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Optimization of furniture testing

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Abstract: In the area of sitting furniture testing there are different standards existing that define minimal quality range. These kind of testing are long lasting and expensive. The intention is optimisation and shortening of testing time (and decrease of expenses) for standard chairs in production. Research object in this paper was standard joint consisting of round tenon and mortise. Also there were two modified tenon joints made. Joints were statically and dynamically tested. Results of static and dynamic testing are given in form of load momentum. High coefficient of correlation of all sample groups shows strong dependence between static and dynamic testing of samples. From results of three samples testing it can be concluded that there is possibility for decreasing expenses for quality determination especially those related to durability of construction (replacement of dynamic testing with static testing).

Keywords: Optimisation, wooden joints, furniture quality, furniture testing

INTRODUCTION

Until the second part of last century scientific approach to construction were not known. Construction method choice depended on a skill and experience of the craftsman.

With mass production of furniture, need for scientific approach in design appeared, which enabled a production with extensive use of machines and constant technological improvement of process. Further development has been achieved with introduction of new wooden based and non-wooden based materials with previously unknown characteristics. At beginning, the scientific approach was introduced very often in construction industry and construction of buildings. After that, number of research studies on constructions of furniture, its parts or joints showed an significant increase in the use of this approach in that area.

New trends in design have implemented the use of new materials and technologies that have been constantly developed. This development encouraged constructors for introducing of new construction solutions. Suitable choice of construction assembly is very complex and its final choice depend on various influencing factors.

At the beginning selection is determined by formative and functional solution set by a designer. Following step is developing of constructional solution. Choosing quality range possibility of results in various range of product diverting in price classes. Those classes determine material choice for furniture production, also taking in consideration conformation of chosen wooden and non-wooden material to the standards defining furniture quality. Standards include functionality, durability, surface resistance and quality of the material, as well as precision range in production. The classification of products in price classes enables choice of different materials for products intended for same purposes. This choice will depend on a price of a final product intended for certain market. Technology chosen for the production of a design defines the choice of constructional solution. Construction development highlights differences between almost same constructional solutions from the time of manufacture production process compared to nowadays production. At the same time new technologies of production offer a possibility of multiply repeated high quality production of both joinery and whole product.

Besides different studies of types of joints and their geometry, some authors, Dziegielewski and Zenkteler (1975), Korzenniowski (1984), Biniek and Smardzewski (1987), Dziegielewski (1991,), Wang and Juang (1994), also observed different criteria that influenced the quality of constructions. Mostly the criteria have been related to the joint material properties, the way and precision of its production, conditions during production, types and properties of adhesives and bindings used.

RESEARCH OBJECTIVE

In the area of sitting furniture testing there are different standards existing that define minimal quality range.

In Croatia exist standards for classification of furniture quality, and for adequate construction, dynamic durability is especially important and it is described in standard HRN D.E2.201. According to this standard three equal samples from regular production must be tested. Quality level is classified depending of number of achieved cycles in three classes: 5000, 25000 and 60000 of cycles. These kind of testing are long lasting and expensive. The intention is optimisation and shortening of testing time (and decrease of expenses) for standard chairs in production. Critical area is connection between chair leg and frame (figure 1). Durability testing is performed until dowel pulling out or connection rupture (figure 2).

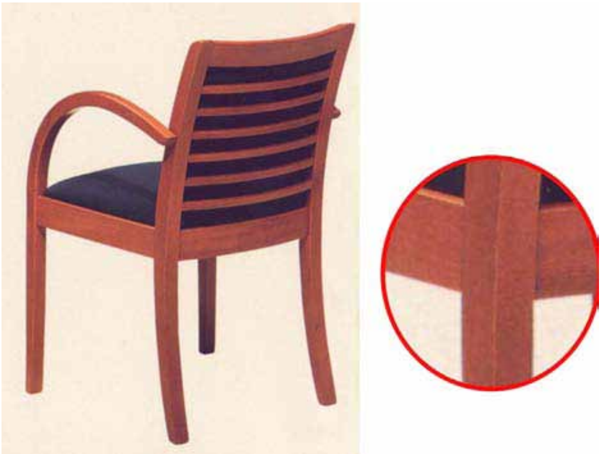

Figure 1 Chair, leg and frame connection

Figure 2 Pulling out and rupture caused by load

MATERIAL AND METHODS

Research object in this paper was standard joint consisting of round tenon and mortise. Also there were two modified tenon joints made. Samples were grouped in three groups: A, B and C. Croatian seating furniture testing method HRN D.E2.201 for determination of strength and durability was evaluated in this paper. According to previous work of Prekrat at al. (2004) joint elements were chair leg (cross section 42 x 28 mm) and chair frame (cross section 50 x 20 mm). Joints were statically and dynamically tested. Dynamic tested was performed in eight stages, according to force in cylinder and air pressure. Force is calculated by measurement at certain air pressure (table 1).

Table 1 Stages for dynamic testing, air pressure and cylinder force

	1	2	3	4	5	6	7	8
Air pressure (bar)	2	2.5	3	3.5	4	4.5	5	5.5
Cylinder force (N)	33.4	42.7	53	64.1	76.6	85.5	97.3	107.6

Eckelman and Hiencz (1977), Dziegielewski et al (1983), Zhang and Eckelman (1993), Warmbier (1997) and Prekrat (2000) evaluated different methods of static and dynamic testing, compared them and proved dependence between methods of static and dynamic testing.

Dziegielewski and Giemza (1983) researched dependence of static and dynamic coefficient where forces were at 80%, 60% and 40% level of static testing. The result is shown at figure 3.

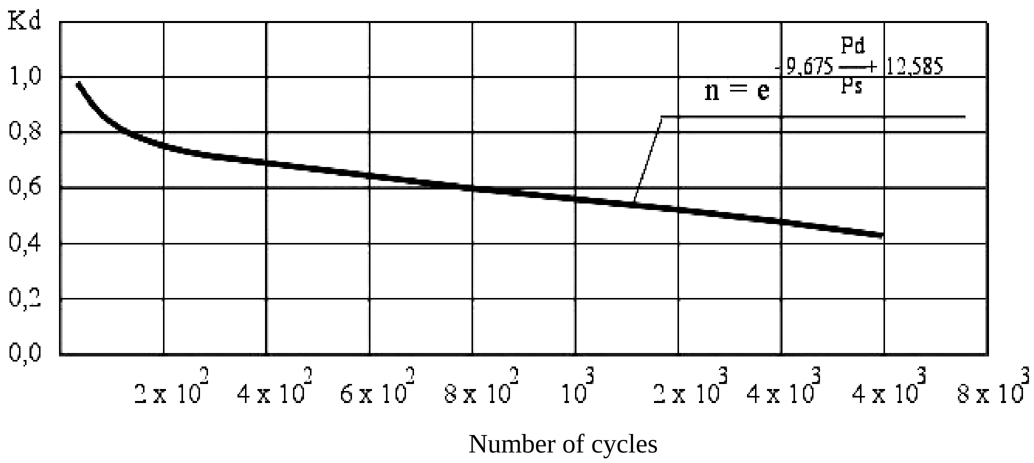

Figure 3 Relation between dynamic load coefficient and number of dynamic loads cycles according to Dziegielewski

RESEARCH RESULTS

Results of static and dynamic testing are given in form of load momentum. Range evaluation was done at figure 4. Statically tested samples were statistically tested according Kruskall-Wallis test, and it showed difference between different sample groups results (table 2).

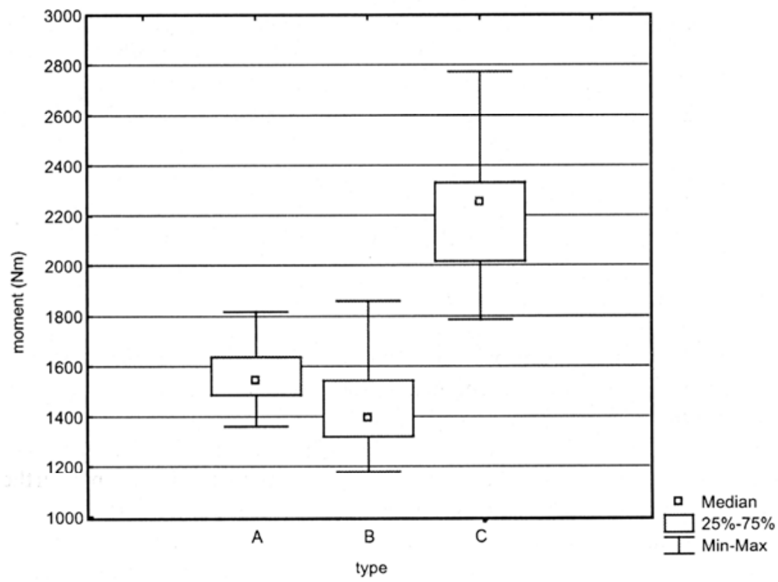

Figure 4 Static MOR for all sample groups

Table 2 Results of Kruskall – Wallis test

Pairs of tested groups	P
B – C	0.0001
A – C	0.0001
A – B	0.0013

Equally, the results were confirmed for all tested sample groups in dynamic testing. Relationship is presented with coefficient, which is quotient between static and dynamic momentum (table 3).

Table 3 Relationship between static and dynamic momentum coefficient for all tested groups

Coefficient Md/Ms			
Dynamic momentum (Nm)	A	B	C
38.43	0.24896	0.26480	0.17156
57.69	0.37374	0.39751	0.25755
76.5	0.49560	0.52713	0.34152
96.57	0.62562	0.66542	0.43112

High coefficient of correlation of all sample groups shows strong dependence between static and dynamic testing of samples (table 4).

Table 4 Coefficient of correlation for sample groups

	A	B	C
Coefficient of correlation	0.92	0.98	0.98

CONCLUSIONS

1) There is strong relationship between coefficient of static and dynamic testing number of cycles.
2) From results of three samples testing it can be concluded that there is possibility for decreasing expenses for quality determination especially those related to durability of construction (replacement of dynamic testing with static testing).
3) Replacement of whole product testing with testing of critical assembly only (decrease of overall expenses).
4) Testing of assembly makes quality determination possible early in planning and design phase.

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Streszczenie: *Optymalizacja badań mebli.* Celem pracy była optymalizacja polegająca na skróceniu czasu i redukcji kosztów badań typowych krzeseł. Przedmiotem badań były połączenia o złączach czopowych. Wysokie współczynniki korelacji wskazują na silną zależność pomiędzy wynikami statycznych i dynamicznych badań próbek. Wskazuje to na możliwość ograniczenia kosztów badań, poprzez zastąpienie badań dynamicznych testami statycznymi.

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