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 Civil & Geotechnical Engineering Consulting Company for  
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 Mobile: (+30) 6936425722 & (+44) 7585939944,  
 www.geodomisi.com - costas@sachpazis.info

**Project: Circular Section Column Design & Analysis, Calculations according to EUROCODE2 1992-1-1:2004 with NA=CEN.**

Job Ref.  
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Section  
 Civil & Geotechnical Engineering

Sheet no./rev. 1

Calc.  
 Dr. C. Sachpazis

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**Circular Section Column Calculations : Design : Tension/Compression 1**

Calculation according to EUROCODE2 1992-1-1:2004

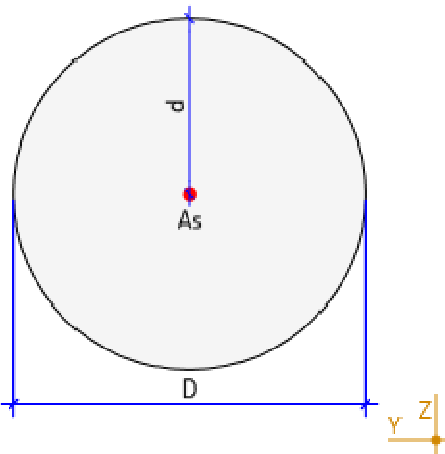
National annex: CEN

**Section data: Circular shape**

**Section dimensions:**

$D = 60$

$d_1 = 30 \text{ cm}$



**Concrete class C25/30**

$f_{ck} = 25 \text{ MPa};$

$\gamma_c = 1.5;$

$f_{cd} = 16.667 \text{ MPa};$

**Steel grade main reinforcement B 500 B**

$f_{yk} = 500 \text{ MPa};$

$\gamma_s = 1.15;$

$f_{yd} = 434.783 \text{ MPa};$

**Loads:**

Name	N, [kN]
ULS 1	-1200
ULS 2	-10

Long term loads participation 100 %

Cracks restriction 0.4 mm

Minimum reinforcement is included

**Results:**

$A_s = 9.817 \text{ cm}^2 (2\text{Ø}25)$

$\rho = 0.347 \%$

$\rho_{min} = 0.2 \%$  (5.655 cm<sup>2</sup>)

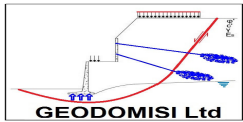
$\rho_{max} = 4 \%$  (113.097 cm<sup>2</sup>)

total reinforcement area

reinforcement ratio

minimum reinforcement ratio

maximum reinforcement ratio



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$$l_{bd} = 405.797 \text{ mm}$$

design anchorage length for tension/compression reinforcement

### Calculations : Design : Tension/Compression 2

Calculation according to EUROCODE2 1992-1-1:2004

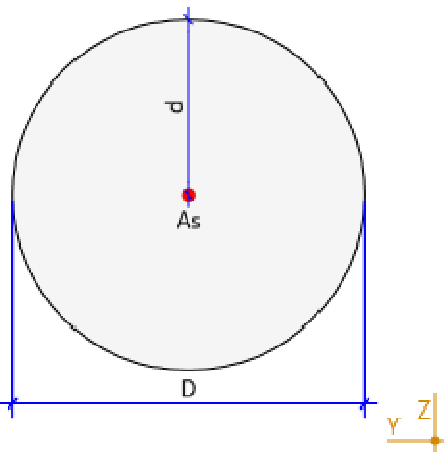
National annex: CEN

### Section data: Circular shape

**Section dimensions:**

$$D = 60$$

$$d_1 = 30 \text{ cm}$$



**Concrete class C25/30**

$$f_{ck} = 25 \text{ MPa};$$

$$\gamma_c = 1.5;$$

$$f_{cd} = 16.667 \text{ MPa};$$

**Steel grade main reinforcement B 500 B**

$$f_{yk} = 500 \text{ MPa};$$

$$\gamma_s = 1.15;$$

$$f_{yd} = 434.783 \text{ MPa};$$

### Loads:

Name	N, [kN]
ULS 1	-1200
ULS 2	-10

Long term loads participation 100 %

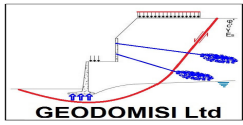
Cracks restriction 0.4 mm

Minimum reinforcement is included

### Results:

$$A_s = 9.817 \text{ cm}^2 (2\emptyset 25)$$

total reinforcement area



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$$\rho = 0.347 \%$$

$$\rho_{min} = 0.2 \% (5.655 \text{ cm}^2)$$

$$\rho_{max} = 4 \% (113.097 \text{ cm}^2)$$

$$l_{bd} = 405.797 \text{ mm}$$

reinforcement ratio

minimum reinforcement ratio

maximum reinforcement ratio

design anchorage length for tension/compression reinforcement

### **Calculations : Design : Axial force with biaxial bending 1**

Calculation according to EUROCODE2 1992-1-1:2004

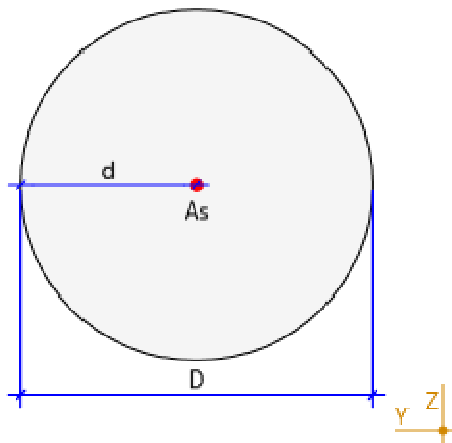
National annex: CEN

### **Section data: Circular shape**

#### **Section dimensions:**

$$D = 60$$

$$d_1 = 30 \text{ cm}$$



#### **Concrete class C25/30**

$$f_{ck} = 25 \text{ MPa};$$

$$\gamma_c = 1.5;$$

$$f_{cd} = 16.667 \text{ MPa};$$

#### **Steel grade main reinforcement B 500 B**

$$f_{yk} = 500 \text{ MPa};$$

$$\gamma_s = 1.15;$$

$$f_{yd} = 434.783 \text{ MPa};$$

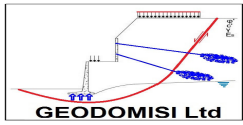
### **Loads:**

Name	$M_y$ , [kNm]	$M_z$ , [kNm]	N, [kNm]
ULS 1	350	120	-10
ULS 2	350	120	-1200

### **Results for critical ULS load case for $A_s$ :**

$$A_s = 38.45 \text{ cm}^2 (8\emptyset 25)$$

total reinforcement area



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$$e_y = -3500 \text{ cm}$$

static eccentricity value in Y direction

$$e_z = -1200 \text{ cm}$$

static eccentricity value in Z direction

### **Final results:**

$$A_s = 38.45 \text{ cm}^2 \text{ (8}\varnothing 25\text{)}$$

total reinforcement area

$$\rho = 1.389 \%$$

reinforcement ratio

$$\rho_{min} = 0.2 \% \text{ (5.655 cm}^2\text{)}$$

minimum reinforcement ratio

$$\rho_{max} = 4 \% \text{ (113.097 cm}^2\text{)}$$

maximum reinforcement ratio

### **Calculations : Design : Axial force with biaxial bending 2**

Calculation according to EUROCODE2 1992-1-1:2004

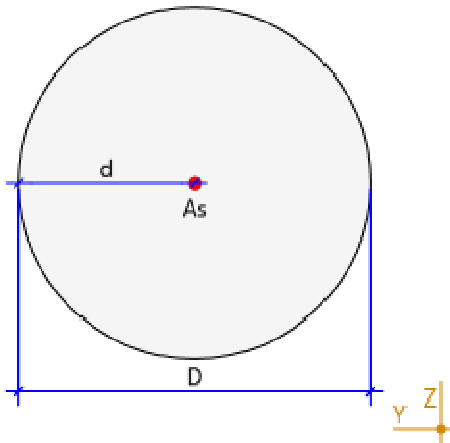
National annex: CEN

### **Section data: Circular shape**

**Section dimensions:**

$$D = 60$$

$$d_1 = 30 \text{ cm}$$



**Concrete class C25/30**

$$f_{ck} = 25 \text{ MPa};$$

$$\gamma_c = 1.5;$$

$$f_{cd} = 16.667 \text{ MPa};$$

**Steel grade main reinforcement B 500 B**

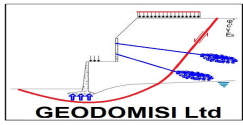
$$f_{yk} = 500 \text{ MPa};$$

$$\gamma_s = 1.15;$$

$$f_{yd} = 434.783 \text{ MPa};$$

### **Loads:**

Name	$M_{y_1}$ [kNm]	$M_{z_1}$ [kNm]	N, [kNm]
ULS 1	350	120	-10
ULS 2	350	120	-1200



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### **Results for critical ULS load case for As:**

$$A_s = 38.45 \text{ cm}^2 (8\emptyset25)$$

$$e_y = -3500 \text{ cm}$$

$$e_z = -1200 \text{ cm}$$

*total reinforcement area*

*static eccentricity value in Y direction*

*static eccentricity value in Z direction*

### **Final results:**

$$A_s = 38.45 \text{ cm}^2 (8\emptyset25)$$

$$\rho = 1.389 \%$$

$$\rho_{min} = 0.2 \% (5.655 \text{ cm}^2)$$

$$\rho_{max} = 4 \% (113.097 \text{ cm}^2)$$

*total reinforcement area*

*reinforcement ratio*

*minimum reinforcement ratio*

*maximum reinforcement ratio*

### **Calculations : Design : Shear and torsion 1**

Calculation according to EUROCODE2 1992-1-1:2004

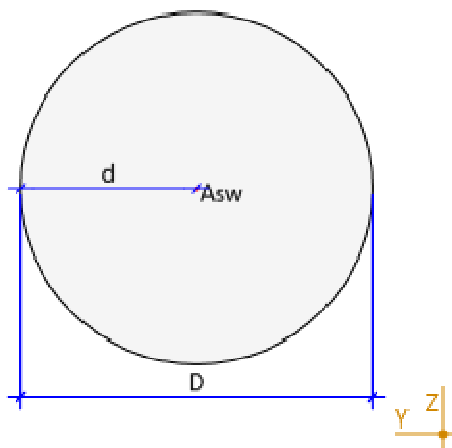
National annex: GEN

### **Section data: Circular shape**

**Section dimensions:**

$$D = 60$$

$$d_1 = 30 \text{ cm}$$



**Concrete class C25/30**

$$f_{ck} = 25 \text{ MPa};$$

$$\gamma_c = 1.5;$$

$$f_{cd} = 16.667 \text{ MPa};$$

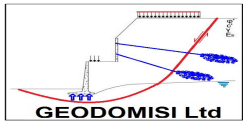
**Steel grade stirrups reinforcement B 500 B**

$$f_{yk} = 500 \text{ MPa};$$

$$\gamma_s = 1.15;$$

$$f_{yd} = 434.783 \text{ MPa};$$

### **Loads:**



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$V = 120 \text{ kN}$   
 $N = -10 \text{ kN}$   
 $T = 250 \text{ kN};$

$A_{sl} = 112 \text{ cm}^2$   
 Number of stirrups arms = 2  
 Stirrups inclination  $\alpha = 90 \text{ deg}$   
 $\text{ctg } \theta = 2$   
 $K_1 = 0.15$   
 $C_{rd,c} = 0 / \gamma_c$

**Results:**

$V_{Rd,c} = 64.278 \text{ kN}$   
 2 arms x  $\varnothing 10 \text{ mm}$   
 $T_{Rd,c} = 2442.902 \text{ kN}$   
 $s = 24.6 \text{ cm}$   
 $s_{max} = 30 \text{ cm}$   
 $\rho = 0.213 \%$   
 $\rho_{min} = 0.08 \%$  (5.655 cm<sup>2</sup>)

stirrups

stirrups spacing

maximum stirrups spacing

reinforcement ratio

minimum reinforcement ratio

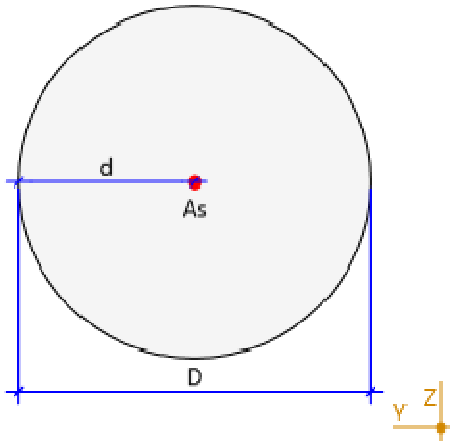
**Calculations : Analysis : Tension/Compression 1**

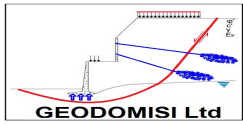
Calculation according to EUROCODE2 1992-1-1:2004  
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**Section data: Circular shape**

**Section dimensions:**

$D = 60$   
 $d_1 = 30 \text{ cm}$





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**Concrete class C25/30**

$f_{ck} = 25 \text{ MPa};$   
 $\gamma_c = 1.5;$   
 $f_{cd} = 16.667 \text{ MPa};$

**Steel grade main reinforcement B 500 B**

$f_{yk} = 500 \text{ MPa};$   
 $\gamma_s = 1.15;$   
 $f_{yd} = 434.783 \text{ MPa};$

**Reinforcement:**

Total reinforcement area  $A_s = 113 \text{ cm}^2$

**Results for ULS calculation:**

$N_{min} = -9437.099 \text{ kN}$   
 $N_{max} = 4913.043 \text{ kN}$   
 $\rho = 3.997 \%$   
 $\rho_{min} = 0.2 \%(5.655 \text{ cm}^2)$   
 $\rho_{max} = 4 \%(113.097 \text{ cm}^2)$

maximum compression force  
 maximum tension force  
 reinforcement ratio  
 minimum reinforcement ratio  
 maximum reinforcement ratio

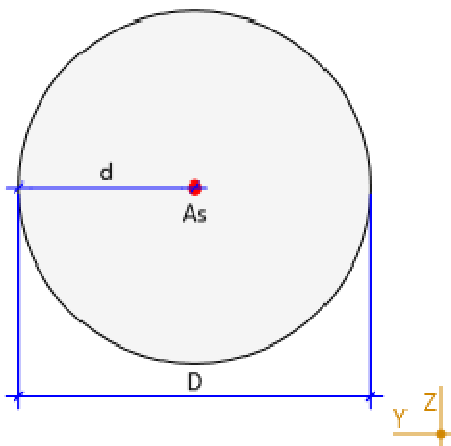
**Calculations : Analysis : Axial force with biaxial bending 1**

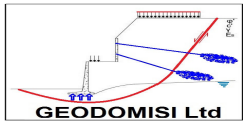
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**Section data: Circular shape**

**Section dimensions:**

$D = 60$   
 $d_1 = 30 \text{ cm}$





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**Concrete class C25/30**

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 $\gamma_c = 1.5;$   
 $f_{cd} = 16.667 \text{ MPa};$

**Steel grade main reinforcement B 500 B**

$f_{yk} = 500 \text{ MPa};$   
 $\gamma_s = 1.15;$   
 $f_{yd} = 434.783 \text{ MPa};$

**Reinforcement:**

Total reinforcement area  $A_s = 39.27 \text{ cm}^2$   
 Eccentricity value in Y direction  $e_y = 0 \text{ cm}$   
 Eccentricity value in Z direction  $e_z = 0 \text{ cm}$

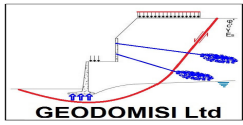
**Results for ULS calculation:**

$M_{max} = 485770 \text{ [Unit.kNm]}$   
 $N = -1100 \text{ [Unit.kNm]}$   
 $\rho = 1.389 \%$   
 $\rho_{min} = 0.2 \%(5.655 \text{ cm}^2)$   
 $\rho_{max} = 4 \%(113.097 \text{ cm}^2)$

maximum bending moment  
 input normal force  
 reinforcement ratio  
 minimum reinforcement ratio  
 maximum reinforcement ratio

**Interaction diagram between bending moment  $M_y$  and axial force  $N$**





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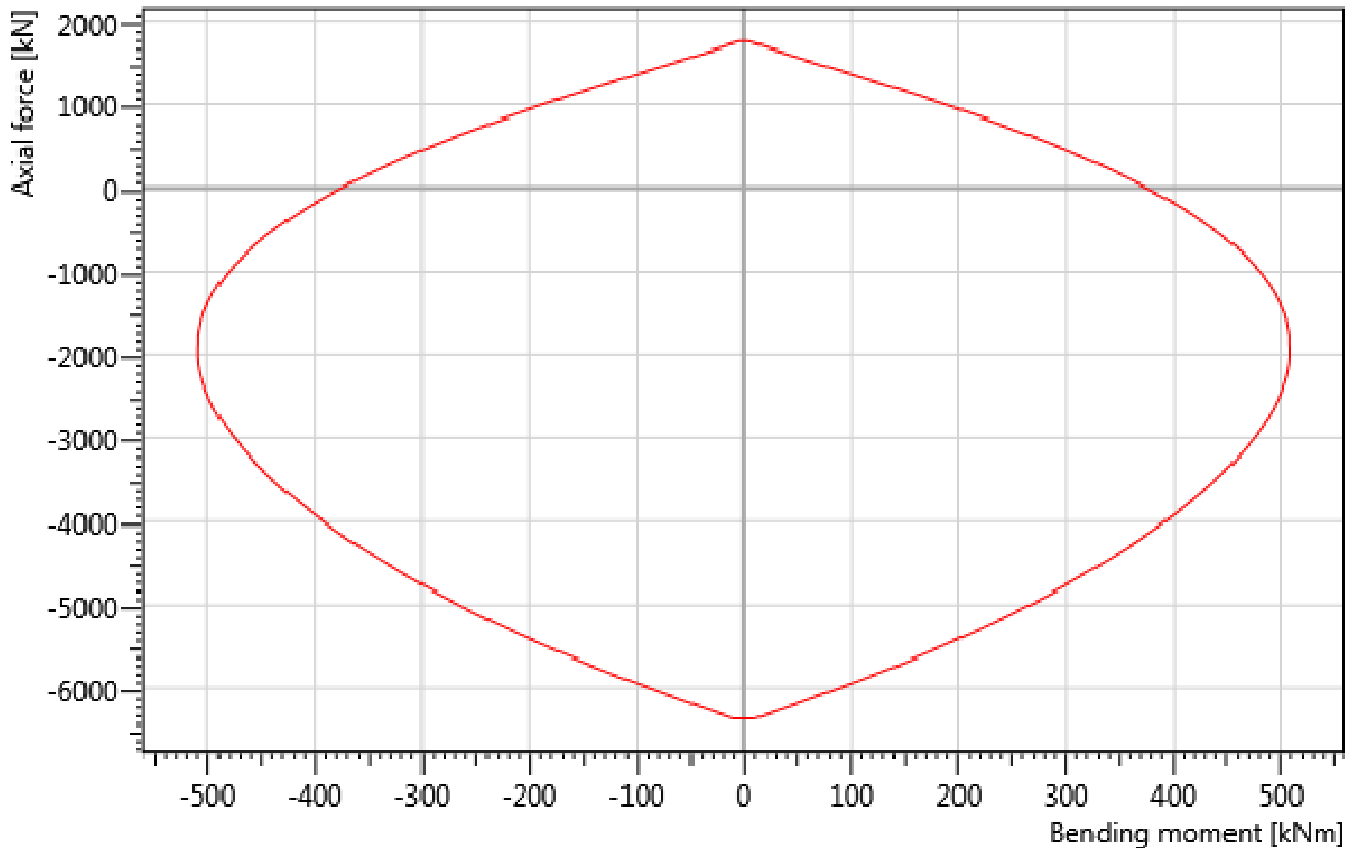
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**Interaction diagrams**

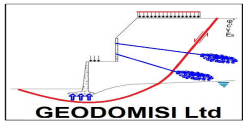


**Calculations : Analysis : Shear and torsion 1**

Calculation according to EUROCODE2 1992-1-1:2004

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**Section data: Circular shape**



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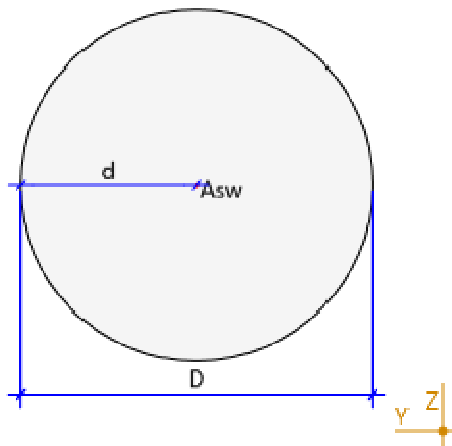
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**Section dimensions:**

$D = 60$   
 $d_1 = 30 \text{ cm}$



**Concrete class C25/30**

$f_{ck} = 25 \text{ MPa};$   
 $\gamma_c = 1.5;$   
 $f_{cd} = 16.667 \text{ MPa};$

**Steel grade stirrups reinforcement B 500 B**

$f_{yk} = 500 \text{ MPa};$   
 $\gamma_s = 1.15;$   
 $f_{yd} = 434.783 \text{ MPa};$

**Reinforcement:**

Stirrups spacing  $s = 24.6 \text{ cm}$   
 Stirrups arms  $2 \times \text{Ø}10$   
 Stirrups inclination  $\alpha = 90 \text{ deg}$   
 Tension force in section  $N = -10 \text{ kN}$   
 $\text{ctg } \theta = 2$   
 $k_1 = 0.15$   
 $C_{rd,c} = 0.18 / \gamma_c$

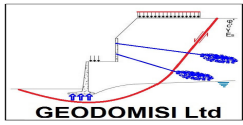
**Results for ULS calculation:**

$V = 149.917 \text{ kN}$   
 $V_{Rd,c} = 72.771 \text{ kN}$   
 $V = 1255.941 \text{ kNm}$   
 $T_{Rd,c} = 2442.902 \text{ kNm}$   
 2 arms  $\times \text{Ø}25$   
 $s = 24.6 \text{ cm}$   
 $s_{max} = 30 \text{ cm}$   
 $\rho = 0.213 \%$   
 $\rho_{min} = 0.08 \%(5.655 \text{ cm}^2)$

maximum allowable shear force

maximum allowable torsion force

stirrups  
 stirrups spacing  
 maximum stirrups spacing  
 reinforcement ratio  
 minimum reinforcement ratio



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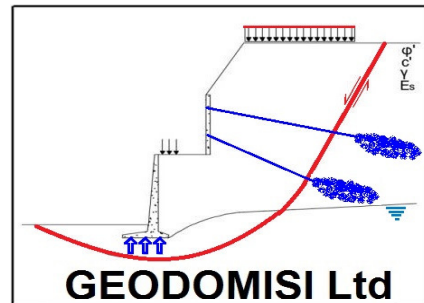
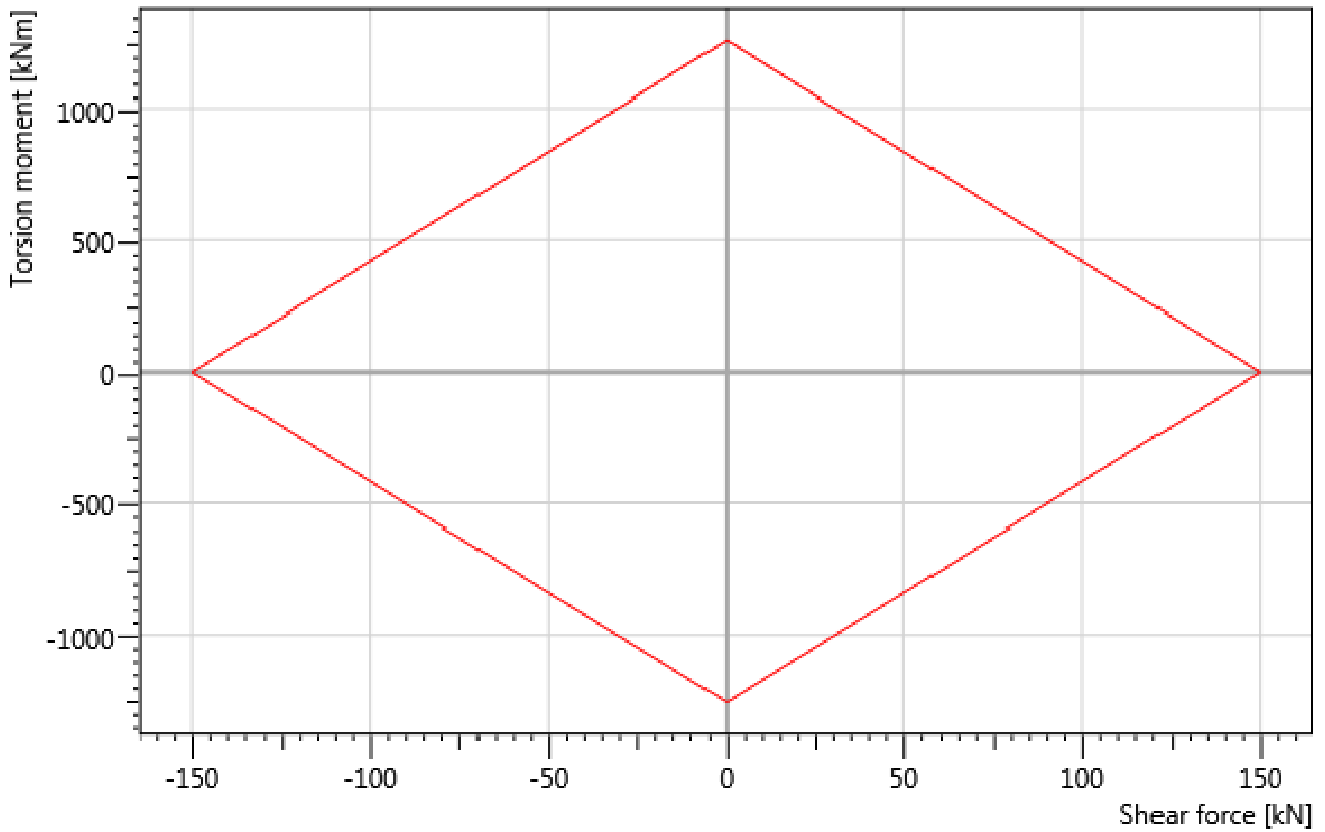
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**Interaction diagram between shear force and moment of torsion>**

Interaction diagrams



**GEODOMISI Ltd. - Dr. Costas Sachpazis**  
 Civil & Geotechnical Engineering Consulting Company for  
 Structural Engineering, Soil Mechanics, Rock Mechanics,  
 Foundation Engineering & Retaining Structures.  
 Tel.: (+30) 210 5238127, 210 5711263 - Fax.: +30 210 5711461  
 - Mobile: (+30) 6936425722 & (+44) 7585939944,  
[www.geodomisi.com](http://www.geodomisi.com) - [costas@sachpazis.info](mailto:costas@sachpazis.info)