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INFLUENCE OF CONSTRUCTION ON WETTING OF WOODEN FENCES

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ABSTRACT

In our investigation, we studied the influence of a construction solution on laboratory water absorption and drying of fence parts after watering. Moisture content has a significant impact on durability of wooden construction. Using an experimental method, six different constructions of vertical planks were joined to a horizontal bearing and wetted artificially. These models were performed to determine the influence of the construction execution on water uptake and drying speed. Inclination of the upper surface, profile of grooves in the vertical plank and mode of setting enable lesser water absorption and easier drying of the construction. Minor watering and faster drying reduce swelling and cracking of wooden elements as well as protect them from wood decay organisms. Considering the proposed constructions the maintenance intervals of surface coats would decrease.

KEY WORDS: wooden fences, durability, construction, detail, ecology, watering

INTRODUCTION

Exterior fences belong to types of furniture, which are exposed to weathering. Designing and fabricating balcony and garden fences, we have to consider several criteria, which significantly influence the quality and durability of fences. These criteria are mechanical and constructional properties, as well as function, production, economic and aesthetic demands. We studied construction of vertical plank with a horizontal bearing, which have the greatest influence on the mechano-technical properties and consequently on the durability of wooden fences. In this research, we focused on a joint element - the critical part where the rainwater stagnates and consequently watering wood influences its durability. Because of rainwater absorption and slow drying, the instability of wood increases and causes tension among individual wood elements as well as between coat and wood surface. As a consequence of the dimension instability of wood, contact surfaces can open and it may come to their deformation. The moist wood is also exposed to pests, additionally decreasing its durability and quality. If moisture content of wood exceeds 20 % than it is susceptible to decay. However, at impropriate construction it is frequently above 30%.

It is a fact that a trend of increased use of wood in construction, like for wooden fences, is apparent. From the environmental point of view, it is required to use wood preservatives in minimum quantities. Extending the life span and maintenance intervals is also desired. The problem is how to extend wood durability of fences with constructive protection. An appropriate construction increases dimension stability and prolongs maintenance intervals.

Many authors studied durability of exterior wood but most of them investigated durability from the viewpoint of resistance to damages caused by weathering. The investigators exposed surface protected samples to rainwater in various climatic conditions and defined the rate of damage according to climatic situation of the location (Creffield 1989). They observed durability of various surface coats on different types of wood (Morrell 2001), and the influence of chemical protection and coats for wood (Graystone 1985, Williams et al. 1996, Turkulin et al. 1999, Sell et al. 2001). Recently, many experts studied wood modification and its impregnation with environment-friendly wood preservatives. It is known that the quantity of impregnated wood has doubled in the last few years (Humar 2004). Landolf and Eggenberger (2001) and Risi (2001) investigated the influence of different materials on durability of fences.

Some authors who studied the durability of wooden products as regard construction aspects (Sell 2000, Turkulin and Sell 2002) resuscitated the knowledge of our ancestors. They set up criteria for a construction execution, which would prolong the durability of the façade. The authors gave special attention to erosion of materials and emphasised the importance of wood species for stability of wood products.

Gockel (1996a) and Spöri (1989) call attention to the significance of inclined areas at frontal surfaces of wooden pillars exposed to rainwater, and the importance to protect the upper front surfaces with a protective lining (e.g. of metal). Water retaining on the bottom front surfaces of vertical planks can also be problematic. The article of Gipeblo group (2000) suggests inclined and round shaped bottom front planks of fence elements as well. Gockel (1996b) points out the importance of an adequate fixing of wooden elements too, and possibility of black spot emergency around the nails, having an impact on aesthetic appearance.

The purpose of the research was to determine the influence of the construction of balcony and garden fences on wetness and to propose a construction solution, allowing a lesser possibility of water absorption and faster drying of wooden elements. We tried to find out the most appropriate execution of joints among horizontal and vertical elements exposed to wetting, and therefore having a rather short durability.

MATERIAL AND METHODS

In the described research, we decided to focus on the detail where vertical plank is fixed to the horizontal fence construction (Fig. 1).

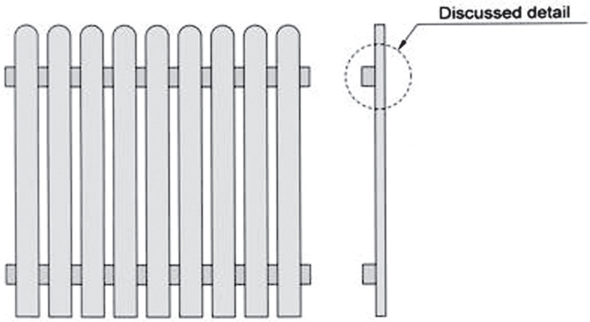

Fig. 1: Detail of fence with vertical plank fixed to the horizontal construction

We used a laboratory method for artificial wetting of details and studied the influence of construction solutions on water absorption. The samples were made from pine sapwood and heartwood. Planks were 5 cm wide, cut vertically to the width of elements and then planed on a planing machine. To suppress variable wood properties the elements were sawn serially from the same plank, which is important for testing of different constructions. After planing, the elements were cut to the length of 300 mm. The dimensions of vertical planks were 300 × 130 × 30 mm, and those of horizontal ones: 300 × 60 × 40 mm. We made six different details (A to F) of a fence with vertical planks. On two horizontal bearing planks we made a groove on the lower face, on four bearing planks we made an inclined profile at an angle of 14 degrees. The fixation between the horizontal bearing plank and the vertical plank was in all cases made by screwing (Fig. 2).

Prepared elements were marked A, B, C, D, E, and F:

- Sample A is made of perpendicularly cut elements.
- Sample B has a groove made in a vertical plank, with an upper inclined surface. The upper area of the bearing plank is inclined for 14^0.
- Sample C differs from sample B because its groove, made on the plank, is 10 mm higher than the height of the bearing transverse plank, making a dripping profile in this way.
- Sample D has a profiled bearing plank at the contact part. In this way the contact surface is diminished and the outside surfaces perpendicular.
- Sample E, similar to the sample D, has a profiled bearing plank at its contact part. Apart to this, it has a bearing plank with a dripping profile, and an upper surface inclined for 14^0. Ornament vertical plank is screwed down to longitudinal plank in such a way that the head of the screw is on the outer side of the plank.
- Sample F differs from the sample E, because its vertical plank is screwed down on the transverse bearing plank, so that the head of the screw is on the outer side of the bearing plank.

Before wetting, the models were weighted. To perform artificial wetting procedure small plastic tubes conducting water were prepared. Each tube had four holes, and its end tightened up. The water flow was regulated; it had to be slow for the water to drip evenly on the samples (Fig. 3).

The models were placed at an equal distance from the tubes and artificial wetting started. Water ran into small tubs; in this way, the flow equability of individual samples was also controlled. The process of wetting lasted for three hours with constant and controlled flow of drops. We measured water evaporation (drying) of the test samples by weighing (gravimetrically) them each day for ten days, when the drying was monitored. Based on the data of mass losses the quantity of water emitted daily from each test case was calculated.

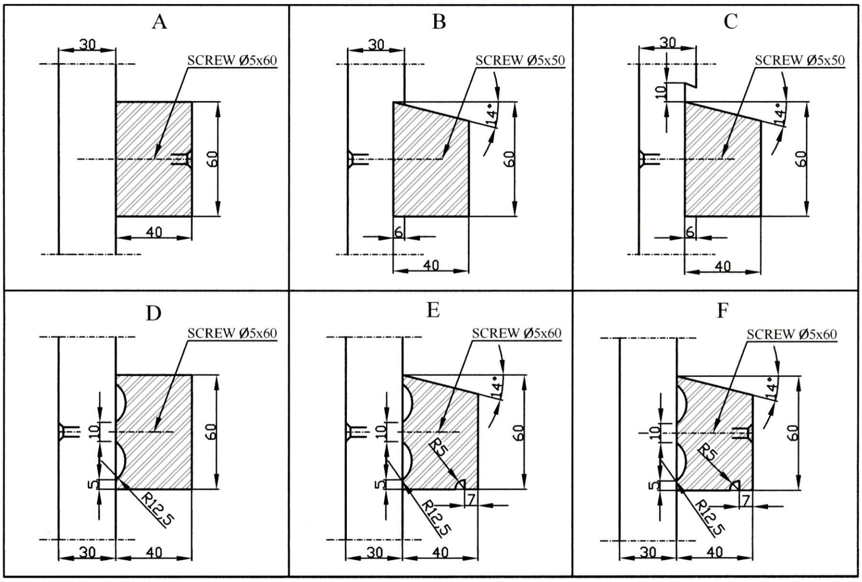

Fig. 2: Details of models

Fig. 3: Experimental system of artificial wetting

RESULTS AND DISCUSSION

The weight of the samples before water absorption intake was 1041.3g – 1173.8g. Immediately after wetting, the weight of all the samples increased. We measured mass losses of individual samples according to the duration of drying at room temperature.

Measuring the differences in the mass we found out the influence of different construction executions on water absorptionintake and drying speed. On the basis of measurements obtained, we can conclude that construction solution has its effect on water absorptionintake and drying speed. Tab.1 shows that the wood dried most intensively the first day after wetting. Then the water amount was diminishing exponentially. The way the detail was executed had its influence on the quantity of eliminated water (Tab. 1).

Tab. 1: Absolute water presence in samples

Time (days)	Sample					
	A	C	D	E	F	B
	Mass difference (g)					
Before wetting	0	0	0	0	0	0
1	73.5	63.8	16.7	72.2	52.2	57.7
2	44.7	43.9	8.8	44.2	34.3	37.4
3	37	35.7	7.7	35.1	27.7	31.3
4	32.2	30.7	7.6	29.6	23.6	27.2
5	27.8	26.4	6.5	24.7	19.5	23.1
7	20.8	19.2	5.1	14.6	10.4	14.4
8	19.3	17.6	4.6	11.4	8.1	12.3
10	16.9	15.9	4.5	9.4	4.6	9.3

The comparison of the contact surface impact was performed on samples A and D (Fig. 2). It is clear from the graph that the testers' water absorptionintake was approximately the same. The difference emerged at drying; the sample D was drying more quickly than the sample A (Fig. 4).

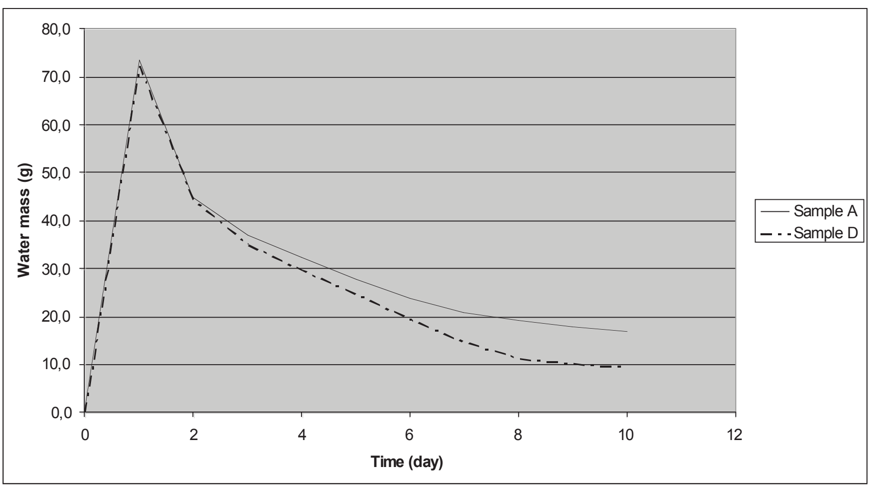

Fig. 4: Water mass loss for samples A and D

Samples D and E (Fig. 2) were used to show influences of the upper edge inclination and dripping profile. It is evident from the graph that inclined edge and dripping profile have influence on wetting; the sample E was much less wet. The first four days the sample D was drying more quickly, because its water content was higher, later the both samples were drying rather evenly (Fig. 5). Gockel (1996a) and Spöri (1989) came to similar findings as well, calling attention to the significance of inclined front surfaces of vertical elements.

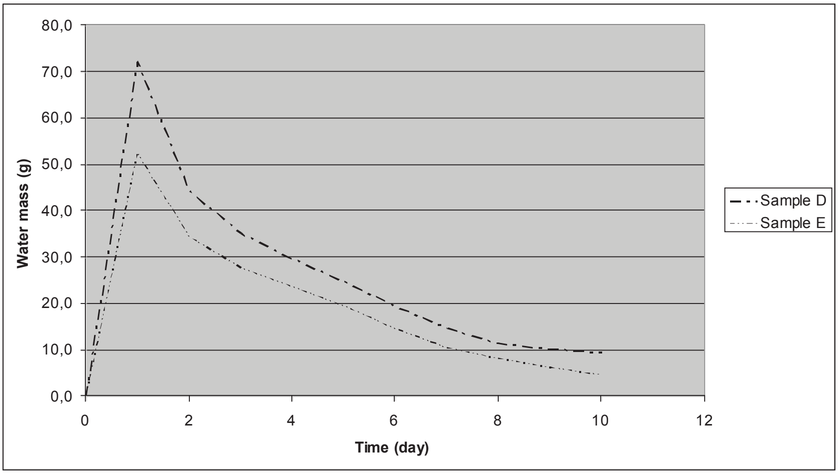

Fig. 5: Water mass loss for samples D and E

To show impact of dripping profile on vertical plank the samples A, B and C were considered (Fig. 2). It is clear from the graph that the dripping profile has an essential impact on water absorptionintake; at sample C, the values of water absorptionintake were namely very low. It is also evident that at sample B the execution with a groove without dripping profile does not have an essential effect on diminished wetting, which is nearly equal to that of the sample A. It is also interesting that the water content at samples A and B became nearly equal after the second day of drying, and then they both behaved in a similar way (Fig. 6).

Designing the details, the possibility of simple exchangeability of worn out elements has to be taken into account. At sample B the exchange of vertical planks is not simply done; it causes a problem, which is not the case with sample C.

The samples E and F were used to present the impact of screwing (Fig. 1). The testers differ only regarding the screwing direction. As seen from the graph, the sample F was a bit wetter than the sample E, which had the screw head on the outer side (Fig. 7). The reason for that was the wetting performed on the bearing plank spot; the outer side of the vertical plank was not wetted. During the process of wetting, water circles around screws emerged. Gockel (1996b) also observed similar phenomena on the case of wooden façade linings.

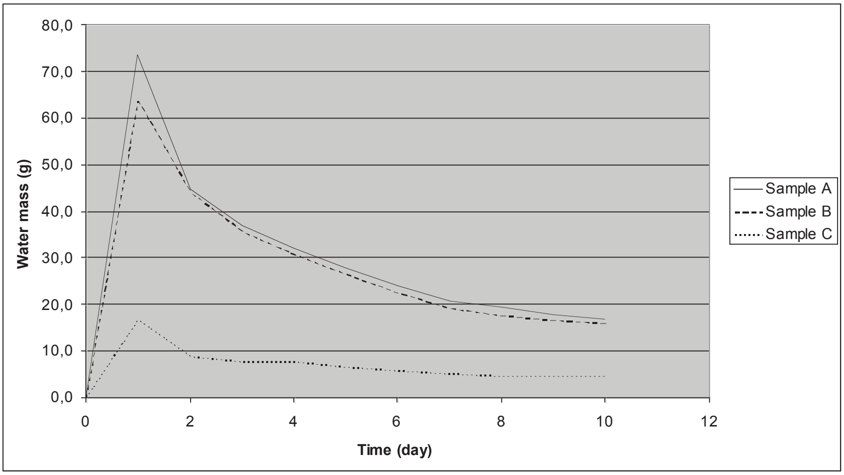

Fig. 6: Water mass loss for samples A, B, and C

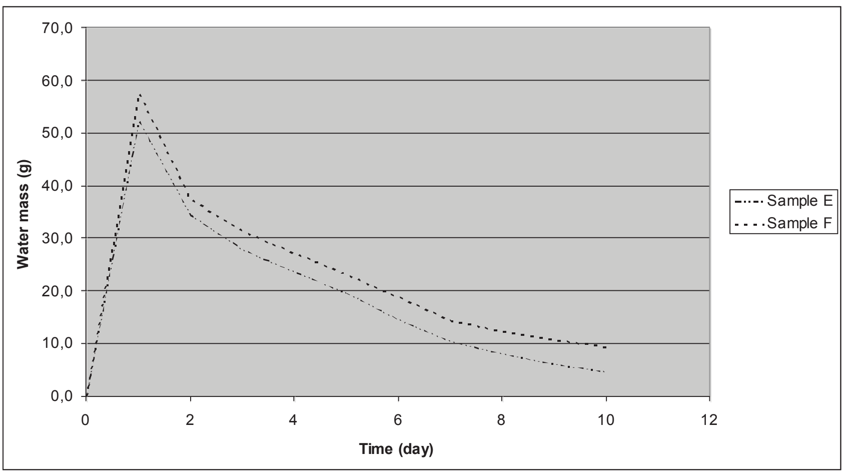

Fig. 7: Water mass loss for samples E and F

Water was retained on all the edges, therefore, we suggest to shape edges round and to do dripping profiles (Fig. 8).

Fig. 8: Water mass retained on edges

Figure 9 shows the diagrams of all the six testers during the process of wetting and drying. It can be seen from the graph that far the best results were obtained using the sample C.

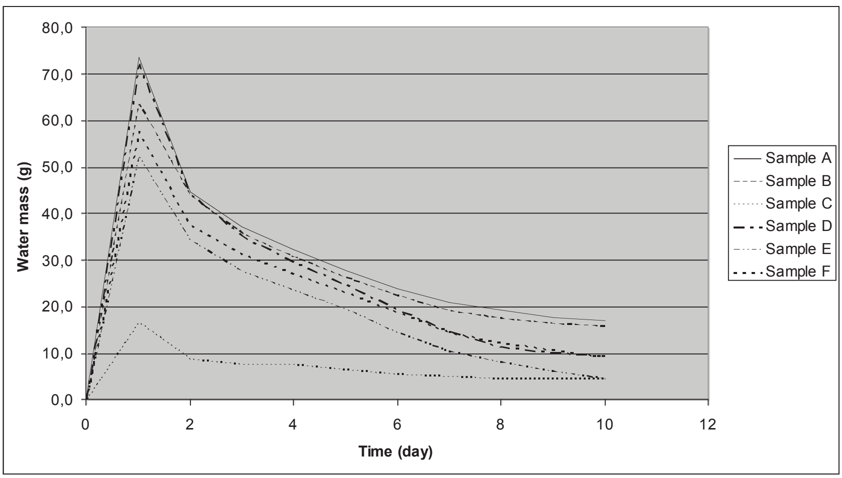

Fig. 9: Water mass loss for all the models

The failing of the samples A and D was a flat upper surface of the transverse bearing. This was the reason for water not to leak out but remained on the surface, moistening the vertical plank also. The both testers were intensively drying at the beginning. The largest water content remained, nevertheless, in the sample A. Because of the profiled contact surface of sample D, the drying was faster. In all the other test cases the upper surfaces were inclined, therefore, the water leaked out sooner, so the testers got less wet. In the test case C, besides having an inclined surface it also had a groove with dripping profile in the vertical plank, resulting in a lesser water absorption of the construction. The test case C reached by far the lowest value of wetting. It absorbed little water, but it also dried more slowly.

The question remains how the test case would prove in hard rain and wind. In such conditions, the water would in spite of the groove with dripping profile most likely be drawn upward the profile, and therefore, increase wetting. For that reason, it would be advisable to perform the research in real situation.

Because we noticed a wet circle around the head of the screw, it would be advisable to use joint shackles, which do not reach to the upper surface, or to make a dripping profile in the plank above the screw, which could be a continuation of this research.

In the case C, we attained the best results; nonetheless, the manufacturing of this model was most demanding of all the cases (which makes the final product more expensive).

Therefore, a solution, which is simpler to be realised, but regarding water absorptionintake and drying good enough, is suggested (Fig. 10). Contact surface can also be diminished with a distance holder, but from the visual aspect, and because of greater width of the fence, this solution cannot always be acceptable.

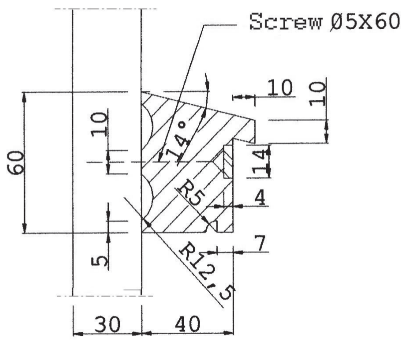

Fig. 10: Suggested detail

In our research, we found out that construction execution has an important influence on drying of wooden parts, just like as it was established by the authors dealing with wooden façades (Sell 2000, Turkulin, and Sell 2002). Also at the execution of fences, it is important to take care of details, which have crucial influence on wood durability.

CONCLUSION

From the results of absorbed and emitted water, we can conclude that the speed of drying was influenced by the detail execution of the samples.

The results obtained show the following findings:

- When constructing the fences exposed to weathering, it is reasonable to make elements joint together with the smallest possible surface. This has a considerable impact on evaporation, because the air movement is more extensive.
- The inclination of the upper surface and the groove in the vertical plank result in lesser water absorption of the fence construction and for that reason, it is advisable to produce horizontal parts with inclined upper surface and with groove.

- On vertical planks of the fence, fixed on horizontal bearing planks, a dripping profile in the groove can be made in vertical planks. In this way the lowest wetting is reached. Damaged fence planks can simply be replaced. It is interesting that the groove without dripping profile does not have great impact on a diminished absorption of water.
- Screwed joints have a negative influence on wood wetting because around the screw, an area with higher wetness appears and the probability of fungal infection is high. If we use screws it is advisable to use them on the inner side and if possibly hidden or protected with a groove.
- As we noticed water stagnation on lower edges we suggest round edges and a groove profile on parts which are most exposed to wetting

The construction of the fence has to enable protection against water uptake and ensures faster drying of wood elements and maintenance intervals can be longer.

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