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Express assessment of some building parameters in milking parlors for cows

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Abstract

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The analysis of the construction and planning parameters of milking parlor with different capacity and configuring the animals on the milking platforms was carried out. The studies are complemented by an assessment of the construction parameters in different variants of the input - output traffic of the animals to the milking parlor. The subject of the analysis is to determine the quantity for the different variants of the situation. On this basis, regression equations for express estimation of the change of the basic building materials (concrete and reinforcing steel) with changing the capacity of the milking parlor are derived. The equations are universal and could be used extensively to initially estimate the intrinsic the basic building materials (concrete and reinforcing steel) in the construction of the floor profile.

Keywords: express estimation; milking parlor; planning parameters; regression equations

Introduction

Various types of milking parlor equipment are produced worldwide, which have a number of advantages and technological limitations (Herd et al., 2007; Lamb Farms, 2007). The choice of the type and equipment of the milking parlor is strictly individual for each specific design case and is determined by the many factors related to the capacity of the farm, the adopted breeding technology, management of milking cows and the real possibilities for building a new or reconstruction of an existing building (Mein, 1995; William 2000; Leso et al., 2018). The farmer's preferences for the type and size of the equipment, as well as his plans for improving the technological process are additional conditions in the development of technical-technological projects (Armstrong, 1989; 1990; NRAES, 2001; Mandal et al., 2019; Kumar et al., 2020). In all cases, the influence of these arguments is refracted through the prism of the necessary inherent construction costs and the possibilities for their minimization (or optimization). This requires the development of a methodology (model) for express assessment of the main Quantities concrete and reinforcing steel in the construction of the floor profile of different types of milking parlors (Knoblauch & Galton, 1992; Chastain, 2000).

The objective of this study is to develop regression models for rapid evaluation of the main building materials (concrete and reinforcing steel). To achieve this goal, the following tasks have been set: 1) Analysis of the quantities of concrete and reinforcing steel in different types of milking parlor with a capacity of 2x2 to 2x12 milking places (with step 1x2). 2) Determination of the type and coefficient of correlation between the observed quantities. 3) Subtraction of regression equations to determine the quantities (for the materials indicated) in each specific variant.

Material and Methods

Object of study

The object of the study are milking parlors with different configuration and capacity, with front entrance, side entrance and ordinary exit ("Tandem", "Herringbone 30", "Herringbone 60", "Parallel"). The subject of the analysis are the used quantities of concrete C16 / 20 (B20) and steel B420 (AIII), necessary for the construction of the floor of the different types of milking parlors. The floor execution for all milking parlors is similar. The reinforcing steel is constructed in the form of a lattice with a distance between the bars of 15 cm. The calculations were performed according to Eurocode EN 206-1 and EN 1992-1-1.

Investigated parameters

The analysis of the stated quantitative costs in different types and capacities of milking parlors is described with the indefinite type of function:

$$yi = \int(xi), \quad kg/m^3 \qquad (1)$$

Where: yi - the amount of concrete (reinforcing steel) for a given type of milking parlor m^3 (kg); xi - capacity of a given type of milking parlor.

The analytical description of that function is consistent with the linear regression equation:

$$y = a + bx, \quad m^3 \text{ (kg)} \qquad (2)$$

The free term (a) and the regression coefficient (b) are determined using the Least Squares Method using the Statistics 10 software product.

Determining the type of dependence and the degree of influence of the capacity of each type of milking parlor was performed by correlation analysis in accordance with the expression:

$$r = \frac{\sum(xi + Mx)(yi + Mx)}{\eta\delta x + \delta y} \qquad (3)$$

Included in the Statistics 10 software product, where:

x_i - the average of the analyzed variables within the specified interval;

Mx - the average value of the argument (defined within the range of 2 to 12);

y_i - each value of the arguments (number of places) for the milking parlor;

η- the number of variants observed;

δx - mean squared deviation for the values of the received argument (number of milking places on the milking parlor);

δy - mean square deviation of the analyzed variable (concrete and reinforcing steel), m³ (kg).

Results and Discussion

The data in Table 1 describe the quantity of reinforcing steel used to build the floor of different types of milking parlors. For the observed capacities from 2x5 to 2x12 the amount of reinforcement varies from 970 to 1782 kg, for "Herringbone 30°", from 878 to 1424 kg, for "Herringbone 60°", from 1514 to 3229 kg for "Tandem".

Table 1. Quantity of reinforcing steel used to build the floor of different types of milking parlors, kg

Capacity	"Tandem"	"Herringbone 30°"	"Herringbone 60°"	"Parallel"
2x5	1514	970	878	796
2x6	1759	1086	956	874
2x7	2004	1202	1034	952
2x8	2249	1318	1112	1030
2x9	2494	1434	1190	1108
2x10	2739	1550	1268	1186
2x11	2984	1666	1346	1264
2x12	3229	1782	1424	1342

When positioning of the cows is perpendicular to the axis of the technological channel ("Parallel") the required amount of reinforcement for the construction of a milking parlor with a capacity of 2x5 is 796 kg and increases to 1342 kg for a capacity of 2x12. The values show that the increase in the capacity of the milking parlor is related to the increase of the amount of reinforcing steel required for the construction. The average growth rate in the milking parlor type "Parallel" and "Herringbone 60°" - has the lowest value - 78 kg, and for "Herringbone 30°" - 116 kg. The highest increase in the amount of reinforcing steel is observed in "Tandem" - 255 kg, about 3 times more than that of a milking parlor type "Parallel". The relationship between the material used and the number of milking places is absolutely linear. The argument for this is that the difference in the quantity of reinforcing steel used to build the floor between each of two gradations is the same (Fig. 1).

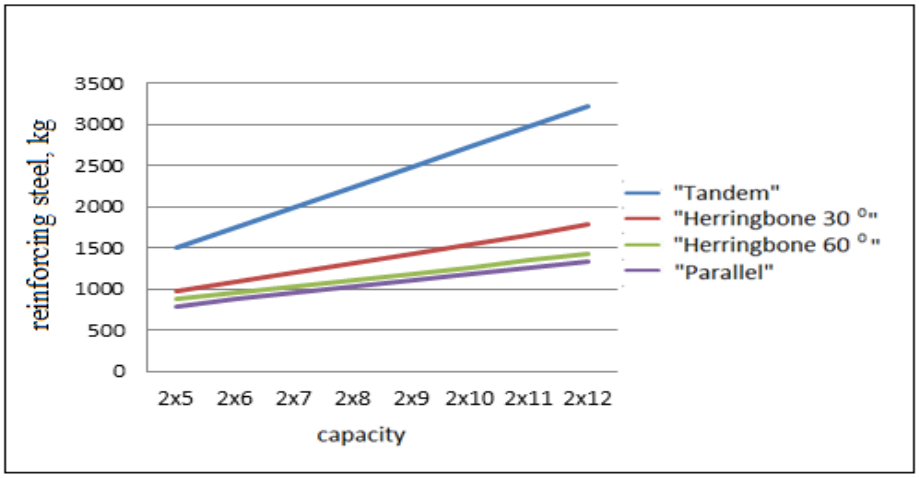

Fig. 1. Quantity of reinforcing steel used to build the floor of different types of milking parlors, (kg)

Table 2 presents the quantity of concrete used to build the floor of the considered types of milking parlors. The data show that with increasing capacity of the milking parlor, it is understandable that the amount of concrete to increase by 1.4 m³ for "Parallel", 1.8 m³ for "Herringbone 60°", 2.3 m³ for "Herringbone 30° "and at most in "Tandem" - 5.2 m³. The linear relationship between the quantity concrete used to build the floor of the investigated milking parlors and the number of places is preserved (Fig. 2).

Table 2. Quantity of concrete used to build the floor of different types of milking parlors, m³

Capacity	"Tandem"	"Herringbone 30°"	"Herringbone 60°"	"Parallel"
2x5	31.2	18.8	15.8	14.3
2x6	36.4	21.1	17.6	15.7
2x7	41.6	23.4	19.4	17.1
2x8	46.8	25.7	21.2	18.5
2x9	52	28	23	19.9
2x10	57.2	30.3	24.8	21.3
2x11	62.4	32.6	26.6	22.7
2x12	67.6	34.9	28.4	24.1

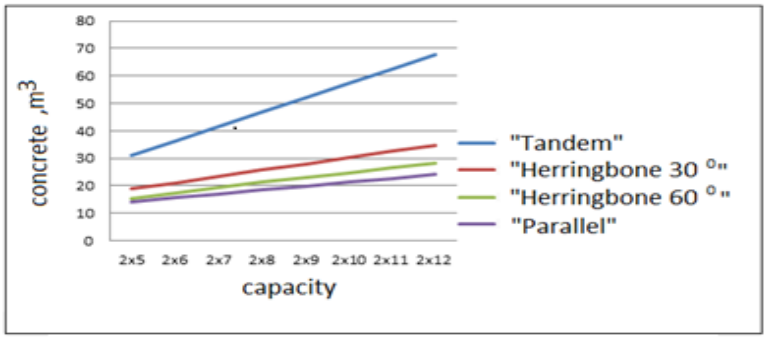

Fig. 2. Quantity of concrete used to build the floor of different types of milking parlors, (m3)

As can be seen from the graphs, the dependence of the used construction quantities of reinforcing steel and concrete, depending on the capacity for each type of milking parlor, is linear with a correlation coefficient r> 0.9. This makes it possible to perform an analytical description of the quantitative dependence by means of the linear regression equation:

$$y_i = a_i + b_i \quad (4)$$

From the values shown in Tables 1 and 2 it is established that the increase in the capacity of the milking parlor, regardless of its type leads to an increase in the observed quantities of building materials. The derived regression equations from Table 3 can be used by investors and designers for initial (express) estimation of the quantities of reinforcing steel and concrete when comparing different types of milking parlors.

Table 3. Regression equation for express estimation of the amount of concrete (m³) and reinforcing steel (kg) needed to build the floor of different types of milking parlors

Milking parlor type	Regression equations	
	concrete	reinforcing steel
"Tandem"	y=5.2+5.2x	y=289+245x
"Herringbone 30°"	y=7.3+2.3x	y=390+116x
"Herringbone 60°"	y=6.8+1.8x	y=488+78x
"Parallel"	y=7.3+1.4x	y=406+78x

Conclusion

The type of milking parlor and its capacity have an extremely high impact on the quantity of concrete and steel for building the technological profile of their floor. The established dependence on the previous point is strictly linear in nature with a correlation coefficient (of all variants analyzed) above 0.9. Equations for linear regression of the observed construction quantities for different milking parlor variants are derived.

Recommendation

The created linear regression models can be used by investors and designers for rapid assessment of the quantities used (concrete and reinforcing steel) needed to build the floor in different types of milking parlors.

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