IL_GUI

User Manual

Influence Line Analyzer

Statically Determinate Beams

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MATLAB-based influence line analysis software

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1 Introduction

IL_GUI is a MATLAB graphical user interface for computing and visualising influence lines for statically determinate beams. It uses fully analytical expressions derived from the direct application of the unit load method and supports the evaluation of structural responses due to both point loads and uniformly distributed loads (UDL).

The program supports:

- Five beam configurations: Simply Supported, Cantilever, Overhang Right, Overhang Left, and Overhang Both
- Four response quantities: Reaction R_A, Reaction R_B (or Fixed-end Moment M_A), Shear force $V(a)$, and Bending moment $M(a)$
- Multiple applied loads (point loads and UDL), additive
- Graphical output: influence line diagram with shaded positive/negative zones and load visualisation
- Results figure with per-load contributions, bar chart, and critical load positions
- Shear discontinuity detection when a point load is placed directly at the section position

1.1 Requirements

- MATLAB R2016b or later (standard `uicontrol`-based GUI)
- No additional toolboxes required

1.2 Getting Started

To launch the GUI, type the following in the MATLAB Command Window:

```
>> IL_GUI
```

The main window (1200×720 px) will open, ready for beam definition.

2 Sign Convention and Coordinate System

Warning

Understanding the sign convention is essential for correct interpretation of influence line ordinates and computed responses.

- The x-axis runs **from left to right** along the beam, starting at $x = 0$ (the leftmost point of the total beam including overhangs).
- For **overhang-left** and **overhang-both** beams, the left support A is located at $x = a_L$ (not at $x = 0$). The right support B is at $x = a_L + L$.
- The **unit load** travels from $x = 0$ to $x = L_{\text{tot}}$.
- **Positive** IL ordinates for R_A and R_B indicate an upward (tension) reaction.
- **Positive** shear $V(a)$ is defined by the standard structural sign convention (left face up / right face down).
- **Positive** bending moment $M(a)$ produces tension on the bottom fibre (sagging convention).

3 Unit System

All inputs and outputs use a consistent unit system:

Quantity	Unit	Symbol
Span / Overhang lengths	metre	m
Section position a	metre	m
Point load P	kilonewton	kN
UDL intensity w	kilonewton/metre	kN/m
Reactions R_A, R_B	kilonewton	kN
Fixed-end moment M_A	kilonewton·metre	kN·m
Shear $V(a)$	kilonewton	kN
Moment $M(a)$	kilonewton·metre	kN·m
IL ordinate (reactions/shear)	kN/kN	–
IL ordinate (moment)	kN·m/kN	–

4 GUI Layout Overview

The main window is divided into three areas:

1. **Left panel** (220 px wide): Beam definition inputs, Generate IL button, beam sketch thumbnail, and usage instructions.
2. **Central axes**: Influence line diagram with shaded areas and load visualisation.
3. **Right panel** (242 px wide): Load definition inputs, load list, and Compute button with total response display.

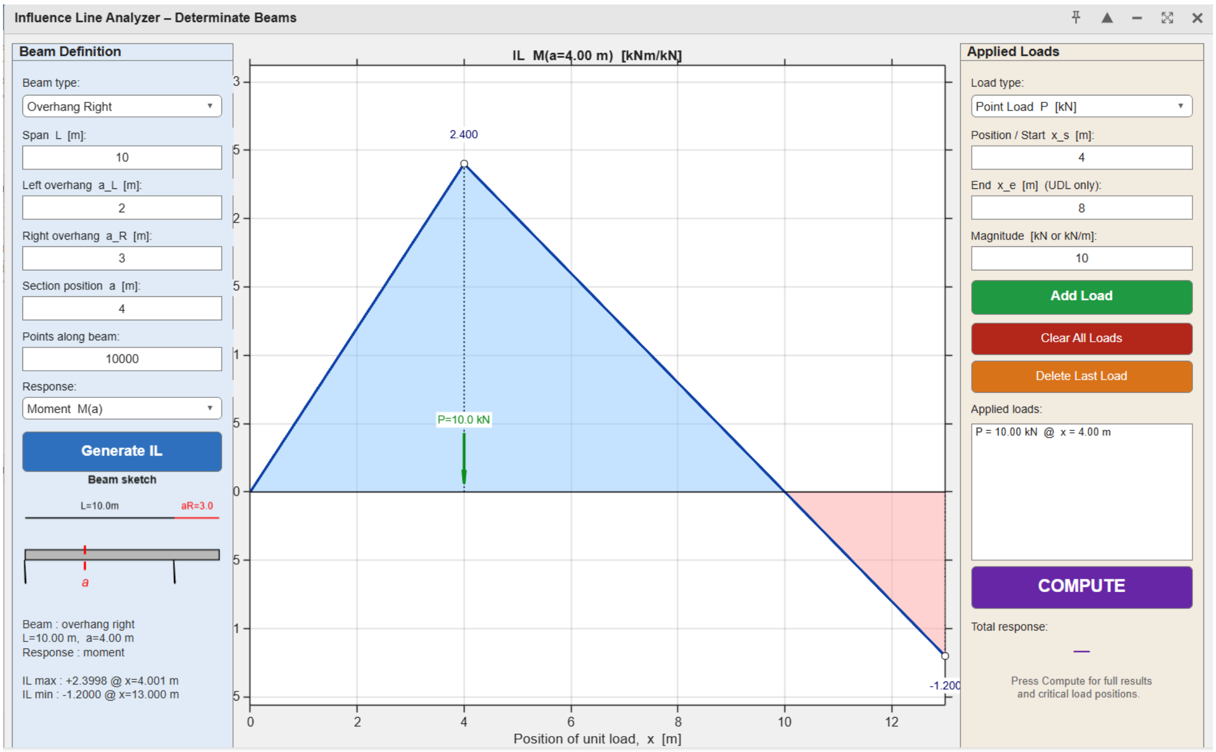

Figure 1: Main GUI window.

4.1 Left Panel Controls

Control	Description
Beam type	Drop-down: Simply Supported, Cantilever, Overhang Right, Overhang Left, Overhang Both
Span L [m]	Main span between supports
Left overhang a_L [m]	Cantilever extension to the left of support A (used for Overhang Left / Both)
Right overhang a_R [m]	Cantilever extension to the right of support B (used for Overhang Right / Both)
Section position a [m]	Location of the section for $V(a)$ or $M(a)$ (must be strictly inside the span)
Points along beam	Number of discretisation points for the IL (default 800; minimum 200)
Response	Drop-down: Reaction R_A, Reaction R_B (or M_A), Shear $V(a)$, Moment $M(a)$
Generate IL	Closes all other figure windows, computes and plots the influence line, and updates the beam sketch
Beam sketch	Thumbnail showing beam geometry, supports, and section position a

4.2 Right Panel Controls

Control	Description
Load type	Point Load P [kN] or UDL w [kN/m]
Position / Start x_s [m]	Load position (point load) or start of UDL
End x_e [m]	End position of UDL (ignored for point loads)
Magnitude	Load value in kN (point) or kN/m (UDL)
Add Load	Adds the defined load to the list and redraws the IL
Clear All Loads	Removes all loads and closes the results window
Delete Last Load	Removes the most recently added load, allowing incremental correction without clearing everything
Applied loads list	Scrollable list of all currently defined loads
COMPUTE	Evaluates the structural response for all loads and opens the Results figure
Total response	Summary of the computed total response displayed inline

5 Beam Types

Beam type	x_A	x_B	Description
Simply Supported	0	L	Pin at A, roller at B; no overhangs
Cantilever	0	L	Fixed wall at A, free end at B
Overhang Right	0	L	Span $[0, L]$; beam extends a_R beyond B
Overhang Left	a_L	a_L+L	Beam starts a_L before support A
Overhang Both	a_L	a_L+L	Overhangs on both sides

> **Tip**
>
> For overhang beams, loads and section positions are defined along the *total beam coordinate* $x \in [0,\, L_{\text{tot}}]$, not just the span. The total beam length is $L_{\text{tot}} = a_L + L + a_R$.

6 Response Types

6.1 Reaction R_A

The influence line ordinate for the vertical reaction at support A when a unit load is placed at position ξ:

$$\eta_{R_A}(\xi) = \frac{x_B - \xi}{x_B - x_A} \tag{1}$$

For the cantilever, $\eta_{R_A} = 1$ everywhere (the wall carries all vertical load).

6.2 Reaction R_B or Fixed-end Moment M_A

For simply supported / overhang beams (reaction at B):

$$\eta_{R_B}(\xi) = \frac{\xi - x_A}{x_B - x_A} \tag{2}$$

For the cantilever (fixed-end moment M_A, positive clockwise):

$$\eta_{M_A}(\xi) = -(\xi - x_A) \tag{3}$$

6.3 Shear Force $V(a)$

For a unit load at ξ, and letting $R_A(\xi) = (x_B - \xi)/(x_B - x_A)$:

$$\eta_V(\xi) = \begin{cases} R_A(\xi) - 1 & \xi < a \\ R_A(\xi) & \xi > a \\ \big[R_A(a) - 1,\; R_A(a)\big] & \xi = a \quad \text{(discontinuity)} \end{cases} \tag{4}$$

For the cantilever:

$$\eta_V(\xi) = \begin{cases} 0 & \xi < a \\ -1 & \xi > a \end{cases} \tag{5}$$

> **Warning**
>
> When a **point load** is placed exactly at the section position a, a shear discontinuity occurs. The program reports both V^- (just left of a) and V^+ (just right of a) separately. The total response panel shows $[\,V^-,\; V^+\,]$ in this case.

6.4 Bending Moment $M(a)$

$$\eta_M(\xi) = \begin{cases} R_A(\xi)\,(a - x_A) - (a - \xi) & \xi \le a \\ R_A(\xi)\,(a - x_A) & \xi > a \end{cases} \tag{6}$$

For the cantilever:

$$\eta_M(\xi) = \begin{cases} 0 & \xi \le a \\ -(\xi - a) & \xi > a \end{cases} \tag{7}$$

7 Workflow

1. **Define the beam.** Select the beam type, enter L, overhang lengths (if applicable), section position a, number of discretisation points, and the desired response from the drop-down menus in the left panel.

2. **Generate the influence line.** Click **Generate IL**. All previously open figure windows are automatically closed. The IL is plotted in the central axes with blue/red shading for positive/negative zones. The beam sketch thumbnail updates. Key ordinates (end points and maximum/minimum) are annotated on the plot.

3. **Add loads.** In the right panel, choose the load type, enter the position (and end position for UDL) and magnitude, then click **Add Load**. The load is drawn on the IL diagram as a coloured arrow (point load) or hatched block (UDL). Repeat for each load. Use **Delete Last Load** to remove the most recent entry if a correction is needed, or **Clear All Loads** to start over.

4. **Compute the response.** Click **COMPUTE**. The total response is displayed in the right panel and a separate *Results* figure window opens (see Section 8).

8 Results Figure

The Results figure contains four sub-plots:

Sub-plot	**Content**
Top (full width)	Influence line with all applied loads overlaid
Bottom-left	Bar chart of the response contribution from each individual load. For shear discontinuity cases, two bars (V^-, V^+) are shown per load. A dashed horizontal line marks the total.
Bottom-right	Critical load positions: IL curve with shaded optimal UDL zones (positive zone in pink, negative zone in blue), critical point markers, and a text box reporting the positive and negative UDL areas A^+ and A^-.

A summary annotation at the bottom of the Results figure lists the contribution of each individual load and the grand total response.

9 Response Calculation

9.1 Point Load

For a point load P at position x_P, the response contribution is:

$$R = P \cdot \eta(x_P) \tag{8}$$

where $\eta(x_P)$ is the analytical IL ordinate evaluated at x_P.

9.2 Uniformly Distributed Load (UDL)

For a UDL of intensity w acting over $[x_s, x_e]$, the response is:

$$R = w \int_{x_s}^{x_e} \eta(\xi)\, d\xi \tag{9}$$

The integral is evaluated numerically using the trapezoidal rule (`trapz`) on the discretised IL segment. The endpoints x_s and x_e are guaranteed to be included in the integration grid.

9.3 Critical UDL Zones

The maximum positive response due to a full-span UDL w is obtained by loading all regions where $\eta > 0$:

$$R^+_{\max} = w \cdot A^+, \qquad A^+ = \int \max(\eta,\, 0)\, dx \tag{10}$$

Similarly for the minimum (most negative) response:

$$R^-_{\min} = w \cdot A^-, \qquad A^- = \int \min(\eta,\, 0)\, dx \tag{11}$$

Both A^+ and A^- are reported in the critical load positions sub-plot of the Results figure.

10 Examples

10.1 Example 1: Simply Supported Beam – Midspan Moment

Setup: Simply supported beam, $L = 10$ m, response = Moment $M(a)$, section $a = 5$ m.

Expected IL: A triangle with peak at $x = 5$ m:

$$\eta_{\max} = \frac{a(L-a)}{L} = \frac{5 \times 5}{10} = 2.5 \text{ kN·m/kN} \tag{12}$$

Point load check: $P = 20$ kN at $x = 5$ m $\Rightarrow M = 20 \times 2.5 = 50$ kN·m.

Full-span UDL check: $w = 5$ kN/m $\Rightarrow M = 5 \times \frac{L^2}{8} = 5 \times \frac{100}{8} = 62.5$ kN·m.

```
% In IL_GUI:
% Beam type   : Simply Supported
% L           : 10 m
% a           : 5 m
% Response    : Moment M(a)
% Click Generate IL
% Load 1 : Point Load  P = 20 kN  @  x = 5 m   -> M = 50.0000 kNm
% Load 2 : UDL   w = 5 kN/m  [0 - 10 m]        -> M = 62.5000 kNm
```

10.2 Example 2: Overhang Right Beam – Reaction R_A

Setup: Overhang Right beam, $L = 8$ m, $a_R = 3$ m, response = R_A.

Key ordinates:

- At $x = 0$ (left end): $\eta = 1.0$
- At $x = 8$ m (support B): $\eta = 0$
- At $x = 11$ m (free end): $\eta = -3/8 = -0.375$

A point load of $P = 10$ kN at $x = 11$ m produces $R_A = -3.75$ kN (i.e. the support A is pulled downward by the load on the overhang).

10.3 Example 3: Cantilever – Shear at $a = 4$ m

Setup: Cantilever, $L = 8$ m, response = Shear $V(a)$, $a = 4$ m.

Expected IL:

- $\eta = 0$ for $0 \leq x < 4$ m

- $\eta = -1$ for $4 < x \le 8$ m
- Discontinuity $[0, -1]$ at $x = 4$ m

A UDL of $w = 6$ kN/m over [4, 8] m gives $V = 6 \times (-1) \times 4 = -24$ kN.

11 Using MATLAB Online

Users without a local MATLAB installation can run IL_GUI entirely in a web browser using MATLAB Online.

11.1 What is MATLAB Online?

MATLAB Online provides the full MATLAB environment inside a web browser. It supports `uicontrol`-based GUIs, the Command Window, and figure windows — everything needed to run IL_GUI. Files are stored in MATLAB Drive (cloud storage linked to your MathWorks account).

11.2 Accessing MATLAB Online

11.2.1 Option A: Institutional Campus-Wide License (Recommended)

Many universities provide campus-wide MATLAB licences with unlimited access.

1. Go to `https://matlab.mathworks.com`
2. Click **Sign in to get started**
3. Enter your university e-mail address
4. Sign in with your institutional credentials (SSO)
5. If you do not yet have a MathWorks account, create one using your institutional e-mail — the campus licence will be linked automatically
6. MATLAB Online will open in your browser

Tip

Check whether your institution has a campus-wide licence at:
`https://www.mathworks.com/academia/tah-support-program/eligibility.html`

11.2.2 Option B: Basic MATLAB Online

If your institution does not have a campus-wide licence:

1. Go to `https://www.mathworks.com/products/matlab-online.html`
2. Create a MathWorks account using your work or school e-mail
3. Access MATLAB Online with **20 hours per month** of compute time and **5 GB** of MATLAB Drive storage

Note

The basic tier is sufficient for IL_GUI. A typical session (generate IL, add several loads, compute) takes only a few seconds.

11.3 Uploading and Running the Program

1. **Upload the file.** In the Current Folder panel, click the *Upload* button and select `IL_GUI.m` from your computer.

2. **Run the program.** Type in the Command Window:

```
>> IL_GUI
```

The GUI window opens inside the browser. All controls work identically to the desktop version.

3. **View the results figure.** After clicking COMPUTE, the Results figure opens as a separate figure tab in MATLAB Online.

4. **Save figures.** Right-click on any figure and select *Save As* to download it to your computer.

Tip

MATLAB Drive files persist between sessions. Install the free **MATLAB Drive Connector** on your computer to synchronise files automatically between your local machine and MATLAB Online.

Warning

MATLAB Online requires a stable internet connection. If the connection drops during a session, unsaved Command Window output may be lost. The uploaded files remain in MATLAB Drive.

12 Limitations

- Statically **determinate** beams only (no continuous beams or frames)
- Two-dimensional (in-plane) analysis only
- One section position a per session (re-generate IL to change a)
- UDL integration uses the trapezoidal rule on the discretised IL; accuracy improves with higher point count (default 800 is more than adequate for engineering purposes)
- The cantilever R_B response returns the fixed-end moment M_A; the label in the GUI reads "R_B (or M_A)" to reflect this
- No load combinations — evaluate each case separately
- No self-weight calculation (apply manually as a UDL if needed)

Version History

Version	Date	Changes
1.0	February 2026	Initial release
1.1	March 2026	Generate IL now closes all other open figures; *Delete Last Load* button added to the right panel; header comment block restructured with full license text

13 Troubleshooting

Issue	**Solution**
Input Error: "Span L must be > 0"	Ensure the span field contains a positive numeric value.
Input Error: "Section a must satisfy …"	The section position must be strictly *inside* the span ($x_A < a < x_B$). Adjust a or check a_L/a_R values.
Shear result shows two values $[V^-, V^+]$	Expected behaviour: a point load placed exactly at the section causes a discontinuity. Both values are analytically correct.
Load rejected: "Range must be within …"	For UDL, both x_s and x_e must lie within $[0, L_{\text{tot}}]$ and $x_s < x_e$.
Results figure does not update after adding a load	The Results figure is only regenerated when COMPUTE is clicked. Adding loads only updates the main IL diagram.
Old results figure still visible after Generate IL	Expected: Generate IL closes all other figures automatically. If a figure persists, close it manually and re-click Generate IL.
Computed response is zero for a UDL entirely in the zero zone	Correct: the IL is zero in that region (e.g. a cantilever shear IL is zero for loads to the left of the section).
GUI appears small on a high-DPI display	Adjust MATLAB's display scaling or set the OS display scale to 100%.

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