We may consider the parametric equations of torus:

$$x = (c + r \cdot \cos v) \cdot \cos u$$
$$y = (c + r \cdot \cos v) \cdot \sin u$$
$$z = r \cdot \sin v$$

For an effective calculation, the Parametric system is more convenient than the Cartesian system.

For a segment of torus shell, corresponding to an X axis that is within the bisecting plane, the following limits are valid:

$$r \in [a - t, a]$$
$$v \in [0, 2\pi]$$
$$u \in [-\alpha, \alpha]$$

For clarifications, please consider the figure.
Don't forget that α must be in radian units!

The geometric centroid x_G coordinate is:

$$x_G = \frac{\iiint_V x dV}{\iiint_V dV}$$ (and note that, choosing Cartesian coordinate system as in figure, y_G and z_G are vanishing)

The elementary volume is given by $dV = dx \cdot dy \cdot dz = J \cdot dr \cdot dv \cdot du$, where J is Jacobian determinant of coordinates transform (from Cartesian system to Parametric system) $(x, y, z) \to (r, v, u)$, i.e. $J = r \cdot (c + r \cdot \cos v)$ [you may consider http://mathworld.wolfram.com/Torus.html for this results; or you may calculate it- it's not so difficult…]

The coordinate x_G is given by formula:

$$x_G = \frac{\iiint_V x dV}{\iiint_V dV} = \frac{I_1}{I_2} = \frac{\int_{a-t}^{a} \int_{0}^{2\pi+\alpha} \int_{-\alpha} r \cdot (c + r \cdot \cos v)^2 \cdot \cos u \cdot du \cdot dv \cdot dr}{\int_{a-t}^{a} \int_{0}^{2\pi+\alpha} \int_{-\alpha} r \cdot (c + r \cdot \cos v) \cdot du \cdot dv \cdot dr}$$

The Triple-Integrals evaluation is below:

$$I_1 = \int_{-\alpha}^{+\alpha} \cos u \cdot du \cdot \int_{0}^{2\pi} \int_{a-t}^{a} \left[rc^2 + r^3 \cos^2 v + 2cr^2 \cos v \right] \cdot dr \cdot dv = 2 \sin \alpha \int_{0}^{2\pi} \left[c^2 \frac{r^2}{2} + \cos^2 v \cdot \frac{r^4}{4} + 2c \cos v \cdot \frac{r^3}{3} \right]_{r=a-t}^{r=a} dv =$$

$$= 2 \sin \alpha \left[c^2 \frac{a^2 - (a-t)^2}{2} v \Big|_{v=0}^{v=2\pi} + \frac{a^4 - (a-t)^4}{4} \left(\frac{v}{2} + \frac{\sin 2v}{4} \right) \Big|_{v=0}^{v=2\pi} + 2c \frac{a^3 - (a-t)^3}{3} \sin v \Big|_{v=0}^{v=2\pi} \right] =$$

$$= 2 \sin \alpha \left[c^2 \frac{a^2 - (a-t)^2}{2} 2\pi + \frac{a^4 - (a-t)^4}{4} \pi \right] = 2\pi \sin \alpha \left[c^2 \left(a^2 - (a-t)^2 \right) + \frac{a^4 - (a-t)^4}{4} \right]$$

and

$$I_2 = \int_{-\alpha}^{+\alpha} du \cdot \int_{0}^{2\pi} \int_{a-t}^{a} \left[rc + r^2 \cos v \right] \cdot dr \cdot dv = 2\alpha \int_{0}^{2\pi} \left[c \frac{r^2}{2} + \cos v \cdot \frac{r^3}{3} \right]_{r=a-t}^{r=a} dv =$$

$$= 2\alpha \left[c \frac{a^2 - (a-t)^2}{2} v \Big|_{v=0}^{v=2\pi} + \frac{a^3 - (a-t)^3}{3} \sin v \Big|_{v=0}^{v=2\pi} \right] = 2\alpha \left[c \frac{a^2 - (a-t)^2}{2} 2\pi \right] = 2\pi\alpha \cdot c \left(a^2 - (a-t)^2 \right)$$

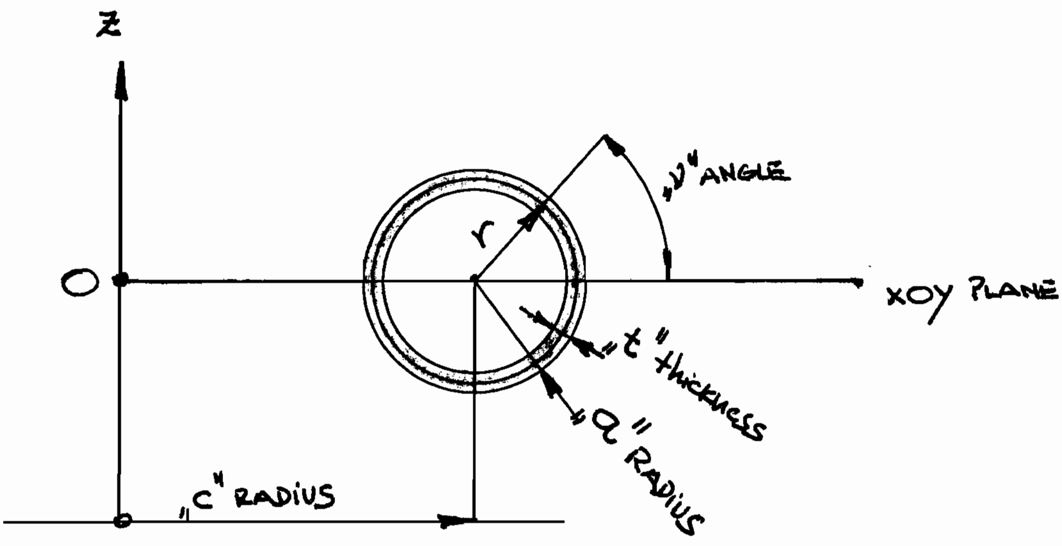
The final result is:

$$x_G = \frac{\iiint_V x dV}{\iiint_V dV} = \frac{I_1}{I_2} = \frac{\sin \alpha}{\alpha} \frac{c^2 \left(a^2 - (a-t)^2 \right) + \frac{a^4 - (a-t)^4}{4}}{c \left(a^2 - (a-t)^2 \right)} = \frac{\sin \alpha}{\alpha} \left(c + \frac{a^4 - (a-t)^4}{4c \left(a^2 - (a-t)^2 \right)} \right) =$$

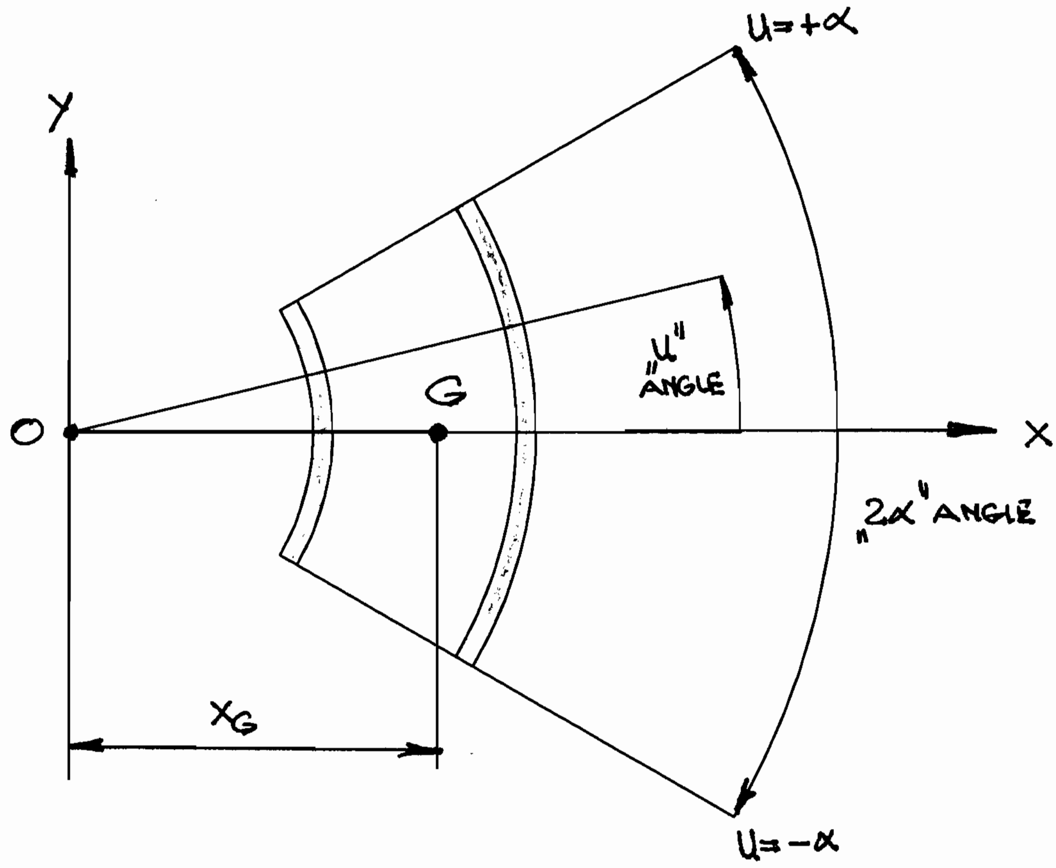
$$= \frac{\sin \alpha}{\alpha} \left(c + \frac{\left(a^2 - (a-t)^2 \right) \cdot \left(a^2 + (a-t)^2 \right)}{4c \left(a^2 - (a-t)^2 \right)} \right) = \frac{\sin \alpha}{\alpha} \left(c + \frac{a^2 + (a-t)^2}{4c} \right)$$

where

c is the radius of elbow, 2α is the angle of elbow, in radians (e.g $\alpha = \pi / 4$ for a 90 degree elbow), a is the external radius of section (i.e. a half of OD of pipe) and t is the thickness of elbow.



Z
O
r
"ν" ANGLE
XOY PLANE
"t" thickness
"a" RADIUS
"c" RADIUS



U=+α
Y
"U" ANGLE
O
G
X
"2α" ANGLE
XG
U=-α