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FUNCTIONAL ANALYSIS OF THE WEBBING USED IN AUTO SEATBELTS

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Abstract: *The reason this paper was made was to identify the functions with the highest importance factor of webbing used in auto seatbelts. For these functions to satisfy all the requirements of operating, functions resulted from analyzing the properties of the webbing. Depending on the importance of each function was developed an objective hierarchy of them, pursuing the imposed decisions technic. Using the Analysis and engineering value it was possible to do the functional analysis of the properties of webbings. By setting the functions value it was possible to obtain a series of decisions, specifying that a function corresponds to a single operating property. Following this analysis it was observed that the main characteristic of webbings is that they have a very good resistance to tensile stresses, characteristic imposed by the manner of operation during use. An important factor that was taken into account in analyzing the webbings was the fabric structure. The structure has a major impact on the function and use of webbings in the belt assembly, considering the fact that their primary role is to save the life of the user, in case of impact of a vehicle. Based on this study the following research is focused on the functional properties of the seatbelt, in order to design and manufacture seatbelts with appropriate exploitation properties.*

Key words: *properties, webbing, functions, utility, development, seatbelt*

1. INTRODUCTION

Seatbelt is an arrangement of straps with a securing buckle, adjusting devices and attachments which is capable of being anchored to the interior of a vehicle. It is designed to diminish the risk of injury to its wearer, in the event of collision or of abrupt deceleration of the vehicle, by limiting the mobility of the wearer's body [1]. The base element of this assembly is the webbing.

The webbing is designed to provide positional stability in the case of impacts created by a collision. The main function of the webbing is used to provide safety to the passengers against uncontrolled movements during collisions or similar incidents.

The webbing of the seatbelt assembly provides a balancing force, that brings the user from a state of moving into a state of positional rest.

The main functional characteristics, required in operation of the webbing from the seatbelts assembly are: abrasion resistance, light resistance and heat, capacity to be removed and replaced easily and a good behavior of retraction [2].

2. MATHERIALS AND METHODS

The property is the quality of a product to render a precise notion or the idea expressed, meaning it is the characteristic necessary to make the product useful [3], [4], [5], [6]. Due to the great importance that it has in use, the webbing has a number of properties that have a major impact on the proper functioning. The functionality analysis of the webbing shows that this must satisfy a set of properties that are shown in Table 1.

Table 1: *Functional properties of webbing used in seatbelts*

No.	Properties oriented webbing belt
1.	Tensile stress
2.	Tensile elongation
3.	Dry and wet strength dyeing
4	Endurance resistance
5	Resistance to displacement
6.	Resistance to sliding
7.	Abrasion resistance
8.	UV resistance
9.	Dimensional stability
10.	Resistance to perspiration acid and alckaline dyeing
11.	Dyeing whashability
12.	Flexibility
13.	Durability

To each specific functionality properties of webbing corresponds to a characteristic function.

Function is the first fundamental concept with which the value engineering operates and is a result of the product's properties which is capable to satisfy a necessity [3], [4], [5], [6]. A function is useful, distinct whether there can be independence of other functions. Each function has a use value, and the total use values of functions, render the global use value of the product used - the seatbelt webbing.

The application of engineering value is done in three steps: functional analysis, value of functions and design or redesign of the product based on the required functions.

Functional analysis answers the question "what?" and "what makes the product?". At the same time, the analysis and engineering value allows drawing up a list of functions which the analyzed product performs.

The value of the functions that answer the questions: "how important is the function for the user?" and "how well it meets user requirements?", allows precise highlighting of the importance level of each function.

Based on the principles from the Analysis and engineering value have established a set of functions of the webbing, as shown in Table 2. Each function of the webbing corresponds to a single operating property.

Table 2: *Webbing functions*

Symbol	Function name	Technical dimension	Function type
F1	Be cyclic tensile	Tensile stress, [7]	Primary, objective, necessary, general
F2	To have limited breaking elongation	Tensile elongation, [7]	Primary, objective, necessary, general
F3	Be resistant to abrasion	Dry and wet strength dyeing, [8]	Primary, objective, necessary, general
F4	Be resistant to repeated bending	Endurance resistance	Primary, objective, necessary, general
F5	Be easy to use/ have o good withdrawal behavior	Resistance to displacement	Primary, objective, necessary, general
F6	To have resistance to seam stitching	Sliding resistance	Primary, objective, necessary, general
F7	To have resistance in contact with other textile materials (peeling) or abrasive materials	Resistance to abrasion, [9]	Primary, objective, necessary, general
F8	To have light resistance	UV resistance	Secondary, objective, necessary specific to webbing
F9	To keep their shape and dimensions in terms of temperature and humidity	Dimensional stability, [10]	Secondary, objective, necessary specific to webbing
F10	Be resistant in alkaline and basic environment	Resistance to perspiration acid and alckaline dyeing, [11]	Secondary, objective, necessary specific to webbing
F11	To have soil resistance	Washability resistance	Secondary, objective, necessary specific to webbing
F12	To have low rigidity in longitudinal direction	Flexibility	Secondary, objective, necessary specific to webbing
F13	To have ageig resistance	Durability	Secondary, objective, necessary specific to webbing

The contributions of the functions to the achievement of the use value are uneven. Thus, each of them participate differentiated to the completion of the use value of the seat belt webbing, which enables us to rank them in rapport with properties. For ranking the functions is used the technique of imposed decisions from engineering value. This involves comparing the functions two by two and application of scores by the form (1 – 0), (0.5 – 0.5) or (0 – 1), with the specifications that the score 0 represents low importance, 0.5 represents a level of medium importance and 1 is the utmost importance level [3], [4], [5], [6].

The total number of decisions resulted from comparing the 13 functions of the seatbelts is calculated with the equation (1):

$$D = C_2^2 = \frac{n(n-1)}{2} \quad \textbf{(1)}$$

The coefficient of importance for each function is calculated as the ratio between the sum of the score awarded, N and the total of the decisions D, as follows:

$$I = \frac{N}{D} \quad \textbf{(2)}$$

3. RESULTS AND DISCUSSION

The 13 functions of the webbing used in seatbelts obtained using the analysis and engineering value in Table 2 are divided into 7 pimary and 6 secondary functions, according to the importance attributed to them in application. Thus equation (1) leads to determining the number of decisions necessary to analyze primary and secondary functions, namely:

- The number of decisions Dp, for the primary functions:

$$D_p = C_7^2 = \frac{7 \cdot (7-1)}{2} = 21 decisions \quad \textbf{(3)}$$

- The number of decisions Ds, for the secondary functions:

$$D_s = C_6^2 = \frac{6 \cdot (6-1)}{2} = 15 decisions \quad \textbf{(4)}$$

In Tables 3 and 4 are presented the comparative analysis of primary and secondary functions. The values of the coefficients of importance are given by the ranking of the primary and secondary functions. Of these functions, important in terms of the ranking, is taken into account in designing or redesigning the webbing of the seatbelt

Table 3: *Comparative analysis of primary functions*

Functions	Decisions for primary functions																					Sum of the score awarded	Functions coefficient of importance
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	N	I
F1	1.0	0.5	0.5	1.0	1.0	1.0																5.0	0.714
F2	0.0						0.5	1.0	0.5	0.5	1.0											3.5	0.500
F3		0.5					0.5					0.5	0.5	0.0	0.5							2.5	0.357
F4			0.5					0.0				0.5				0.0	0.0	0.5				1.5	0.214
F5				0.0					0.5				0.5			1.0			0.5	0.5		3.0	0.429
F6					0.0					0.5				1.0			1.0		0.5		0.5	3.5	0.500
F7						0.0					0.0				0.5			0.5		0.5	0.5	2.0	0.286

Table 4: *Comparative analysis of secondary functions*

Functions	Decisions for secondary functions															Sum of the score awarded	Functions coefficient of importance
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	N	I
F8	0.0	1.0	1.0	0.5	0.5											3.0	0.500
F9	1.0					0.5	0.5	1.0	1.0							4.0	0.667
F10		0.0				0.5				0.5	1.0	1.0				3.0	0.500
F11			0.0				0.5			0.5			0.0	0.5		1.5	0.250
F12				0.5				0.0			0.0		1.0		1.0	2.5	0.417
F13					0.5				0.0			0.0		0.5	0.0	1.0	0.167

Following the ranking of functions of webbing of the seatbelt and comparing them with each other, two by two, we observe that the main function which has the highest level of importance is the function F1 (0.714), function which shows that, priority, the webbing must be resistant to tensile stresses. Equally, the next level of importance have functions F2 (0.500) and F6 (0.500) respectably tensile elongation and resistance to sliding. Of medium importance could be considered functions F3 (0.357) and F5 (0.429), while those of lesser importance are the functions F4 (0.214) and F7 (0.286).

As for the secondary functions, the maximum level of importance presents function F9 (0.667). This indicates that, under conditions of temperature and humidity, the webbing must meet the requirement for dimensional stability. The following functions, on the next level of importance are F8 (0.500) and F10 (0.500). Functions F8 and F10 aim that the next conditions which car seat belt webbing must meet, are UV resistance and resistance to perspiration acid and alkaline dyeing. Function F8 (0.417) has a medium importance, while those with lower importance are the functions F11 (0.250) and F13 (0.167). Thus, resistance of painting to webbing washing and its durability are not functions with an important priority.

4. CONCLUSIONS

Structural characteristics of the fabrics have a major importance in designing webbing for auto seatbelts.

The properties of webbings used in the analyzed auto seatbelts, must be in accordance with the final process of utilization.

Designing or redesigning of the seatbelt webbing requires a thorough knowledge of their operating procedures in order to define properly the functions they perform in operating.

Using value engineering was possible to achieve an objective hierarchy of the functions of webbing for seatbelt with the purposes to identify the characteristic with the highest level of importance that will be taken into account in designing these products.

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