Random materials modeling : Statistical approach proposal for recycling materials

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Résumé :

Le but de cette communication est donner une idée sur l'application des déchets issus des déconstructions des structures en génie civil. La densité sèche et l'absorption de l'eau ont été étudiées. Les coefficients des matériaux recyclés (coefficients de Lamé, λ et μ) dépendent fortement de la porosité. Sachant que les matériaux recyclés sont des matériaux aléatoires. Par conséquence, l'approche statistique sera une des méthodes la plus convenable pour l'évaluation de la certitude du comportement mécanique. Ceci nous conduit également à une réponse globale de la structure issue des matériaux recyclés.

Abstract :

The current paper aims to promote the application of demolition waste of the Civil Engineering constructions. To achieve this assignment, two main physical properties, i.e. dry density and water absorption of the recycled aggregates have been chosen and studied at the first stage. The material moduli of the recycled materials, i.e. the Lamé's coefficients, λ and μ strongly depend on the porosity. Moreover, the recycling materials should be considered as random materials. As a result, the statistical approach would be the most suitable way to handle and assess the level of certitude of the materials behavior as well as structures response.

Mots clefs : Recycling materials, linear elasticity, random materials, statistical approach, level of certitude, multi-scale modeling

1 Introduction

The exploration of the natural resources for construction purposes leads to millions of tonnes of construction and demolition wastes every year. Traditionally, the demolition wastes have been used for the road

pavements. Unfortunately, the demolition wastes have not been well applied in the building construction as building materials due to the fact that the mechanical strength is not enough good to be used in the building constructions. Moreover, its stochastic physical proprieties could not provide sufficient confidence for the construction purposes. Therefore, the use of the stochastic approaches is extremely essential to deal with these materials and prepare the most reliable stress-strain relation in determining the mechanical actions in the structural elements.

2 Stochastic linear elasticity modeling

More than one hundred experimental data involving the density and water absorption have been statistically analyzed using various qualities of recycled aggregates and recycled aggregate sizes over the globe from 2003 until now in [1]. The outcomes demonstrate that they obey the normal distribution and a nonlinear relation between water absorption and density is suggested in order to classify the recycled materials. Based on our own experimental test results using the recycled aggregate from "Nord ils de France", the proposed relation does not seemingly match very well and it is required to be checked out using more experimental data. The new proposed statistical relation is applied into the mechanical properties, Lamé's coefficients which would determine the hazardous materials behavior [2].

$$\lambda \approx \lambda(\sigma_M, \tau_{SD}) \tag{1}$$

$$\mu \approx \mu(\sigma_M, \tau_{SD}) \tag{2}$$

where σ_M, τ_{SD} are the mean value and standard deviation of Lamé's coefficients, respectively. In this way, the random strength of materials can be extracted using the random constitutive law for the simplest case as following :

$$\sigma_{ij}(\sigma_M, \tau_{SD}) = \lambda(\sigma_M, \tau_{SD})\, \varepsilon_{kk}\, \delta_{ij} + 2\, \mu(\sigma_M, \tau_{SD})\, \varepsilon_{ij} \tag{3}$$

where, σ_{ij} and ε_{ij} are the elastic stress and the infinitesimal deformation, respectively.

3 Conclusion

Finally, the geometry scaling approach is studied to handle the equilibrium equation in the material point of view and the structure as well [3]. In fact, the structure can be considered as the random Cauchy's materials assembling with various boundary conditions and the complex geometry. Consequently, the mechanical reactions of the local zone should be different from the whole structure and so the equilibrium equation in weak form has to take into account in the random material modeling and stochastic boundary conditions as well. The Monte Carlo simulations can be realized to verify the statistical-based equilibrium equation in the elastic beam deflection case.

Références

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