Abstract

This habilitation thesis represents a selection of the results of scientific activity after 2004, when the author obtained the title of Doctor of Engineering. The summary of the results is presented in the following chapters.

Chapter 1. General method of reducing the general torsion of multi-story civil structures with spatial cooperation by slabs.

The main contributions in this chapter are:

1.The development of a general method for reducing the general torsion in the case of multi-story civil structures based on a mathematical model that aims to reduce the eccentricity between the center of mass and the center of rigidity at the level of the floors, as well as directing the main axes of inertia of the floors, following appropriate directions, so that the associated plastic mechanism or the favorable plastic mechanism generates a significant number of plastic joints.

2.The method developed in the work has a high degree of generality, being able to be applied to structures on frames, structures with structural walls, dual structures and structures with tubes or with a flexible central tube. Also, in the process of reducing general torsion, the structural systems that ensure circulation on the elevation of the structure (stairs, elevator box, etc.) are taken into account.

3.In order to generalize the application and use of the method of reducing the general torsion of multi-story structures, this chapter presents the calculation algorithm for the proposed mathematical model, which is transposed into a program in Matlab code that can be used for any structural system used to multi-story structures in civil engineering. In order to explain the practical application of the results obtained in this chapter, case studies are presented for all the structural systems encountered in multi-story civil engineering structures.

Chapter 2. Study of numerical algorithms and probabilistic Monte Carlo algorithms for determining area, static moments, center of mass and inertia tensor for complex planar surfaces.

The main contributions in this chapter are:

1.Development of a general numerical method for determining mass and inertial geometric characteristics for surfaces with complex configuration.

2.Equivalence of moments of inertia for a flat surface with a complex configuration to the moments of inertia of a rectangle.

3.Development of an algorithm for calculating the inertia tensor for surfaces with complex configuration and implementing this algorithm in Matlab code. Validation of the calculation algorithm in the case of simple surfaces through analytical solutions.

4.Development of a calculation algorithm for the inertia tensor of planar surfaces with complex configuration with the probabilistic Monte Carlo method.

5.The methods developed in this chapter allow equating the stiffness of vertical elements of multi-story structures (columns, structural walls and tubes) with rectangular elements. This equivalence is used in the mathematical model presented in chapter 1, which reduces the general torsion of multi-story structures in the field of civil engineering.

Chapter 3. Study of numerical algorithms and probabilistic Monte Carlo algorithms for determining volume, mass, static moments, center of mass and mass inertia tensor for bodies with complex configuration.

The main contributions in this chapter are:

1.Development of a general numerical method for determining mass and inertial geometric characteristics for three-dimensional bodies with complex configuration.

2.Creation an algorithm for three-dimensional bodies with complex configuration, for the calculation of the inertia tensor and the implementation of this algorithm in Matlab code. Validation of the calculation algorithm in the case of simple three-dimensional bodies.

3.Development of an algorithm for calculating the inertia tensor of three-dimensional bodies with complex configuration with the probabilistic Monte Carlo method.

4.The methods developed in this chapter allow determining the inertial characteristics for slabs and stairs that are used in the mathematical model presented in chapter 1, to reduce the general torsion of multi-story structures in the field of civil engineering.

Chapter 4. Increasing the critical loss of stability force in the case of straight bars with variable step section.

The main contributions in this chapter are:

1.Realization of analytical models for bars with constant and variable section in steps to determine the critical force of loss of stability for straight bars with different kinematic conditions at the ends, covering all the important possibilities encountered in practice.

2.The increase of the critical force of loss of stability in the case of the bar with variable section in steps compared to the bar of constant section was studied and highlighted for the following types of kinematic conditions applied to the ends of the bar: **hinged-support (models C1-C2)**, **free-embedded (models C3-C4)**, **sliding-embedding-embedded (models C5-C6)** and **embedded-embedded (models C7-C8)**.

3.In order to determine the critical force of loss of stability in the case of the bar where the cross-section along a bar varies, an algorithm was made which was transposed into a calculation program in Matlab code. The Matlab numerical calculation program was validated based on the analytical solutions obtained in the case of theoretical models for compressed bars with constant and variable section.

4.The obtained results can be successfully applied in the case of tensegrity structures, because by increasing the critical force of loss of stability in compressed bars, the geometric rigidity of these structures can be increased, by increasing the degree of prestressing of the cables of tensegrity structures.

Chapter 5. Scientific, didactic and professional achievements. Evolution and career development plan.

The following aspects are presented in this chapter:

1. The didactic and scientific achievements of the author of the habilitation thesis, as well as the impact and visibility of the scientific activity. Web of Science and BDI indexed publications, citations, grants obtained, lectures at universities abroad and research projects carried out as project director were highlighted.

2. The evolution and development plan of the university career in which a projection is made into the future and the main scientific and didactic objectives of the author of the habilitation thesis are set.

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