# Pedagogical Computational Environment about the Behavior and Dimensioning of Composite Beams

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Abstract - Composite beam is a system made of steel and concrete elements, a combination which takes advantage of each material, structural steel sections, concrete slabs and shear connectors, in structural terms as well as in constructive terms. This work presents the design and constructive aspects of composite beams summarized in a computational system made in Visual Basic language. The objective is to show pedagogical purposes of theoretical and practical learning of the calculations of steel and concrete composite beams, simply supported, according to ultimatestrength-limit state, supported, unsupported, with partial or full interaction, and subjected to uniformly distributed load, and presenting comments and quotations from the ABNT (Technical Standards Brazilian Association) NBR 8800/86.

This work provides knowledge about this subject to undergraduate and graduate students, as well as guidance to any professional in need of this information. The software interface is in Portuguese.

*Index Terms* - composite beams, pedagogical computational environment.

## INTRODUCTION

Composite beams have long been recognized as the most economical elements for floor systems built of a concrete slab and supporting steel sections. It is a perfect use of the principal virtues of component materials: the tensile strength of steel and the compressive strength of concrete.

Their ease of construction, superior strength and stiffness-toweight ratios, and favorable fireproofing characteristics make them the preferred system components in applications where the floor is required to carry primarily gravity loads.

The program was devised to facilitate the learning and with educational objectives, describes in a practical and simple way, explaining all the steps to follow a complete calculation and analyses the composite beams in pedagogical computational environment that provides structural engineers with a unique guide towards an early adoption of the innovative technology that will enable them to furnish their clients with better more economical structures.

## THE PROGRAM

The pedagogical program was created according to ABNT (Technical Standards Brazilian Association) NBR 8800/86 to calculate composite beams simply supported. The data is shown below and the screens are in Portuguese. The initial screen is shown in picture 1.



PICTURE 1 INITIAL SCREEN OF THE PROGRAM

The program allows choosing or inputting data:

- The profile in the wide-flange sections table or enter with dimensions manually picture 2.
- The kind of slab, steel deck or normal concrete slab picture 3 and picture 4.
- The beam spacing picture 5.
- The length of beam picture 5.
- Various others parameters of building, like supported or unsupported building picture 5.
- The interaction, full or partial (in that case the degree of interaction), picture 6 and picture 7.
- The direction the slab if is parallel to ribs of formed deck or perpendicular to the ribs picture 5.
- The kind of shear connectors, stud bolt or profile U picture 6 and picture 7.

And gives complete calculation and analyses the composite beams in reports:

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- A detailed report is calculated by the program and shows, in the screen 9, the items 1 to 8 described below
  - 1- Materials properties
  - 1.1- Steel beams
  - 1.2- Connectors
  - 1.3- Concrete slab
  - 2- Geometric Properties
  - 2.1- Steel profile of composite beam
  - 2.2- Connectors stud bolt or profile U
  - 2.3- Steel deck slab
  - 3- Loadings
  - 3.1- Effective width definition
  - 3.2- Loadings before the concrete has cured
  - 3.3- Loadings after the concrete has cured
  - 3.4- Over weight loads
  - 3.5- Loadings composition
  - 4- Design steel beam alone
  - 4.1- Local slenderness of flange
  - 4.2- Local slenderness of table
  - 4.3- Local slenderness torsion parameters
  - 4.4- Moment bending
  - 5- Composite beam calculation
  - 5.1- Effective width calculation
  - 5.2- Profile class definition
  - 5.3- Neutral axis verifying
  - 5.4- Interactions beam considerations
  - 5.5-Transformed section calculation
  - 5.6- Supported beam considerations
  - 6- Deflection verify
  - 7- Shear strength in the profile flange
  - 8- Shear connectors
  - 8.1- Connectors number calculation
  - 8.2- Connectors building dispositions
- A resume report is calculated by the program and shows, in the screen 10, the items 1 to 5 described below:
  - 1- Design steel beam alone
  - 1.1- Local slenderness of flange
  - 1.2- Local slenderness of table
  - 1.3- Local slenderness torsion parameters
  - 1.4- Moment bending
  - 2- Composite beam calculation
  - 2.1- Effective width calculation
  - 2.2- Profile class definition
  - 2.3- Neutral axis verifying
  - 2.4- Interactions beam considerations
  - 2.5-Transformed section calculation
  - 2.6- Supported beam considerations
  - 3- Deflection verify
  - 4- Shear strength in the profile flange
  - 5- Shear connectors
  - 5.1- Connectors number calculation
  - 5.2- Connectors building dispositions
- Screens with theory resume about composite beams.

The pictures 2 to 12 show the program screens in agreement these stages.



## PICTURE 2 PROFILE IN THE WIDE-FLANGE DEFINITION SCREEN



#### PICTURE 3





PICTURE 4 STEEL DECK SLAB PARAMETERS DEFINITIONS SCREEN



PICTURE 5 INPUT SCREEN BUILDING DEFINITION, BEAM SPACING, BEAM LENGTH, SUPPORTED OR UNSUPPORTED, FULL OR PARTIAL INTERACTION



PICTURE 6 PROFILE U - SHEAR CONNECTORS DEFINITIONS SCREEN







PICTURE 8 DETAILED REPORT SCREEN



PICTURE 9 RESUME REPORT SCREEN



PICTURE 10 THEORY RESUME ABOUT COMPOSITE BEAMS SCREEN 1/3



PICTURE 11 THEORY RESUME ABOUT COMPOSITE BEAMS SCREEN 2/3



PICTURE 12 THEORY RESUME ABOUT COMPOSITE BEAMS SCREEN 3/3

# CONCLUSIONS

The program was devised to facilitate the learning and with educational objectives, describes in a practical and simple way, explaining all the steps to follow a complete calculation and analyses the composite beams in pedagogical computational environment that provides structural engineers with a unique guide towards an early adoption of the innovative technology that will enable them to furnish their clients with better more economical structures.

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