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Optimization criteria in the structural elements design for concrete industrial roofs. -Reinforced (prestressed) concrete structures

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Abstract. Structural elements of rooftops for industrial halls are, usually, designed in shape of beams made from different materials. In this paper are reviewed structural elements made from reinforced concrete, with solid section and truss section, simply supported on the columns. The loads were considered for to geographic areas, north and south, according to the active standards. Following the design calculus and economic evaluation results the conclusion that reinforced (prestressed) concrete beams are lighter than the reinforced (prestressed) concrete trusses, for 6 m and 12 m spans, and for spans greater than 12 m, the reinforced (prestressed) concrete trusses are lighter than the solid section beams. Regarding the cost, the concrete solid section beams have smaller costs compared to the concrete trusses, for 6 m spans. For spans greater than 12 m, inclusively, concrete trusses are more economical relative to the solid section beams.

Keywords: reinforced (prestressed) concrete beams (GB), reinforced (prestressed) concrete trusses (FB), bars, optimizing, rational .

1. Introduction

The development that the construction industry knows today needs extension of research in this field, in order to find optimal solutions. These needs to confer the accomplishment of more challenges, among we remember: minimal expenditure of labour and material, reduced execution period, completion of other criterias regarding the good functionality during exploitation. All of these demands need to be fulfilled so that the construction's reliability is altogether satisfied.

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In this paper are analysed structural elements like solid section beams and trusses, made from reinforced and prestressed concrete, simply supported on the columns of the hall.
The presented analysis is developed on two criterias, cost and material consumption, but a more extended analysis can be done considering other criterias as well, in this way the paper leaves a wide research field for the future.
There are some studies regarding the establishing of rational solutions for industrial halls, and by default, for roof elements, but these are limited. In this paper are considered the variability of the span and bay, which greatly extends the filed of application in designing the construction elements.
But, the problem, in it's complexity, remains open to studies that are necessary, further, for answering the question if the realised structures are really the most economical solutions.

2. Rational solutions for beams for industrial roofs

The beams for industrial rooftops can be realised as elements of different types, each one having it's own parameters concerning weight, execution time and, finally, the cost.
In the absence of studies that offer the type of the rational element for a given design theme, the paper analysis the beams made of reinforced (prestressed) concrete having continuous section – solid setion beams – or discontinuous – trusses – simply supported on the columns of the supporting structure.
There are considered spans between 6 m and 36 m with associated bays between 3 m and 24 m, covering the usual field of industrial constructions.
Concerning the actions, there were considered two design loads: one adequate to the northern area, with a snow intensity of 2,5 kN/m^2 and other to the southern area with a snow intensity of 1,5 kN/m^2, at each one of them adding, obviously, the dead load of the rooftop fitted with thermal insulation.(3) ,(7).
The dimension of the beam were obtained using the designing program ROBOT MILLENNIUM, which delivers the stresses in the bars, and other necessary data for the economical evaluation. The design of the concrete elements was effected by hand.
The results obtained for this two types of elements are presented in the following charts.
In figure 1 is pictured the weight's variation dependent on the span for the bay of 3 m, northern load area.
In figure 2 is presented the variation of the cost dependent on the same parameters.
Figure 3 pictures the weight's variation dependent on the span, for the 6 m bay, northern location area.
In figure 4 is presented the variation of the cost dependent on the same parameters.

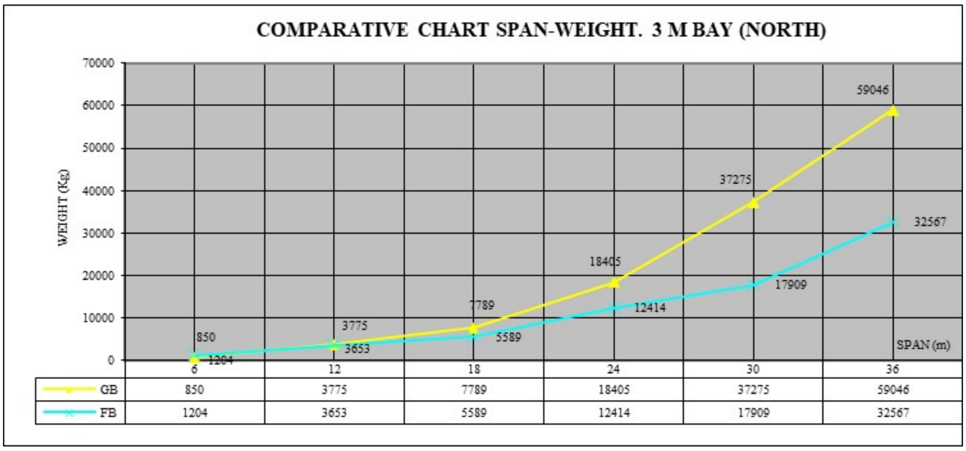

Fig. 1. Comparative chart span - weight. 3 m bay.

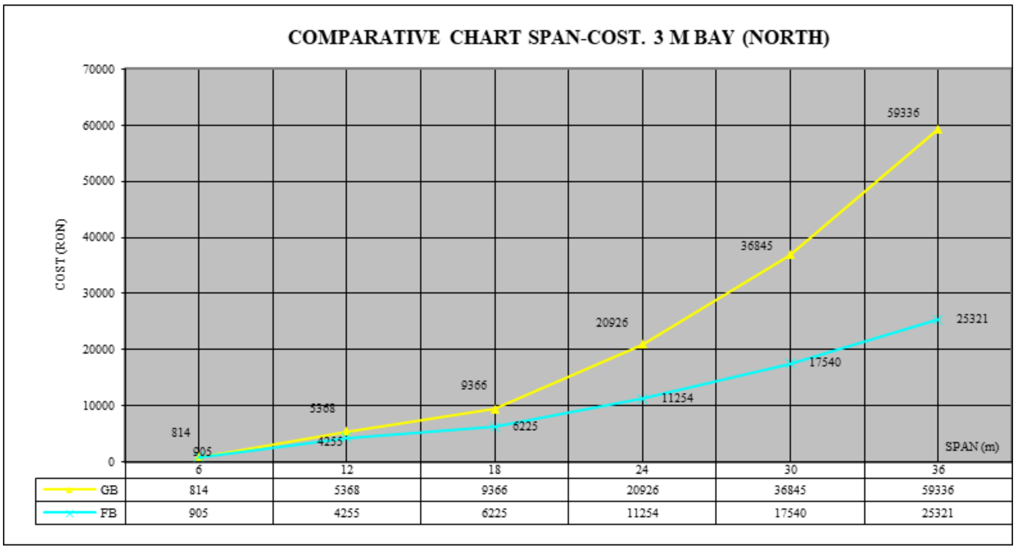

Fig. 2. Comparative chart span - cost. 3 m bay.

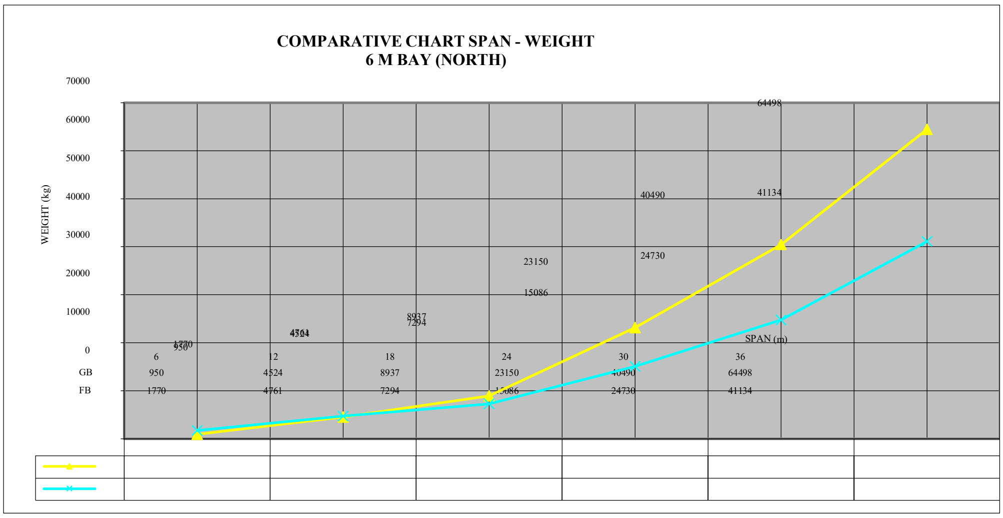

Fig. 3. Comparative chart span - weight. 6 m bay.

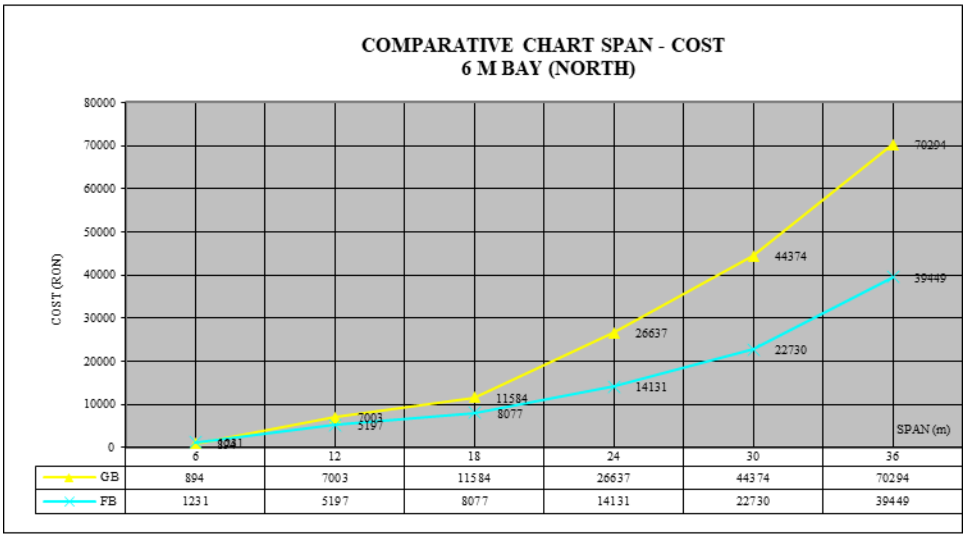

Fig. 4. Comparative chart span - cost. 6 m bay.

In figure 5 is presented the variation of the weight dependent on the span, 3 m bay, for the solid section beams correspondent to the two location areas, north and south.

Figure 6 ilustrates the weight's variation dependent on the same parameters, for trusses.

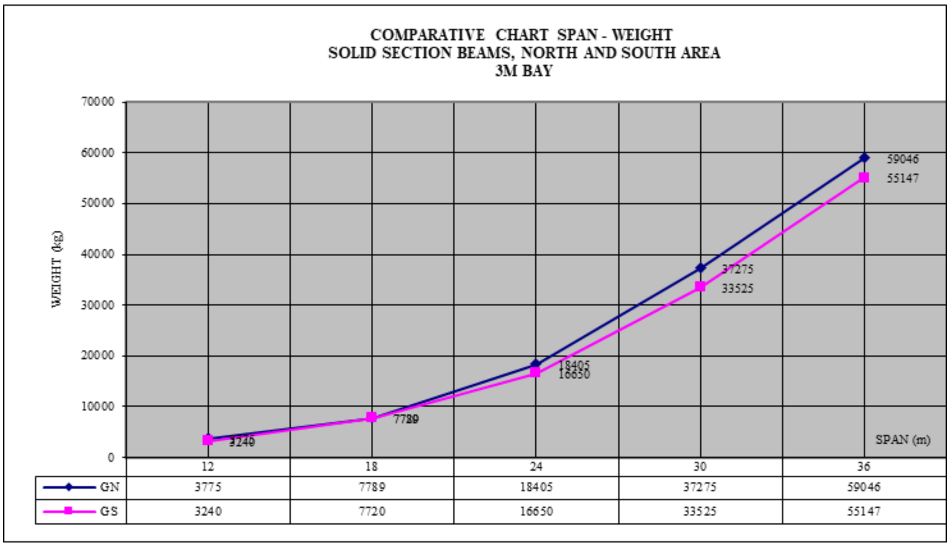

Fig. 5. Comparative chart span - weight, solid section beams, north and south area. 3 m bay.

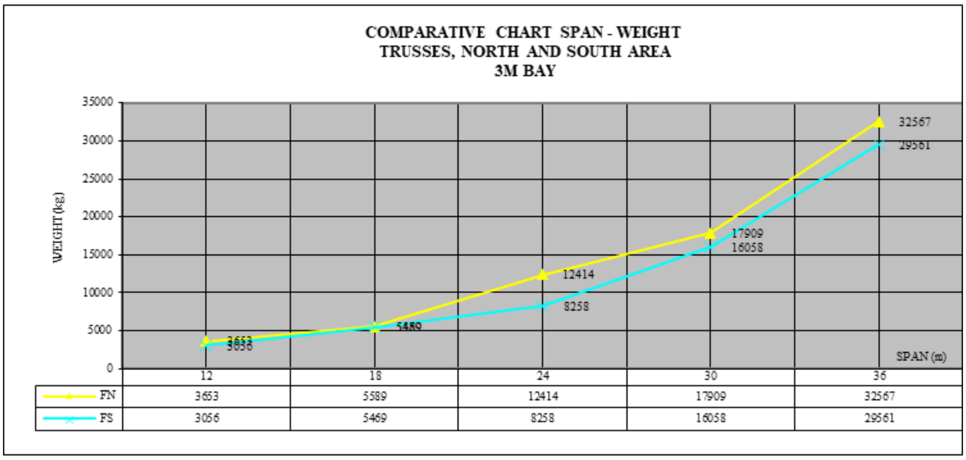

Fig. 6. Comparative chart span - weight, trusses, north and south area. 3 m bay.

In the same way were determined weight and cost coefficients for the other bays, as well. Numerical data corresponding to the weights are presented in the tables 1 and 2.

Table 1. Weight and cost coefficients for reinforced (prestressed) concrete solid section beams

REINFORCED (PRESTRESSED) CONCRETE SOLID SECTION BEAMS - WEIGHT (kg)					
SPAN (m) / BAY (m)	**12**	**18**	**24**	**30**	**36**
3	3775	7789	18405	37275	59046
6	4524	8937	23150	40490	64498
9	5535	10422	26340	46295	79750

12	6625	12555	29845	53695	97550
15	7776	16888	37225	63900	111525
18	9077	19598	40860	68855	128050
24	10782	23777	47546	77685	156375

Table 2. Weight and cost coefficients for reinforced (prestressed) concrete trusses

REINFORCED (PRESTRESSED) CONCRETE TRUSSES - WEIGHT (kg)					
SPAN (m) / BAY (m)	**12**	**18**	**24**	**30**	**36**
3	3653	5589	12414	17909	32567
6	4761	7294	15086	24730	41134
9	5711	9682	17461	29846	52958
12	6820	11501	21321	35825	74741
15	8359	15304	27240	51591	93806
18	9752	18214	30645	59963	115746
24	11859	23577	39098	76564	131315

3. Conclusions

The obtained results lead to the following main conclusions:
- as concerns the cost material, reinforced (prestressed) concrete beams are more rational than reinforced (prestressed) concrete trusses for spans of 6 m and 12 m, over this spans the trusses have lower weights;
- beam ranking according to material consumption is kept, for spans of 6, 18, 24, 30, 36 m and as regards it's costs; for 12 m span, although solid section beams have less weight, their cost is higher in comparison with the one of the trusses;
- altering the value of the design load doesn't change the type of structural, evidential the dimensions being correspondent to the design load.

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