

---

**BiaxialPRO – Complex cross-section analysis**

# **What's new?**

**Version 3.0**

**STRUANG**  
**Studio Tecnico Ing. Alessandro Angelini**

Via Unterer Wiesenweg 36  
Prissian - Tesimo  
39010 (BZ)  
ITALY

E-mail: [alessandro@struang.com](mailto:alessandro@struang.com)  
Web: [www.struang.com](http://www.struang.com)

# Contents

|                                 |   |
|---------------------------------|---|
| Contents                        | 2 |
| General                         | 3 |
| Disclaimer of Warranty          | 3 |
| Version                         | 3 |
| Description                     | 4 |
| BiaxialPRO main features        | 4 |
| General characteristics         | 5 |
| Cross-sections types            | 5 |
| Main characteristics            | 5 |
| Publications                    | 6 |
| Previous version                | 6 |
| New Version                     | 6 |
| What's new?                     | 7 |
| Further implementations         | 7 |
| Etool – RC Cross-section design | 7 |
| Cross-section generator         | 8 |

# General

## Disclaimer of Warranty

Struang - Studio Tecnico Ing. Alessandro Angelini (Author) makes no warranties or representations with respect to the contents or performance of the BiaxialPRO package or this manual. It particularly disclaims any implied warranty of fitness for any particular purpose.

The BiaxialPRO package is provided "as is" with all faults. Any claims made by sales literature or salespersons do not constitute warranties. Because of the diversity of hardware, software and conditions under which the system may be used, Author cannot make any warranty of fitness for a particular purpose. The entire risk of using the software must be assumed by the user. Accordingly, the user is recommended to thoroughly test the software before relying on it. In any event, any liability of Author is excluded.

It is the user's responsibility to ensure that they conform to any laws concerning the changes and restrictions they are permitted to make to an end user's computer and its software.

Struang - Studio Tecnico Ing. Alessandro Angelini reserves the rights to revise and to make changes to the software and and/or this manual without incurring any obligation to notify any person of such changes and revisions. There are no warranties, explicit or implicit, that the codes of the software are free of minor error, or are consistent with any particular standard of accuracy, or that they will meet user requirements for any particular application. They should not be relied on for any purpose where incorrect results could result in loss of property or personal injury. The use of BiaxialPRO software for any such purpose it is at user risk. The author, Ing. Alessandro Angelini, disclaim all liability of any kind, direct or consequential, resulting from usage/use by the user of this code. If user find that something does not seems to work correctly with the BiaxialPRO software, he could email a notification of problem to [struang.engineering@gmail.com](mailto:struang.engineering@gmail.com). If user use BiaxialPRO to produce scientific articles, we would appreciate being informed of the article's title, authors and place of appearance.

2025 Struang - Studio Tecnico Ing. Alessandro Angelini this publication and BiaxialPRO package:

All rights are reserved.

No part of this publication or the BiaxialPRO computer program to which it refers may be reproduced, transcribed, transmitted, stored in a retrieval system, or translated into any language, in any form or by any means mechanical, manual, electronic, magnetic, chemical, optical, or otherwise, except so far as described in this manual or accompanying Licence Agreement, without the prior written permission of Struang - Studio Tecnico Ing. Alessandro Angelini. Successful prosecution for unauthorized reproduction can result in imprisonment and/or fines.

BiaxialPRO package and its manual belonging to Struang - Studio Tecnico Ing. Alessandro Angelini.

## Version

This document refers to BiaxialPRO version 3.0

Manual printed Jan 2025 for BiaxialPRO version 3.0

## Description

BiaxialPRO software provides serviceability and ultimate analysis of a reinforced and composite cross-sections with standard and complex geometry.

### BiaxialPRO main features

- Analysis
  - Linear and non-linear analysis of a generic non-homogeneous cross-section (concrete-steel-timber-carbon-glass fibers)
  - Staged construction analysis for composite cross-section (I.e. composite deck beams)
  - Columns 2<sup>nd</sup> order effects calculations
  - Beam analysis tool (Beam and cantilever scheme for any point force and distributed constant and variable linear loads, up to 6 load cases combinations)
- Geometry
  - Cross-sections geometry: standard rectangular, circular, “T”, non-standard hollow sections, non-symmetrical composite sections, hollow infilled composite sections with embedded profiles, several complex geometries defined on CAD environment.
  - Geometrical calculation of cross-section properties (i.e. section centroid and ellipse of inertia)
  - Cross-section wizard for standard RC and composite cross-sections
- Materials
  - Structural Steel material according EN1993-1-14: elastic-plastic and elastic-plastic with linear hardening
  - Concrete material according EN1992-1-1 and EN1992-1-1: parabola-rectangle stress-strain law include option for modified parabola-rectangle in compression for Annex L EN1992-1-1
  - Rebar according EN1992-1-1 and EN1992-1-1 : elastic-plastic and elastic-plastic with linear hardening
  - Different materials for rebars
  - Concrete confinement according to UNI-EN 1992-1-1
- Output
  - Stress and strain coloured map for any type of analysis (matrix material reacting or not to the tensile stress), with the capability to show a section cut for a specific plan of the cross-section
  - Ultimate cross-section resistance 3D domain with all the external forces plotted against the domain. This allows a quick verification of all the external forces in terms of ultimate resistance
  - Ultimate cross-section resistance 2D domain for a specified set of forces (M<sub>x</sub>, M<sub>y</sub> and N)
  - Moment vs Curvature diagram for any Biaxial bending direction. This graph shows the resistance of the cross section by increasing the curvature, showing all the relevant achieved point during the element loading (I.e. concrete spalling, reinforced yielded, concrete plasticisation, failure)
  - Ductility calculation for seismic request UNI EN 1998 (ITA annex)
  - Crack-width calculation (UNI EN 1992-1-1 - method1: based on rebate stress, diameter and distances inside the tensile zone; method2: rebar stress based)
  - Shear studs connection for a generic non-homogeneous composite cross-section (included timber/concrete)
  - Detailed report of all the relevant calculation (excel and word documents). Report Lang.: English, Italian and German. Report Format: Word, Excel and .txt
- Verifications
  - UNI EN 1992-1-1 SLS and ULS verification. A general verification panel shows the cross-section utilization factor for any verification type and for all the combinations (unlimited)
  - Minimum and maximum amount of reinforcement according EN1992-1-1

- Import/export
  - Import and export of un-limited forces combinations
  - Import and export of reinforcement
  - Import export of cross-section dxf (CAD)
  - Cross-section mesh export in dxf

## General characteristics

BiaxialPro is a specialized software with a user interface designed by an engineer for engineers. The cross-section geometry can be defined using the interface, for standard simple sections, or using a Cad software (AutoCAD, draft sight etc..). For the latest case all the geometrical parameter are defined inside the drawing Cad environment using a specific set of layer for any element (rebars, edge, openings, embedded profiles). Therefore, BiaxialPRO generates a high defined mesh of the cross-section representing all the “micro fiber”. It associates to each micro fiber the property of the relative material. The calculations then follows the structural theory using integration formulation. In general, for any Biaxial bending direction, it calculates the cross-section response/reaction direction

Calculation can be performed assuming the matrix, in general concrete or timber or whatever confined a tensile fiber ( i.e., grfp etc.), reacting to the tensile stress or not reacting ( I.e. cracked concrete )

## Cross-sections types

- Reinforced concrete
- Composite
- Un-reinforced\*

For the composite cross-sections it allows full embedded, partial embedded or external steel profiles.

\* (with a specific definition)

## Main characteristics

BiaxialPRO provides several graphs and diagrams output using Matlab libraries.

Output information consists of:

- Figure
- Section geometry
- Section mesh
- Centroid and ellipse of inertia
- Diagrams
- Stress strain relations for rebar and matrix material
- 3D interaction domain (N Mx My)
- 2D interaction domain
- Moment Vs curvature diagram
- Stress diagram using colormap for each analysis type and each combination
- Calculation Report
- All mechanical, geometrical, forces and settings assumptions
- Geometry information (i.e. reinforcement position, Inertia, neutral axis, etc)
- Crack width calculation details based on 7.3.4 EN 1992-1-1
- Maximum and minimum stress for each combination
- 3D stress distribution
- Curvature details with failure tables (yielding and plastic achievement at any curvature) (release 2.0)

### **Publications**

- BiaxialPRO has been used for the analysis of rc cores and steel-concrete composite cores presented in the technical paper called "Costruzioni Metalliche" of January 2021
- BiaxialPRO has been presenting during the latest Italian steel conference in participation with the partner Arcelor Mittal Luxembourg

## **Previous version**

BiaxialPRO Software - Version 2.5.2 released Jan 2025.

## **New Version**

BiaxialPRO Software - Version 3.0 released May 2025.

# What's new?

BiaxialPRO software version 2.5.2 has been enhanced with several implementations and improvements included in the new version called 3.0. The main changes are listed in the following paragraphs.

## Further implementations

### Etool – RC Cross-section design

1. Shear resistance without reinforcement  
Implemented the shear resistance without reinforcement according to UNI-EN-1992-1-1:2004.
2. Graphs updated  
Bending domains and shear resistance graphs have been updated and moved in a more convenient position.
3. Reinforcement percentage view  
On the user interface has been added the reinforcement percentage referred to the rc section.
4. Reinforcement position drawing added
5. New layout

The screenshot displays the BiaxialPRO-EngineeringTool software interface, specifically the 'RC Cross-section' design tab. The interface is divided into several sections:

- Menu:** A list of options on the left side, including '1. Use and nominal life', '2. Materials', '3. Cover', '4. Anchorage', '5. Exposure', '6. Fire req.', '7. Pad Foundation', '8. Pad f. settings', '9. RC Cross-section' (selected), '10. Reinforcement', '11. Loads', and '12. Steel'.
- Input Fields:**
  - Exposure:** b [cm] (40), h [cm] (60).
  - Fire req.:** Cover [mm] (30).
  - Pad Foundation:** Type (Beam), Øagg [mm] (25).
  - Pad f. settings:** Default di (checkbox), VSpac. [mm] (30).
  - Reinf.:** A table for reinforcement details.

|       | Nr. | Ø [mm] | s [mm] | di [mm] | Area [cm²] | ρ [%] |
|-------|-----|--------|--------|---------|------------|-------|
| Top 1 | 6   | 20     | 40     | 46      | 18.85      | 23.06 |
| Top 2 | 2   | 14     | 292    | 88      | 3.08       | ρ [%] |
| Top 3 | 1   | 12     | 308    | 130     | 1.13       | 0.96  |
| Bot 3 | 4   | 16     | 85     | 130     | 8.04       | 17.66 |
| Bot 2 | 2   | 18     | 284    | 88      | 5.09       | ρ [%] |
| Bot 1 | 4   | 12     | 91     | 46      | 4.52       | 0.74  |
  - Stirrups:** Nb. (2), øst [mm] (10), s [cm] (15), Area [cm²/m] (10.5), θ [°] (45), α [°] (90).
  - Results:** σcp (0.00 [MPa]), Mx,Ed (10.0 [KNm]), NEd (-10.0 [KN]), Vrd,cls (no arm.) (25.7), Vrd,acc (93.7), Vrd,cls (161.9).
- Reinforced position in the concrete cross-section:** A diagram showing the layout of reinforcement bars within a rectangular cross-section. Labels indicate the positions of Top 1, Top 2, Top 3, Bot 3, Bot 2, and Bot 1.

At the bottom left, there is a footer with the text: 'BiaxialPRO - EngineeringTool', 'Version 3.0 - Powered by STRUANG', 'Via Unterer Wiesenweg 36', '39010 Tesimo (BZ) ITALY', 'All Rights Reserved Jan 2025', and the STRUANG logo.

Cross-section generator

Further cross-sections have been implemented for a quick geometry definitio.

BiaxialPRO-Standard-Cross-sections

Standard Cross-Section Wizard

Reinforced concrete "I" non simmetrical section

B  (mm) Section width  
 H  (mm) Section height  
 H1  (mm) Top slab height  
 H2  (mm) Bottom slab height  
 B2  (mm) Bottm slab width  
 W  (mm) Web width

Horizontal rebar distance to concrete edge:

ce  (mm)

Reinforcement data

| Layer | Nr.Rebars                      | Ø                               | Distance Ci                      |
|-------|--------------------------------|---------------------------------|----------------------------------|
| [-]   | [-]                            | [mm]                            | [mm]                             |
| 1     | <input type="text" value="2"/> | <input type="text" value="20"/> | <input type="text" value="40"/>  |
| 2     | <input type="text" value="0"/> | <input type="text" value="16"/> | <input type="text" value="100"/> |

APPLY

BiaxialPRO Versin ...

Reinforcement Perc.

ρ [%]

☒ Mesh creation

Off ☐ On