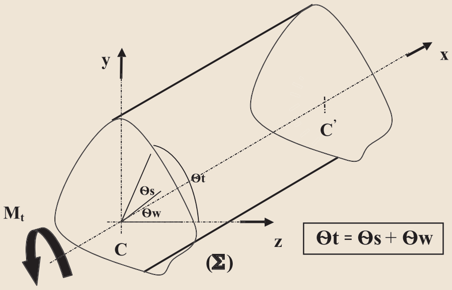
Simon Bechara

Simon Torsion Theory©

In presence of the warping effect, the rotation angle Θt becomes function of the shear and warping stresses developed in a section. As described by S. Vlassov's equation, the Torsion moment Mt = Ms + Mw (Algebric Sum). The solution is based on the torsion constant J = $\frac{bt^3}{3}$ for thin walls, and J = $\int r^2 ds$ for closed sections.
I do believe that thin walls are under plates bending law whenever they rotate around their center line rather than pure shear due to their flexibility, the value of J = $\frac{bt^3}{3}$ won't be representative anymore.

Simon Torsion Theory fundamental is that the relation between the Polar shear and the Bi-moment is similar to the relation between a regular Shear and the corresponding flexure Moment of a beam element.



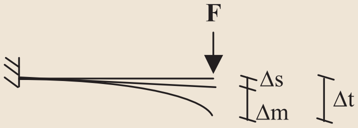
1- The Theory:

The Rotation angle (Twist) Θt of a Section subject to a Torsion Moment Mt (Torque), is equal to the Twist angle Θw resulting from a Pure Warping Behaviour under the moment Mt (Ignoring the Shear Stresses Effect in the plan parallel to the cross section), Augmented by the Twist Angle Θs resulting from the Rotational Sliding of the cross section under Pure Shear Stress due to the same Moment Mt (Ignoring the Normal Stresses Effect perpendicular to the plan of the cross section).

$$\boxed{\Theta t = \Theta s + \Theta w}$$

Θt, Θs and Θw are rotation angles around the X axis (in radian)
X axis is Perpendicular to the Cross Section of the member.

2- Similarity to beams principle:



Similar to a cantilever subject to a concentrated force, Δt = Δs + Δm, Θt = Θs + Θw

3- A section follows Saint Venant Theory when it is highly rigid against warping:

$$\left(\frac{12EIw}{L^3} \to \infty\right) \text{ and not } \cancel{\frac{GJ}{EIw}} \to \infty$$

4- The Warping constant Iw shall now be represented by one or two directions Iw/y and/or Iw/z depending on the section shape and not along the X axis.

For the Same Shape, Iw Varies from Open to Close Section.

5- The Torsion Constant J shall be calculated based on: J = $\int r^2 ds$ For Open and Closed Sections.

For the same shape, J will not vary from Open to Close Section. This will be reflected in Iw and not J

6- When the Ratio

$$\frac{L^3}{12EIw} \longrightarrow 0\text{, Then Mt} \longrightarrow \frac{GJ}{L}\Theta$$

(Warping is Fixed)

7- When the Ratio

$$\frac{L}{GJ} \longrightarrow 0\text{, Then Mt} \longrightarrow \frac{12EIw}{L^3}\Theta$$

(Warping is Fixed)

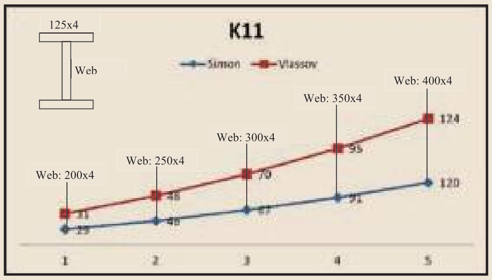
SIMON TORSION THEORY is represented in the above points 1, 2 and 3. Points 4 to 7 are mathematical and physical calculations as an application of the theory.

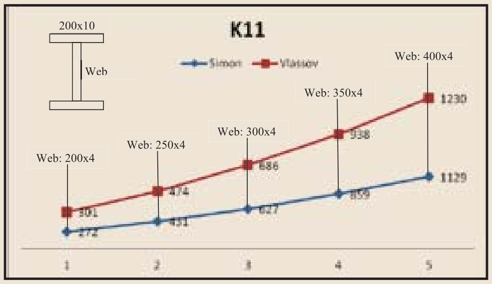
In order to simplify the calculations, the effect of plates bending has not been added in this article.

Comparison between Simon and Vlassov

The following Charts represent the calculated rigidity K(1,1) of a beam element where the warping is considered fixed at both ends. Length of the member is 1 (Unity).

Mt = K11. Θ





As shown in the above charts, Simon's Theory results to a less rigidity then Vlassov theory. We only try to understand the phenomenal behaviour of the nature surrounding us. We shall keep trying to reach a better level of knowledge.