Example nº 12
Frame reinforcement design

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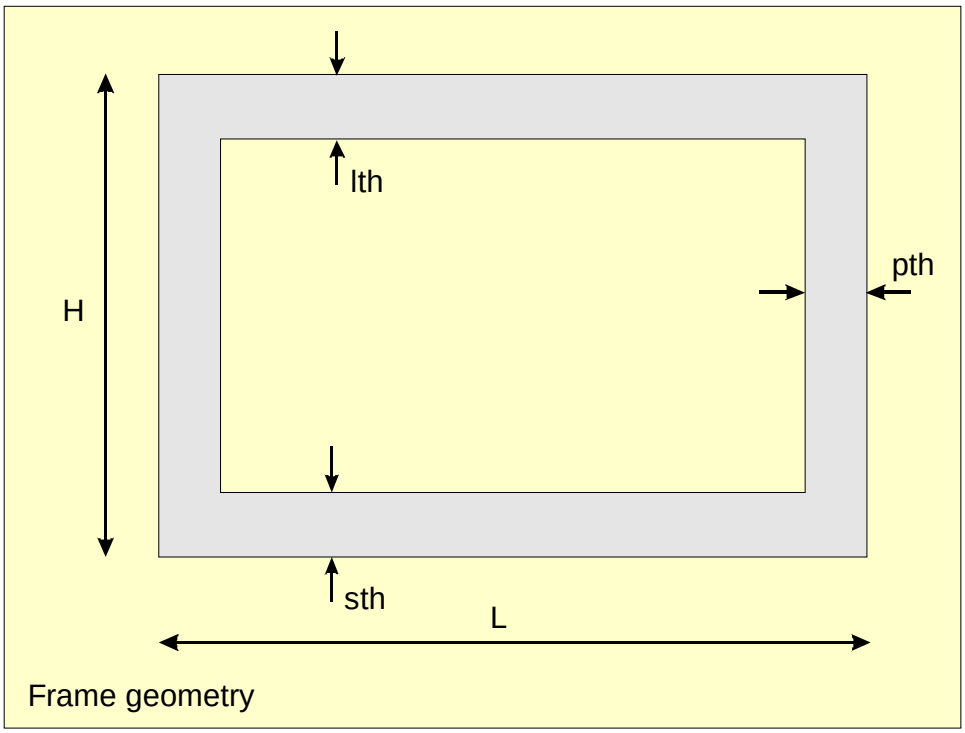
12 EXAMPLE Nº 12: FRAME REINFORCEMENT DESIGN

12.1 AIM

The aim of this example is to show the possibilities of the frame editor of CivilFEM, for the geometrical definition of a frame and the predesign of its reinforcement.

12.2 DESCRIPTION OF THE EXAMPLE

The frame is built as two slabs, for lower slab and lintel, embedded in two vertical walls. It has the following dimensions:



Dimension	Value
H	4.0 m
L	6.0 m
lth	0.4 m
sth	0.3 m
pth	0.3 m

The loads that will be used for the predesign are:

- IAP code heavy vehicle.
- Self weight.
- Uniforme surface load of 4000 N/m^2
- Compactation load: 23000 N/m^2
- Lateral compactation load: 15000 N/m^2

The materials are:

Concrete HA-25 (EHE code)

Reinforcement B 400 S (EHE code)

For the foundation soil, the following geotechnical data will be used:

Specific weight γ = 20000 N/m^3

Ballast Module K= 250000 kN/m^3

Internal friction angle ϕ = 30 º

Earth height over lintel HL= 2 m

12.3 RESULTS TO BE OBTAINED

Obtain the bending and shear reinforcement predesign.

A maximum crack width of 0.3 mm will be considered.

12.4 CALCULATION LOG

12.4.1 Introduction

The International Units System is selected, as the unit system to be used throughout the example.

Next, the parameters of the model (geometry) are set. This way it is easy to modify the model and adapt it to another geometry, or to test different configuration, to perform an optimisation analysis, etc.

The first step for the frame modelling is to chose the materials from the CivilFEM library, selecting the ones specified in the description of the example.

To build the frame it is necessary to set de dimensions. From here, CivilFEM will generate the frame, which can be seen in the frame editor graphical window. Next, the geotechnical properties are defined.

Apart from the dimensions and properties of the frame, it is also necessary to define the loads, that will be set as specified in the description of the example:

- Uniform surface load on the soil.
- Compactation load on the terrain above the frame.
- Lateral compactation load.

The next step is to define the characteristics of the vehicle that will be used to load the structure. The heavy vehicle of the IAP code has 3 axles of 2.0 m length, with a separation between them of 1.5 m. Each wheel has a load of 100kN.

The last step is to assign the materials (concrete and reinforcement steel), previously defined, and to set the maximum crack width (0.3 mm).

In the *Solution View* of the frame editor, the bending and shear reinforcement pre-design can be seen.

For the resolution of this example it is not necessary to solve the model. Nevertheless, a finite element model can be generated in order to continue with the full analysis of the frame.

12.4.2 Log

```
  FINISH
  ~CFCLEAR,,1
  /TITLE, Frame Reinforcement

 ! SETUP
  ~UNITS,SI

   /PREP7

! INITIAL DATA : PARAMETERS

 H=4                      ! Total height (m)
 L=6                      ! Distance between piers
 LTH=0.4                  ! Lintel thickness
```

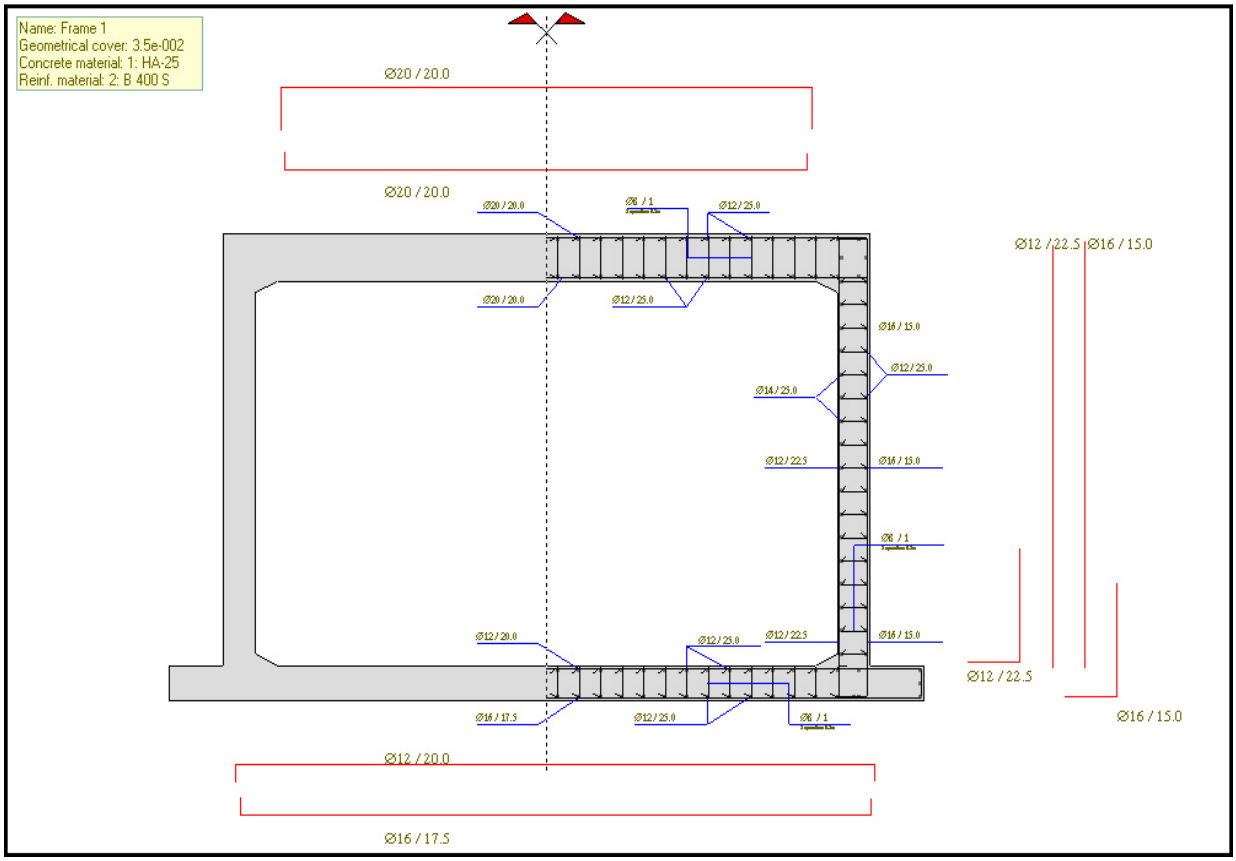
```
 STH=0.3                  ! Slab thickness
 PTH=0.3                  ! Pier thickness
 HL=2                     ! Terrain height over lintel
 TGAMMA=20000             ! Terrain specific weight (N/m3)
 FRIC=30                  ! Terrain friction angle
 KFS=250000000            ! Ballast module

! MATERIALS
~CFMP,1,LIB,CONCRETE,EHE,HA-25,0,0,0
~CFMP,2,LIB,REINF,EHE,B 400 S,0,0,0

! FRAME DEFINITION
 ~FRMDEF,1,H,L,LTH,STH,PTH,,     ! Frame Geometrical Definition
 ~FRMCR,1,0.1,0.2,0.1,0.2        ! Brackets
 ~FRMGT,1,,HL,0,TGAMMA,FRIC,KFS  ! Geotecnical Data
 ~FRMBS,1,2,0.5,0.5              ! Flanges
 ~FRMLDS,1,4000 ,23000 ,15000    ! Surface Loads
 ~FRMVHS,1,3,2,0.6,0.2           ! IAP Heavy Vehicle
 ~FRTRCK,1,1,1.5,1.5,            ! Axles
 ~FRTRCK,1,2,1e5,1e5,1e5,        ! Vehicle Loads
 ~FRMGEN,1,,1,2,0.3e-003         ! Reinforcement Generation
 ~FRMWND                         ¡ Frame window
```

12.5 RESULTS

12.5.1 Reinforcement predesign



12.5.2 Reinforcement list

Frame 1 - Reinforcement list

Pier

	m^2 /100	Fi	Sep (m /10)
Inner cross section reinf. in the center	4.98	12	22.5
Inner cross section reinf. in the support	4.98	12	22.5
Outer cross section reinf. in the center	12.95	16	15.0
Outer cross section reinf. in the support	12.95	16	15.0
Longitudinal inner reinf.	6.00	14	25.0
Longitudinal outer reinf.	3.24	12	25.0

Lintel

	m^2 /100	Fi	Sep (m /10)
Inner cross section reinf. in the center	15.49	20	20.0
Inner cross section reinf. in the support	15.49	20	20.0
Outer cross section reinf. in the center	11.44	16	17.5
Outer cross section reinf. in the support	11.44	16	17.5
Longitudinal inner reinf.	4.00	12	25.0
Longitudinal outer reinf.	4.00	12	25.0

Slab

	m^2 /100	Fi	Sep (m /10)
Inner cross section reinf. in the center	5.27	12	20.0
Inner cross section reinf. in the support	5.27	12	20.0

12.6 SUMMARY

During the resolution of this exercise, the reader has been able to completely practice the functionalities that CivilFEM offers:

- Frame editor.
- Predesign of the geometry and reinforcement of the frame.