SCAFOM RUX POWER SYSTEM
(Heavy Duty Shoring System)

Using Graphics

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SPS Using Graphics                  Rev. 0. August 2011
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Scafom - Rux

Rev. 0. August 2011

Sheet 2

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1.- INTRODUCTION

The purpose of this document is to provide a system to estimate the maximum load capacity for Scafom Power System (SPS) towers under different conditions.

These graphics have been determined through the evaluation of different tower models changing factors such as height, restrained conditions at the top and number of horizontal frames. With these graphics, the maximum vertical load available for a wide range of SPS configurations can be deduced in an easy way.

This is not an exhaustive document. Particular calculations may provide higher values for the maximum vertical load than the graphics in some cases. Also, some special configurations will demand a particular static calculation.

Boundary conditions, load combinations and other considerations are described forward.

2.- GEOMETRICAL CONSIDERATIONS.

Two different cases have been considered:

1. Top unrestrained towers.
2. Top restrained towers.

For each case, different configurations have been checked depending on:

- Plan dimension: 1,2 m x 1,2 m. 1,8 m x 1,8 m. 2,4 m x 2,4 m. 3,0 m x 3,0 m.

- Height – number of horizontal frames:

  Height 4,6 m to 5,8 m. 2 horizontal frame levels.  Height 5,8 m to 8,8 m. 3 horizontal frame levels.  Height 8,8 m to 11,8 m. 4 horizontal frame levels.  Height 11,8 m to 14,8 m. 5 horizontal frame levels.

Graphics provide information for towers from 4,20 meters high to 14,80 meters high and for any plan configuration.
### 3.- CHARACTERISTICS OF MATERIAL

**POWER SYSTEM CHARACTERISTICS**

**Description:** Modular shoring towers.

**Vertical Standard POWER SYSTEM:** Steel S410 pipe Ø 133 mm and thickness 5,6 mm, with welded connections each 600 mm for a 4 way connection with horizontal frames.

**Base Jack POWER SYSTEM:** Steel S355 with yield stress elevated to 410 N/mm², pipe Ø 101,6 mm and thickness 8,0 mm.

**Horizontal frames:** Horizontal frames, steel S355 squared tube 50x50x4 mm.

Diagonal frames, steel S235 squared tube 30x30x3 mm.

Vertical frames, steel S355 with yield stress elevated to 410 N/mm², pipe Ø 48,3 x 3,2 mm.

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### 4.- FOUNDATIONS.

Design, calculation and execution of foundations for SPS shoring towers are responsibility of the customer.

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### 5.- MODELING.

Calculations are made through a three-dimensional model, using the software SAP 2000 version 7.40 considering 2nd order effects.

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### 6.- STANDARDS/REGULATIONS.

- Eurocode 3.
- EN-12812 Falsework.
7.- CHECKING CONDITIONS.

7.1.- LOADS APPLIED AND GEOMETRICAL IMPERFECTIONS.

7.1.1.- WORKING LOAD.
- It is the maximum vertical load available for each configuration.

7.1.2.- SELF WEIGHT.
- Tower elements generated automatically by the program.

7.1.3.- HORIZONTAL LOADS.
- Horizontal load equal to 2,5% of the vertical load.

7.1.4.- SERVICE WIND LOAD.
- SERVICE WIND LOAD = 0,2 KN / m² ➔ S. W. L. = 0,2 KN/m² * 1,3 * Area.
- AERODYNAMIC FACTOR = 1.3

7.1.5.- MAXIMUM WIND LOAD.
- MAXIMUM WIND LOAD = 1,0 KN / m² ➔ M. W. L. = 1,0 KN/m² * 1,3 * Area.
- AERODYNAMIC FACTOR = 1.3
7.1.6 - ECCENTRICITY.

- 25 mm At the top.
- 15 mm At the bottom.

Eccentricities are introduced in the model as a moment.

Top: Working load kN * 0.025 m
Bottom: Working load kN * 0.015 m

Direction for the moment in accordance with the horizontal forces and the out of plumb.

7.1.7 - OUT OF PLUMB.

- HEIGHT / 200

7.1.8 - OUT OF STRAIGHTNESS.

- L/250, “L” from center to center of the horizontal frames.

7.1.9 - BOUNDARY CONDITIONS:

- BOTTOM OF THE TOWER: Hinged in both directions.
- TOP OF THE TOWER:
  - CASE 1: Top unrestrained.
  - CASE 2: Top restrained.

Base jacks at their maximum extension.
7.2.- LOAD COMBINATIONS.

In order to check towers, the static load cases considered are:

- **LOAD 1**: self-weight. Determined automatically by the program.
- **C**: vertical loads and eccentricity.
- **HORIZ**: horizontal loads.
- **WINDSER**: service wind load
- **WINDMAX**: maximum wind load

Load combinations:

**SLSNLMW**: Serviceability Limit State, no load, maximum wind:

LOAD 1 x 1 + WINDMAX x 0,7

Material partial factor of safety = 1

**ULSNLMW**: Ultimate Limit State, no load, maximum wind:

LOAD 1 x 1,35 + WINDMAX x 0,7 x 1.5

Material partial factor of safety = 1.1

**SLSWSER**: Serviceability Limit State, service wind load:

LOAD 1 x 1 + C x 1 + HORIZ x 1 + WINDSER x 1

Material partial factor of safety = 1

**ULSWSER**: Ultimate Limit State, service wind load:

LOAD 1 x 1.35 + C x 1.5 + HORIZ x 1.5 + WINDSER x 1.5

Material partial factor of safety = 1.1

**SLSWMAX**: Serviceability Limit State, maximum wind load:

LOAD 1 x 1 + C x 1 + WINDMAX x 1

Material partial factor of safety = 1

**ULSWMAX**: Ultimate Limit State, maximum wind load:

LOAD 1 x 1.35 + C x 1.5 + WINDMAX x 1.5

Material partial factor of safety = 1.1

**Serviceability Limit State**: For displacements and reactions.

**Ultimate Limit State**: For checking tower stability frames capacity using Eurocode 3.

2nd order effects have been considered.
Table 1 - Load combination factors $\psi$ EN 12812:2004

<table>
<thead>
<tr>
<th>Action</th>
<th>Designation</th>
<th>Combination factors $\psi$</th>
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<tr>
<td></td>
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<td>Load case 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self-weight + max.wind</td>
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<tr>
<td>Direct actions</td>
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<td></td>
</tr>
<tr>
<td>$Q_1$</td>
<td>Deadweight</td>
<td>1,0</td>
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<tr>
<td>$Q_2$</td>
<td>Variable persistent vertical loads</td>
<td>0</td>
</tr>
<tr>
<td>$Q_3$</td>
<td>Variable persistent horizontal loads</td>
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<tr>
<td>$Q_4$</td>
<td>Variable transient imposed loads</td>
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</tr>
<tr>
<td>$Q_5$</td>
<td>Wind, maximum</td>
<td>0,7</td>
</tr>
<tr>
<td>$Q_6$</td>
<td>Wind, working</td>
<td>0</td>
</tr>
<tr>
<td>$Q_7$</td>
<td>Flowing water</td>
<td>0,7</td>
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<td></td>
<td>Seismic</td>
<td>0</td>
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<tr>
<td>Indirect actions</td>
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<tr>
<td>$Q_8$</td>
<td>Other loads</td>
<td>0</td>
</tr>
</tbody>
</table>

$^a$ This load case is a non-collapse requirement in accordance with ENV 1998-1-1.
8.- GRAPHICS.

Top unrestrained:

Height 4,6 to 5,8 meters. 2 horizontal frame levels: Graphic nº 1.
Height 5,8 to 8,8 meters. 3 horizontal frame levels: Graphic nº 2.
Height 8,8 to 11,8 meters. 4 horizontal frame levels: Graphic nº 3.
Height 11,8 to 14,8 meters. 5 horizontal frame levels: Graphic nº 4.

Top restrained:

Height 4,6 to 5,8 meters. 2 horizontal frame levels: Graphic nº 5.
Height 5,8 to 8,8 meters. 3 horizontal frame levels: Graphic nº 6.
Height 8,8 to 11,8 meters. 4 horizontal frame levels: Graphic nº 7.
Height 11,8 to 14,8 meters. 5 horizontal frame levels: Graphic nº 8.
Example:

Tower Scafom Power System (SPS); Height: 8,0 m; Top unrestrained

Plan dimension: 1,80 x 2,40 m.

- Height: 8,0 m → 5,80 < 8,0 m < 8,80 m → 3 horizontal frame levels
- Top unrestrained
- Plan dimension: 1,80 x 2,40 m → 1,80 curve

| Graphic nº 2, curve 1,80 m |

Tower H = 7,60 m → Max. Vertical Load = 142,5 Kn

Tower H = 8,20 m → Max. Vertical Load = 130,0 Kn

Linear interpolation: Max. Vertical Load Tower H = 8,0 m, plan dimension: 1,80 x 2,40 m. → Q

\[ Q = \frac{(142,5 - 130,0) \times (8,2 - 8,0)}{(8,2 - 7,6)} + 130 = 134,16 \text{ Kn} \]

The value obtained through graphics is correct.
8.1.- TOP UNRESTRAINED. 2 HORIZONTAL FRAME LEVELS. GRAPHIC Nº 1.

(Height from 4,60 m to 5,80 m).

In some cases, a particular calculation will increase the maximum allowable load for a SPS tower.
8.2.- TOP UNRESTRAINED. 3 HORIZONTAL FRAME LEVELS. GRAPHIC Nº 2.

(Height from 5,80 m to 8,80 m).

In some cases, a particular calculation will increase the maximum allowable load for a SPS tower.
8.3.- TOP UNRESTRAINED. 4 HORIZONTAL FRAME LEVELS. GRAPHIC Nº 3.

(Height from 8.80 m to 11.80 m).

In some cases, a particular calculation will increase the maximum allowable load for a SPS tower.
8.4.- TOP UNRESTRAINED. 5 HORIZONTAL FRAME LEVELS. GRAPHIC Nº 4.

(Height from 11,80 m to 14,80 m).

In some cases, a particular calculation will increase the maximum allowable load for a SPS tower.
8.5.- TOP RESTRAINED. 2 HORIZONTAL FRAME LEVELS. GRAPHIC Nº 5.

(Height from 4,60 m to 5,80 m).

In some cases, a particular calculation will increase the maximum allowable load for a SPS tower.
8.6.- TOP RESTRAINED. 3 HORIZONTAL FRAME LEVELS. GRAPHIC Nº 6.

(Height from 5,80 m to 8,80 m).

In some cases, a particular calculation will increase the maximum allowable load for a SPS tower.
8.6.- TOP RESTRAINED. 4 HORIZONTAL FRAME LEVELS. GRAPHIC Nº 7.

(Height from 8.80 m to 11.80 m).

In some cases, a particular calculation will increase the maximum allowable load for a SPS tower.

Scafom Power System
4 Horizontal Frame Levels
Height from 8,8 to 11,8 m
Top Restrained

Allowable Compressive Working load per leg (kN)

Tower height (m)

In some cases, a particular calculation will increase the maximum allowable load for a SPS tower.
8.8.- TOP RESTRAINED. 5 HORIZONTAL FRAME LEVELS. GRAPHIC Nº 8.

(Height from 11,80 m to 14,80 m).

In some cases, a particular calculation will increase the maximum allowable load for a SPS tower.