

Prestressed Concrete	GCU09-BP2
Number of hours : 12.00 h	1.00 ECTS credit
CM : 12.00 h	
Reference Teacher(s) : DARQUENNES Aveline	

Objectives :

Advanced structures prestressed concrete calculations.

Content :

Indeterminate effects of prestressing
 Case of a cable
 Case of a parabolic cable
 Calculation of indeterminate times
 concordant cable
 Practical calculation of rotations at the ends
 Exercise: 2 slab bridge spans
 shear
 Following rules BPEL
 Next Eurocodes
 Study of about zones (BPEL)
 Action anchors to abouts (single cable)
 Action anchors to abouts (more cables)
 Balance the lower corner

Bibliography :

THONIER H., LE BETON PRECONTRAIT AUX ETATS LIMITES, Presse des Ponts et Chaussées, 1992.
 CHAUSSIN R., FUENTES A., LACROIX R. , PERCHAT J. LA PRECONTRAINTTE, Presse des Ponts et Chaussées 1992
 FAVRE R., JACCOUD J.-P., BURDET O. et CHARIF H., Dimensionnement des structures en béton, Presses Polytechniques et Universitaires Romandes, 2004

Requirements :

Reinforced concrete, prestressed concrete

Organisation :

Evaluation :

Small project

Composite Steel - Concrete Structures	GCU09-CMX
Number of hours : 24.00 h	1.50 ECTS credit
CM : 24.00 h	
Reference Teacher(s) : GUEZOULI Samy	

Objectives :

This course provides the fundamental bases concerning composite steel-concrete construction, both for buildings and bridges. Understanding the behavior of this type of construction as well as the design in accordance with the Eurocodes standards.

Content :

1. Basic concepts, terminology and areas of application (beams - columns and slabs).
2. Designs buildings and structures, development of calculation methods and codes, Eurocode 4.
3. Study of composite sections: elastic and plastic flexural strength, local buckling and shear, lateral torsional buckling. Classification of composite sections.
4. Load combinations ULS-SLS and pre-design (global analyzes cracked and uncracked). Connection design.
5. Fatigue continuous bridge girders
6. Verifications for composite piles and slabs.
7. Fire resistance.
8. Numerical Modeling.

Bibliography :

1. Comité Européen de Normalisation, 1992, Eurocode 4 - Partie 1,1
2. JOHNSON R.P., 1994, "Composite Structures of Steel and Concrete", Blackwell Scientific Publications
3. A.P.K., 1996, "Construction Métallique et Mixte Acier-Béton", chapitre 8, Ed. Eyrolles
4. A.F.P.C., 1997, "Calcul des ouvrages généraux de construction", chapitre 8, "Modélisation des ouvrages mixtes acier- béton avec leur connexion", Ed. Hermes

Requirements :

Elastic theory of structures and plastic calculations.

Organisation :

Revision of course, personal exercises to perform: 20 hours.

Evaluation :

1 mini-project different for each (Option Buildings and TP).

Hydrogeology	GCU09-HYDR
Number of hours : 12.00 h	1.00 ECTS credit
CM : 12.00 h	
Reference Teacher(s) : LOMINE Franck	

Objectives :

Analysis of behaviour of catchments (urbanized and rural) during precipitation events. Determination of discharge hydrographs and maximum discharging rates. Design of drainage systems.

Content :

1. Characteristics of catchments
2. Statistical analysis of the pluviometric data.
3. Rain-flow transformation
4. Flood flow estimation
5. 1st application I : design of drainage systems
6. 2nd application : numerical modelling of the behaviour of catchments and drainage systems

Bibliography :

1. REMENIERAS G., 1976, "Hydrologie de l'ingénieur, Ed. Eyrolles
2. LLAMAS J., 1993, "Hydrologie générale - Principes et applications", Ed. Gaëtan Morin
3. Ministère de l'Agriculture, 1982, "Synthèse nationale des crues de bassins versants"
4. MUSY, A., 2002, "Hydrologie générale ", Ed. EPFL
5. ANCTIL, F., 2005, Hydrologie, Presses Internationales, Polytechnique Montréal

Requirements :

Statistics, Free surface flow, Hydraulics, Hydrogeology

Organisation :

Course + small project

Evaluation :

Small project

Marine Hydraulic Engineering	GCU09-HYTM
Number of hours : 12.00 h	1.00 ECTS credit
CM : 12.00 h	
Reference Teacher(s) : LOMINE Franck	

Objectives :

- Maritime hydraulics: Modelling of swell. Effect of swell on maritime works.
- Modelling of the phenomena of erosion and sedimentation in estuaries.
- Maritime works & coastal management: An outline of the various arrangements possible to satisfy industry and simultaneously protect the coastal environment.

Content :

1. Maritime hydraulic Concepts : wave theory, wave physics
2. Sea level, wave and stirring, action of waves on structures
3. Sedimentology: definitions, sediment movements, impacts of port development
4. Dredging: dredging techniques, the materials become
5. Design of sea dikes: typologies of

Bibliography :

1. BONNEFILLE R., 1993, ""Cours d'hydraulique maritime"", Ed. Eyrolles
2. LARRAS J., 1979, ""Physique de la houle et des lames"", Ed. Eyrolles
3. GRAF W., ""Hydrodynamique"", ""Hydraulique fluviale"", Presses polytechniques et universitaires romandes
4. LEBRETON J.C., 1974, ""Dynamique fluviale"", Ed. Eyrolles

Requirements :

Physics , waves, fluid mechanics, hydraulics

Organisation :

Calculation of swell deformation in the neighbourhood of maritime works.
Dimensioning of coastal protection structures.
Study of the phenomena of erosion and fluvial deposits.

Evaluation :

Mini project (8 hours).

Pavement Mechanics	GCU09-MECH
Number of hours : 24.00 h	2.00 ECTS credit
CM : 24.00 h	
Reference Teacher(s) :	

Objectives :

Get a deep knowledge of the mechanical behaviour of pavement structures and the practice of their design. Get an expertise of analysis software. Practice evaluation and reinforcement of structures.

Content :

1. Functionality and classification of roads.
2. Traffic characterisation, Equivalent traffic calculation.
3. Mechanical behaviour of subgrade soils and roadbeds.
4. Mechanical behaviour of road materials: fatigue laws and creep.
5. Calculation of allowable stresses and strains: reliability aspects.
6. Structural design: methods and practice, Alizé software.
7. Structural survey methods.
8. Methods and practice of structural reinforcement

Bibliography :

1. PEYRONNE C., CAROFF G., Dimensionnement des chaussées. Presses de l'ENPC. 1984.
2. L.C.P.-SETRA, Conception et dimensionnement des structures de chaussées - Guide Technique. 1994.
3. ULLIDTZ P., Pavement analysis, Elsevier. 1987.

Requirements :

Mechanics of deformable media (GCU05-11), Roads and pavements (GCU08-21)

Organisation :

Lectures, exercises, case studies.

Evaluation :

Project by groups of 2 students

Geotechnical constructions	GCU09-OGEO
Number of hours : 24.00 h	2.00 ECTS credit
CM : 24.00 h	
Reference Teacher(s) : MASSON Samuel	

Objectives :

Knowledge of working techniques and of analysis methods of different typical geotechnical constructions.

Content :

Geotechnique of dams

- foundations pathology: examples and case studies
- earth dams : types, pathology, water flow, stability

Underground works

- geotechnical investigation, characterisation of rock mass
- boring techniques, support types
- mechanical analysis : analytical solutions, convergence-confinement method, numerical methods

Soil reinforcement techniques

- general methods of analysis
- nailing, Reinforced Earth, geotextiles
- other techniques : sand piles, jet grouting, dynamic compaction..

Bibliography :

- Bordes J.-L., Les barrages-réservoirs du milieu du XVIIIe siècle au début du XXe siècle en France, Presses de l'ENPC, 2005.
- Schleiss A. J., Pougatsch H., Les barrages, traité de Génie Civil, Presses de l'EPFL.
- Thomas H., The engineering of large dams. Wiley & Sons, 1976.
- Colombet G., Esteulle F., Bouvard-Lecoanet A., Ouvrages souterrains : conception, réalisation, entretien. Presses de l'ENPC, 1992.
- Panet M., Le calcul des tunnels par la méthode convergence-confinement. Presses de l'ENPC, 1995.
- Hoek E., Practical Rock engineering, www.rocscience.com
- Recommendations Clouterre 1991, Presses de l'ENPC, 1991
- Additif 2002 aux recommandations CLOUTERRE 1991, Presses de l'ENPC, 2002.

Requirements :

Soil mechanics I (GCU06-22), Soil mechanics II (GCU07-21), Engineering geology (GCU05-32), Mechanics of deformable media (GCU05-11), Applied numerical methods (GCU08-13)

Organisation :

Lectures, exercises, case studies.

Evaluation :

Project of construction analysis by group of 2 students

Bridges and Infrastructures	GCU09-POUV
Number of hours : 36.00 h	2.00 ECTS credit
CM : 36.00 h	
Reference Teacher(s) : SOMJA Hugues	

Objectives :

This module aims to provide students with a solid understanding of the general principles of bridge and civil engineering structure design, taking into account:

- The various functions of the structure,
- Mechanical behavior and load-bearing mechanisms,
- Constituent materials,
- The inherent challenges of constructing civil engineering works.

Students will also learn the general rules for preliminary sizing of common bridge elements, as well as the principles of mechanical analysis for both standard and special geometries (such as curved and skew bridges).

The lectures provide students with the essential knowledge needed to complete a mini-project, which involves designing a structure from scratch.

Additionally, students will be introduced to the repair, rehabilitation, and transformation of existing structures through case studies of such operations.

Content :

1. Common typologies and design principles of civil engineering structures.
2. Design of steel structures.
3. Methods of structural analysis: accounting for geometric nonlinearities and the use of finite element models.
4. Dynamic loads: high-speed trains (TGV), seismic activity, and the behavior of footbridges.
5. Analysis of repair, rehabilitation, and transformation operations for civil engineering structures.

Bibliography :

1. CREMER J.M. , "PONTS", notes de cours, université de Liège, 2006
2. JASPART JP, Cours de construction métallique, université de Liège
3. CD ROM ESDEP, leçons de construction métallique, APK, 1999
4. CALGARO J. A., Projet et construction des ponts, presses de l'ENPC, 2000
5. BERNARD GELY A., CALGARO J. A., Conception des ponts, presses de l'ENPC, 1994
6. Documents on moodle

Requirements :

Organisation :

Lectures, and project made by groups of two-three students

Evaluation :

One mini-project, followed by an oral evaluation in the form of feedback on corrections, as well as an oral presentation analyzing a repair/rehabilitation/transformation operation.