, 2001, pp. 532-535.

Have students analyze a tension specimen and an end loaded cantilever beam as Homework No. 3. Outline Homework No. 3 as necessary. Have students review Vaughan's work for homework.

No Class (Friday, October 8, 2004)

Class No. 6 (Friday, October 15, 2004)

Collect Homework No. 3 and compile comments on the 2004 ASCE NCCC design report.

Hand out the description of the concrete tensile test, modified transform section theory, and the electrical resistance strain gage. Explain the basic tests used to characterize concrete and reinforced concrete specimens including the tension test, four point bending test, and end loaded cantilever test.

Show slide (Power Point) presentation of Bob's work.

Hand out guidelines for the final presentation and have the students prepare this information as Homework No. 4.

Class No. 7 (Friday, October 22, 2005)

Collect Homework No. 4. Have students introduce themselves and give a brief outline of what they plan to present during their final presentation.

Hand out a copy of Stephen Marotta's paper entitled, "Structural health monitoring of strategically tuned absolutely resilient structures (STARS)."

Marotta, S.A., Ooi, T.K., Gilbert, J.A., "Structural health monitoring of strategically tuned absolutely resilient structures (STARS)," Proc. of SEM X International Congress, Costa Mesa, California, June 7-10, 2004, Paper No. 172, 6 pages.

Present slide (Power Point) presentation of Marotta's work on RRAPDS technology.

Show slide (Power Point) presentation given at Langley in support of the Aircraft Safety proposal.

Hand out Abhishek Raut's paper entitled, "A method for producing structurally equivalent graphite reinforced cementitious composites." Have students review the paper for homework.

Raut, A. Gilbert, J.A., Ooi, T.K., "A method for producing structurally equivalent graphite reinforced cementitious composites," Proc. of SEM X International Congress, Costa Mesa, California, June 7-10, 2004, Paper No. 173, 6 pages.

Class No. 8 (Friday, October 29, 2005)

Show slide (Power Point) presentation of Abhishek's work.

Hand out a copy of the ASCE/MBT Rules and Regulations for the oral presentation including the judges' score sheet, oral presentations from 2001-2003, and a rough draft of the 2004 oral presentation. Discuss the design report and the format proposed for the oral presentation and have the students read and critique the presentation as Homework No. 5.

Show slide (Power Point) presentation of 2004 oral presentation.

Hand out Teng Ooi's paper entitled: "Dynamic characteristics of highly compliant graphite reinforced cementitious composite plates." Have students review the paper for homework.

Ooi, T.K., Vaughan, R.E. Gilbert, J.A., Engberg, R.C. Bower, M.V., "Dynamic characteristics of highly compliant graphite reinforced cementitious composite plates," Proc. of the 2003 SEM Annual Conference & Exposition on Experimental and Applied Mechanics, Charlotte, North Carolina, June 2-4, 2003, Paper No. 133, 7 pages.

Hand out Dr. Ooi's paper entitled,"Experimental and numerical investigation of the dynamic response of highly compliant, polymer-enhanced, graphite reinforced cementitious composites." Have students review the paper for homework.

Ooi, T.K., Engberg, R.C., Vaughan, R.E., Gilbert, J.A., Bower, M.V., "Experimental and numerical investigation of the dynamic response of highly compliant, polymer-enhanced, graphite reinforced cementitious composites," Proc. of the 2003 SEM Annual Conference & Exposition on Experimental and Applied Mechanics, Charlotte, North Carolina, June 2-4, 2003, Paper No. 135, 6 pages.

Hand out papers from Strain, Optical Engineering, and OE Magazine. Discuss as much of this work as possible.

Schnack, E., Prinz, B., Dimitrov, S., "Interlaminar stress distribution in carbon fibre epoxy composites with the embedded strain gauge technique," Strain, 40(3): 113-118.

Liu, Y., Pan, J.J., Gu, C., Zhou, F., Dong, L., "Novel fiber Bragg grating fabrication method with high-precision phase control," Optical Engineering, 43(8): 1916-1922.

Saxena, V., Sadoqi, M., Kumar, S., Shao, J., "Tiny bubbles," OE Magazine, September 2004, pp. 21-23.

Class No. 9. (Friday, November 5, 2004)

Finish up the discussion on the technical papers and show slide presentation (Power Point) of Dr. Ooi's dynamic analyses.

Prepare story boards for visual presentation.

Class No. 10 (Friday, November 12, 2004)

Invite Dr. Bower to give an overview of composite lamination and lamination failure.

Invite Dr. Toutanji to make a presentation of Cementitious Mixture Design.

Class No. 11 (Friday, November 19, 2004)

Invite Dr. Cost to make a presentation of vibration analysis and finite element techniques.

Discuss SBIR solicitation process. Set up schedule for final presentations.

Class No. 12 (Friday, December 3, 2004)

Begin final presentations; students have 10 minutes for presentation with 5 minutes for questions. Distribute and collect student evaluation forms.

Class No. 13 (Friday, December 10, 2004)

Conclude final presentations; students have 10 minutes for presentation with 5 minutes for questions.

If possible, take the class to Johnson Center and show them some of the work that has been done. Encourage them to help place this year's concrete canoe and have them schedule placement of samples to get the material properties of the materials that comprise the reinforced composite section in question.