

STUDY OF THE INFLUENCE ON THE STRESS AND THE ENVIRONMENTAL IMPACT OF THE TYPE OF KNOTS IN WARREN TRUSSES

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1. Introduction – The benefits of using steel structures for large spans, are among other facilities, its lightness compared to other structural materials, their machining and ease of assembly and the possibility of recycling. Despite the above advantages, has the disadvantages, being a nonrenewable natural resource, require high energy consumption for production, generate significant CO₂ emissions as well as large quantities of waste, both gaseous and solid [1]. Considering that in 2010 crude steel production in the European Union in electric arc furnaces and oxygen steel furnaces totaled 172.9 million tons, the slag generated in the European Union amount to 9,34Mt of slag produced only in electric arc furnaces and 8.37 Mt year in ladle furnaces, which are deposited in landfills that generate serious environmental damage, which is essential to the study of proposals to make more sustainable and less environmentally damaging buildings, from the stage of manufacturing and design to execution [2-5]. Considering these aspects, the study aims to study the influence of tensions and energy consumption in Warren type trusses, when they are subjected to different load values and with different types of knots, in order to optimize the amount of material and energy consumption.

2. Methods – It is designed and analyzed a Warren type truss, as shown in Figure 1, hot rolled steel S275JR according to UNE-EN 10025-2 [6]. On the designed truss are calculated the stresses produced by the application of different load values and assuming different types of knots, through a program of structural calculation (matrix method) and according to the technical code for structural safety in the steel DB SE-A: Steel [7]. From the data obtained, we proceeded to study the amount of material and energy consumption between the different calculated trusses [8].

3. Results and Discussion – Table 1 shows the relationship between the applied loads, the type knots used in the trusses, the stresses obtained in the calculation, the quantity of steel, the price increase based in the quantity of steel and the energy consumed in each case, with reference to the least loaded truss and knotted stiff. The analysis of Table 1 shows that for all load values in the upper and lower chords, stresses are greater in the case of trusses with knots jointed in those with stiff knots. You can also observe that the quantity of steel, the price and energy consumption, increase with increasing applied loads and are always higher in trusses with joints knots than trusses with stiff knots.

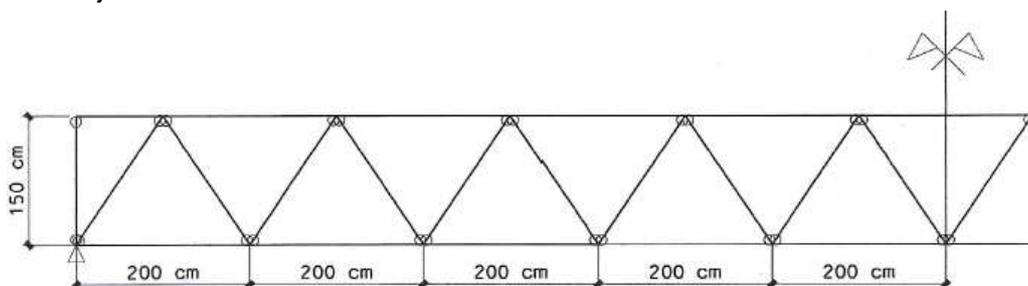


Figure 1 Geometric characteristics of the Warren truss

Point loads in knots (kN)	Types of knots	Elements	Increased load (%)	Stresses maximum (N/mm ²)	Quantity of steel (kg/ml)	Steel (kg)	Price increase (%)	Energy consumption (MJ) *
20	Stiff	Upper chord	0	184,63	46,8	936	0,00	44722,08
		Lower chord		183,26				
		Diagonals		127,79				
20	Jointed	Upper chord	0	185,61	50,9	1018	8,76	48640,04
		Lower chord		183,46				
		Diagonals		164,64				
60	Stiff	Upper chord	200	157,58	132,0	2640	182,05	126139,20
		Lower chord		183,00				
		Diagonals		171,5				
60	Jointed	Upper chord	200	190,12	137,6	2752	194,01	131490,56
		Lower chord		183,26				
		Diagonals		178,36				
100	Stiff	Upper chord	400	185,22	217,0	4340	349,01	207365,20
		Lower chord		185,81				
		Diagonals		205,8				
100	Jointed	Upper chord	400	201,88	218,0	4360	358,68	208320,80
		Lower chord		199,92				
		Diagonals		178,94				

* Data from <http://www.unaus.eu/blog/30-diseno-sostenible-de-estructuras-de-acero> [8].

Figure 2 Values of stresses and energy consumption, depending on the type of load and types of knots used

4. Conclusions – The most important conclusions of this work should include:

- The elements that form the Warren type trusses attain larger stresses in knots jointed than those with stiff joints.
- Increasing loads is a significant increase in energy consumption, being always greater in trusses with knots jointed than stiff joints.
- To achieve similar stresses materials, the quantities of material to be used they are higher in trusses with jointed than trusses with stiff knots.
- The possibility of using stiff knots in trusses type Warren, is a good alternative from an economic and environmental point of view.

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