

# **Ouvrages Sous Sollicitations Dynamiques et Environnementales**

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**COD 2022-2023**

# **UE : Ouvrages Sous Sollicitations Dynamiques et Environnementales**

**Module 1 : Durabilité des matériaux et des structures (15h CM, 6h15 TD)**

**Module 2: Introduction on Data Sciences pour renovation  
1h15CM 2H30 TP**

**Module 3 : Parasismique, dynamique des structures, retrofitting sismique  
(12h30 CM, 3h45 TD, 7h30 TP)**

**Module 4 : Interaction Sol structure –Ouvrages souterrains et Fondations  
(8h45 CM , 3h45 TD, 5H TP)**

**Module 5: Actions de Neige et Vent (5 x 1h15 TP)**

**COD 2022-2023**

CELENE | Mon ENT Cours : [5A GC COD] Ouvrages sous sollicitations dynamiques et environnementales https://celene.univ-orleans.fr/course/view.php?id=5532

CELENE Accueil Tableau de bord Mes cours Mode d'édition

## [5A GC COD] Ouvrages sous sollicitations dynamiques et environnementales

Cours Paramètres Participants Notes Rapports Plus ▾

### ▼ Généralités

Tout replier

Cette UE se compose des modules suivants :

- 1- Durabilité des matériaux et des structures
- 2 - Parasismique et retroffiting sismique
- 3 - Interaction sol structures :
  - fondations sous sollicitations dynamiques
  - ouvrages souterrains
- 4 - Actions du vent et de la neige

 FORUM Annonces

### ▼ Chapitre 1 : Durabilité des matériaux et structures Marqué

 FICHIER CM1 \_ IntroductionOSSDE, Bases de la durabilité , durabilité versus développement durable ?

Plan du cours

- Chapitre 1 : Durabilité des matériaux et...
- Chapitre 2 -3 : Parasismique et dynamique des...
- Chapitre 4 : Interaction sol-structure ...
- Chapitre 5 : Action du vent et de la neige
- Chapitre Dynamique des Structures

Médiathèque

- Vidéos du cours

Activités

- Devoirs
- Forums
- Ressources
- Tests
- Wooclap

Calendrier

septembre 2022

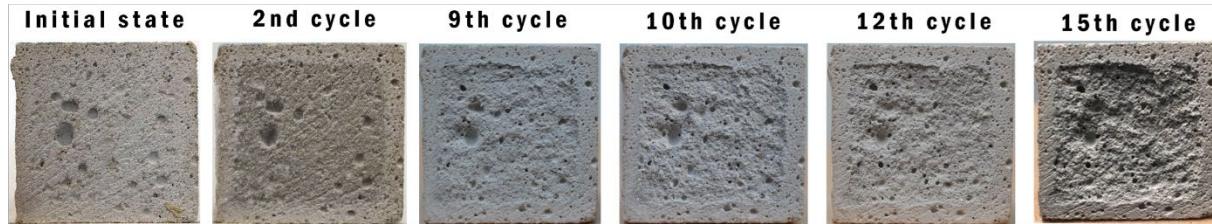
Lu	Ma	Me	Je	Ve	Sa	Di
1	2	3	4			

## Objectives de l'UE:

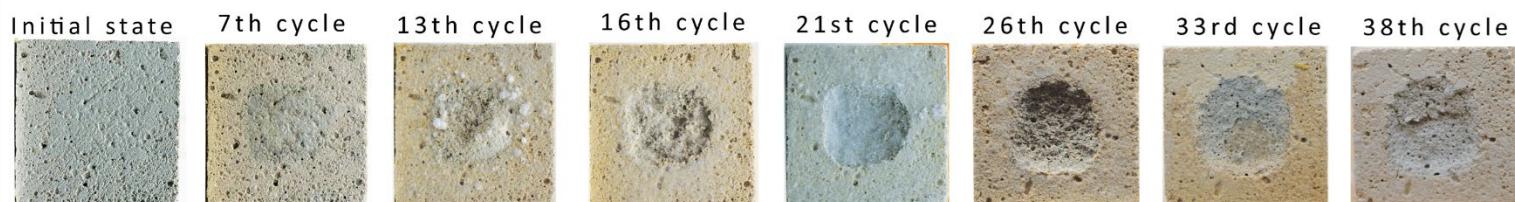
- 1- Compréhension des bases de dimensionnement **durable** des structures, des mécanismes de l'interaction de structures avec l'environnement : température et humidité, charges cycliques, vent et neige, charges dynamiques, séismes
- 2 - Maîtriser les techniques d'évaluation de la durée de vie des structures
- 3 - Apprendre à calculer les charges dues au divers type d'actions de nature non-statique
- 4- Apprendre les techniques de l'évaluation de l'état d'une structure et son état de dégradation suite à son vieillissement, suite à un séisme, à des charges dynamiques (choc) ; apprendre bases de réparations



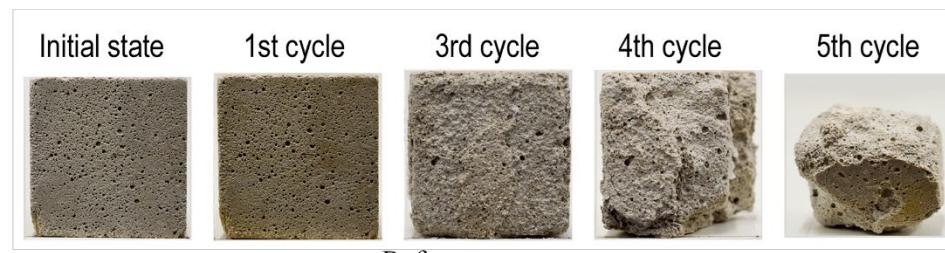




Reference mortar tested after 1 month



Reference mortar tested after 3 month



Reference mortar



Optimal mortar



Optimal mortar with fibers

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# **UE : Ouvrages Sous Sollicitations Dynamiques et Environnementales**

## **Module 1 : Durabilité des structures (15h CM, 6h15 TD)**

1. Introduction : Motivations, definitions (1 CM) D.Hoxha
2. Bases de la Mécanique de la rupture (2 CM + 1TD) D.Hoxha
3. Comportement dépendant du temps (2 CM + 1TD) D.P. Do
4. Durabilité des bétons (2 CM + 1 TD) S. Remond
5. Durabilité des pierres (3 CM + 1 TD) K. Beck
6. Outils DataScience pour la rénovation (D. Hoxha , D.P. Do)

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# **Durability of Materials and Structures**

## **Objectives**

- 1 - Understanding the Durability, its place in the context of sustainability renovation
- 2- Create foundation for design materials and structures fulfilling durability exigences
- 3- Be able to analyze the interaction of a given structure with environment, assess the life use of structures under complex thermal, hydric, mechanic, chemic loads
- 4 - Propose solutions for protection and renovating of existing structures according to exigences of comfort-user , low-carbon and heritage preservation criterion

## **UNIT 1 : Fundamentals and prerequisites of Durability of Materials and Structures**

- Durability, Definitions
- Durability and sustainability, sustainable durability
- Review of prerequisite technical knowledges/skills

Readings : Lecture 1 in the website

References : See references on the readings

## 1- MOTIVATION

Reflexions sur deux outils différents de transmission de l'information



## 1- MOTIVATION

Que connaissez vous de ces deux objets

1163 - 1365 - 2019-



IV century – 989 - 1278-1568

## 1- MOTIVATION



“ Hundreds of firemen of the Paris Fire Brigade are doing everything they can to bring the terrible #NotreDame fire under control. All means are being used, except for water-bombing aircrafts which, if used, could lead to the collapse of the entire structure of the cathedral.

— Sécurité Civile Fr (@SecCivileFrance) April 15, 2019



“ So horrible to watch the massive fire at Notre Dame Cathedral in Paris. Perhaps flying water tankers could be used to put it out. Must act quickly!

— Donald J. Trump (@realDonaldTrump) April 15, 2019

## 1- MOTIVATION



## 1- MOTIVATION

Various kinds of degradations ...



## 1- MOTIVATION

These very good bad ideas !!!!



Stone-Stone compatibility (From K. Beck)

## 1- MOTIVATION



- No known urban pollution sources from anthropological activity
- However various degradation ...

Credits : <http://www.cma-sacre.com>



## **Questions introductives**

Qu'est ce que c'est ULS d'une structure ?

Qu'est ce que c'est SLS d'une structure ?

Quel EC traite de la durabilité ?

What durability of structures stands for ?

What it is sustainability ?

## **Introductory questions :**

What is Ultimate Limit State (ULS) of a structure ?

Maximal load one structure could support without failure, without becoming

What is Serviceability Limit State (SLS)

Maximal load for which one structure could keep its ability to service

What **durability of structures** stands for ?

durability concept is limited to the longevity of a given product, its ability to remain functional (without excessive maintenance), under normal conditions of use, i.e. the conditions it has been designed for

# Sustainability

Indicates an approach of society developing at present such that any of these three dimensions is not compromised for the next generations.

Three aspects: economic, social and environmental

Criterion that a given economic or material flux should satisfy in order to be considered as sustainable :

1 - The consumption rate of renewable resources should not exceed the rate of regeneration of these same resources

2 - The consumption rate of non-renewable resources should not exceed the rate of developing of renewable resources that could substitute these resources

3- The rate of pollution issued by use of any resources should not exceed the capacity of the nature to assimilated this pollution

# Sustainability

Strong versus weak sustainability

*the weak sustainability postulates the full substitutability of natural capital*

*strong sustainability demonstrates that this substitutability should be severely seriously limited due to the existence of critical elements that natural capital provides for human existence and well-being*

# **Sustainable durability**

## **Modern trends on durability**

- *Design sustainable and durable materials and structures*

Meaning ??

- 1- as long as possible life (or time between two maintenances services)
- 2 – respecting the resources renovation
- 3 - respecting the human well being, environment
- 4 – viable economically wise
- 5 – Using recycled materials : how to calculate on these conditions the “life” of a material
- *Monitoring the state of structures/infrastructures*, (continuous monitoring, connected devices, big data approach on decision making about the maintenance, renovation, the structure transform)

# Sustainable durability

## Modern trends on durability (continued)

- Assessment of durability (ULS and SLS approach) of structures, including environmental interaction on assessment

Why ?

1. - Evolution of the state of knowledge (Example : interdiction of asbestos use in constructions in some countries

2 - Evolution of the nature of structures and their use

o The objective of construction different

- Think about the leaving comfort in castles
- Functionality (and comfort) of communist time buildings
- Waste stockage underground works

- Maintenance, protection, renovation

- Transformation, Recycling

# Sustainable durability

## Holistic approach Meaning ??

### Necessity for multidisciplinary research

3 domains : technic, economic/social, environmental

O ..... **but** also multidisplianarity inside the same domain :

Examples in Technical Domain : Multiphysics of degradation mechanisms

How the durability is impacted by :

Temperature

Humidity

Chemical interactions

Coupled **T H M C**

# Fundamentals of Durability (Basic prerequisite)

**Recall**

End of Life :      ULS      or      SLS

## Interactive/adaptative questions

- 1 - What stress is ? Why the stress tensor is symmetric ? What is the stress-state ?
- 2- How the static /dynamic equilibrium state is written : locally ? Globally ?
- 3- What is elastic behavior ? What is elastic limit ? What is a **yield** and/or a failure surface ?
- 4 - Cite some common stress based design criterion for structures and explain their meaning ?
- 5 – Cited some strain-based design criterion and explain their meaning