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STUDY OF THE INFLUENCE ON THE DEFORMATION AND THE ECONOMIC IMPACT OF THE TYPE OF KNOTS IN WARREN TRUSSES

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1. Introduction – The indisputable advantages of steel structures for large spans, makes the use of trusses is commonly used as structural good results using less material than other structural materials and less weight. Despite these advantages and be a highly recyclable material, the main problem is the energy consumption and CO_2 emissions involved in its manufacture. Production of crude steel in 2010 in the European Union was approximately 172.9 million tons a year, with Germany the largest steel producer in the EU, producing 43.8 million tonnes, followed by Italy which produced 25.8 million tonnes and 16.3 million tonnes Spain [1]. According to a 2002 study, the annual steel production in the European Union 40% is produced in electric arc furnaces (EAF) and the remaining 60% in steel oxygen furnaces (BOF), while in Spain, 75% of the production of steel is produced in electric arc furnaces. The latest study takes into Spain by autonomous communities dating from 2005, which is annually produced 12.3 million tons of steel in Electric Arc Furnaces [2]. The production of steel in electric arc furnaces and ladle furnace slag in Spain generates annual 2.55Mt worth a year, which poses serious environmental problems. These data show the importance of investigating and trying to move toward a building with less environmental impact and sustainability. Considering these aspects, the study aims to study the influence on the deformation produced 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 used in structures.

2. Methods – For the realization of this work has designed a Warren type truss with 20m of spans and 1.5m high (Figure 1), with steel S275JR according to UNE-EN 10025-2 and hot rolled sections [3].

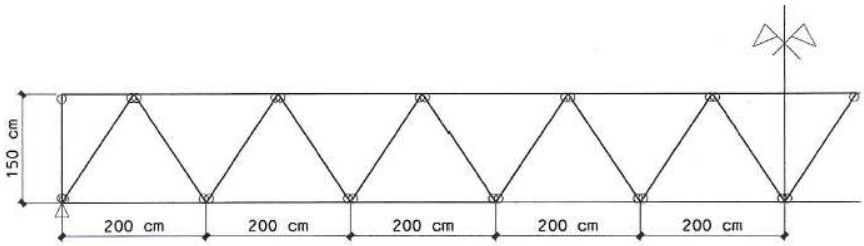

Figure 1 Geometric characteristics of the Warren truss

On the designed truss they are calculated deformations caused by the application of different load values at the knots and assuming different types of unions, through a program of structural calculation and according to the technical code for structural safety in the steel DB SE-A : Steel [4]. Moreover, they have also calculated the deformation in articulated trusses according to previous standards (MV-103 and AE-95), in order to compare the results [5, 6].

3. Results and Discussion – Table 1 shows the relationship in percent between the applied loads, the deformations obtained according to the standards used, the type of knots having the trusses and steel weight in each case, with reference to the truss less load and stiff joints, which has the lowest deformation. The analysis of Table 1 shows that in all types of truss, with increasing loads increase deformations and major increases deformations indicate, for each type, to the trusses with articulated knots. It is also noted that the deformations calculated using the approximate method of steel previous standards are higher than those determined by the current Technical Code. It is also noted that as the load increases to 200%, the trusses articulated need an investment of money above 12% even

with 5.3% deformation over the trusses with stiffs knots. Trusses increases to 400% load, amounts of such materials in both types of trusses, causes deformations have articulated structures than 6% relative to that of stiff knots.

Analysis	Point loads in knots (kN)	Types of knots	Increased load (%)	Increased deformation according DB SE-A: Acero (%)	Increased deformation according MV-103 and EA-95 (%)	Quantity of steel (kg/ml)	Price increase (%)
1	20	Stiff	0	0	------	46,80	0
2	20	Jointed	0	0,67	1,34	50,90	8,76
3	60	Stiff	200	1,79	------	132,00	182,05
4	60	Jointed	200	7,16	21,68	137,00	194,01
5	100	Stiff	400	9,62	------	217	349,01
6	100	Jointed	400	15,66	30,02	218	358,68

Table 1 Percentages of increased deformation and increased price, based on the increased load and the type of knot in Warren type trusses

4. Conclusions – The main conclusions of this work are:

- The Warren truss type work best to deformation, in trusses with stiff knots than articulated.

- At higher applied loads, greater deformation in trusses with rigid and articulated knots.

- Deformation values obtained with previous standards to the present Technical Building Code, introduces greater deformations and therefore remain on the side of safety.

- The increase in deformation and the price (based on the amount of material) between trusses with knots articulated regarding trusses with stiff knots, is similar for each type of load studied, being more expensive trusses with knots articulated than those with stiff knots, from the same deformation.

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