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ALTERNATE METHOD FOR DETERMINATION OF GLUE-LINE TENSILE STRENGTH OF SPLICED VENEERS IN CZECH REPUBLIC

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Abstract

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Quality control is a crucial part of any manufacturing unit, as it assures compliance to established standards as well as maintenance of product quality for internal management purposes. Quality control of spliced veneer in Czech wood based industries is mainly based on ČSN 49 2315 and ČSN 49 2320 standards, which rely on measurement of crack length in finished product. This method has been satisfactorily used since 1985 but requirements of wood based industry has changed a lot in these years. We propose an alternate method for mesurement of tensile strength of spliced veneers. Samples of specified size spliced were taken as mentioned in details and they were subjected to tensile stength measurement. An addtional adhesive tape was used to avoid intra-material fibres disjointing, so that inter-material tensile strength can be measured for spliced veneers. This test can be used for on – site optimization of splicing machine units as well as regular quality control of spliced venners.

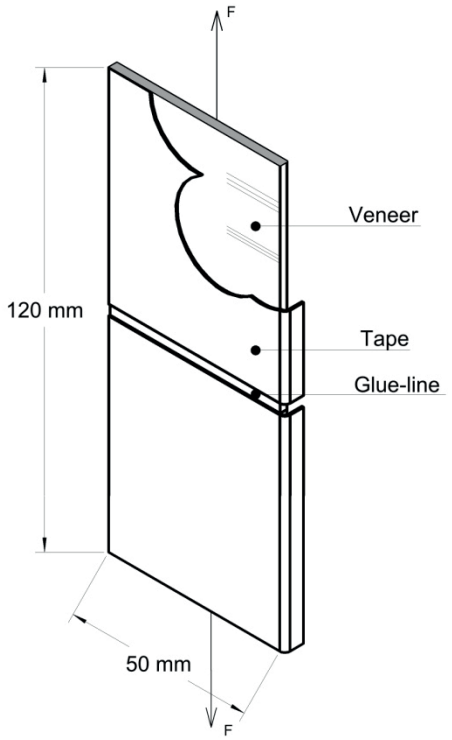
Keywords: veneer, glue-line, splicer machine, veneers splicing quality

INTRODUCTION

Wood based Panels without improvement of surface appearance almost disappeared since needs of the decorative surfaces are needed in the various branches from furniture to the building industry. Although the decorative attribute play major role in the surface applications the importance of mechanical properties are important equally due to ling-term changes of environment and mechanical stressing (Nemli, 2008). There were found various advantages of the veneer overlays utilizations. There were reported higher stability of the panels with the decorative surface (Král *et al*., 2013). This is followed by successful increase of the mechanical properties with various overlays (Kawasaki, Tamami, Zhang, Min, Kawai, 1999; Istek *et al*., 2010; Nemli *et al*., 2005). To achieve certain surface quality, not only material type, but also material adhesion, where various adhesives may be of major interest, plays major role (Nemli, 2008). Due to this complex process the various properties of the surfaces are tested considering the surface adhesion of the veneer (EN 311), or the various resistance of the surface itself (Nemli & Kalaycıoğlu, 2006). Although the various approaches to measure wide scale of physical and mechanical attributes were presented considering lamination techniques or surface resistance, minor focus is connected with the production of decorative veneers, especially in the splicing section where the adhesion quality may be crucial for the further lamination when the precision and sufficient adhesive bonding is needed. Sure, the macroscopic evaluation of the slicing quality was standardized in late eighties' by Czech standards ČSN 49 2315 and ČSN 49 2320, however only the macroscopis evaluation is propose to determine quality of the splicing and bonding at the same time. The lack of the determination by the mechanical evaluation has been seen as a weakness since varrious types of the machinery may be employed in the splicing of veneers. As a new technology is reported or adapted, it necessitates manufacturing company to test for it performance and ability to deliver constant quality product over a range of time. Numerous novel and modified processes in veneer splicing and related

areas have been reported (Wei *et al*., 2013; Liu, 2000; Nakatsuka *et al*., 1975; Hasegawa *et al*., 1977; Engel *et al*., 2008; Blomme *et al*., 2010). Considering this task commonly used standard serves as a good tool for this purpose, since other tests, which ensures quality are equally important. In this research, we propose a test for measuring tensile strength of spliced veneer. While measuring tensile strength the common problems arises from stronger inter-material bonds than intra-material bonds. To address that issue, we have used an adhesive tape, so that strength of intra-material bonds can be measured. We hypothesize that:

1) Our proposed method may give additional approach how to determine veneers splicing quality by determination of the tensile strength of the glue-line.
2) We will prove that this method is usable since tensile strength determination is employed to evaluate splicing quality of two splicing machines with different setups.
3) There will be found differences of bonding quality and the results are feasible to give recommendations to the veneer splicing company.



1: *Design of tested sample (Total length 120 mm; width 50 mm)*

MATERIALS AND METHODS

Method Development

Since the quality of the splicing bonding is assessed mostly macroscopically (ČSN 49 2315; ČSN 49 2320) there is always need of mechanical assessment which specify the glue line between veneer splicing. We propose to prepare samples cut off spliced veneer sheets in dimensions according to Fig. 1 and provide mechanical assessment in form of tensile strength determination. Due to longitudinal direction of the bonding line, the fiber cross-direction is the crucial location in tensional loading. The challenge is the lower strength in tension of the fibers than the glue-line itself. We suggest fixation of each half of the veneer sheet by a tape which is not in the place of glue-line. The tape provide fixation of the fibers and the glue-line surface will be stressed. The maximal force is then calculated by common EQ [1] for mechanical properties in tension:

$$\tau = \frac{F_{max}}{l \times b}, \qquad [1]$$

F_{max} .....the applied maximum force (N),
l .....the length of the bonded test surface (mm),
b .....the width of the bonded surface (mm).

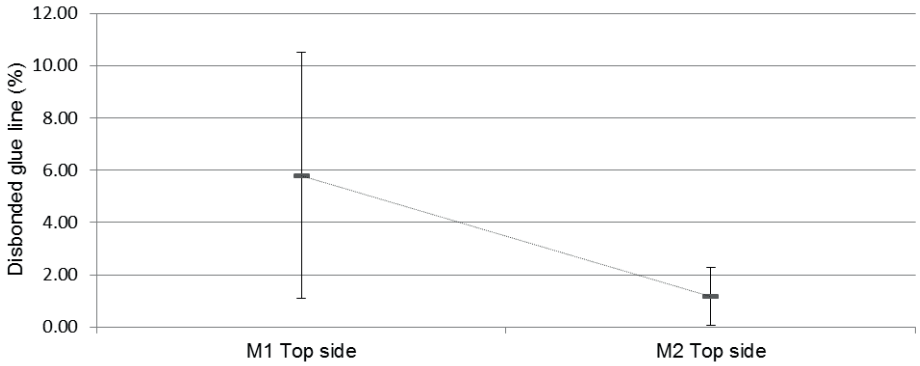
Samples Producing and Testing

Our method was established and used respectively to specify difference in the veneer splicing strength quality of the decorative veneer produced by a company "Jan Ficek drevovyroba inc.; Prumyslova 443, Chrudim" where the unique upgrade of the gluing operation in the machine OMNIMASTER Fisher and Ruckle® were performed. The decorative beech veneers sheets in thickness 0.55 and 1.55 were produced by two automatic veneer splicing and gluing machines. The samples produced by traditional machine OMNIMASTER (M1) and upgraded machine OMNIMASTER (M2). Each side of the glued veneers was evaluated by traditional macroscopic evaluation technique where the disbonded glue line at the end of veneers splicing was recorded in percent. Moreover the tensile strength (TS) of glue line was by our experimental method assessed. The caliper for measuring of not bonded glue line length between two veneers was used and results were defined by percent to the total length of glue line; Tensile strength of glue line was measured using ZWICK®Z050.

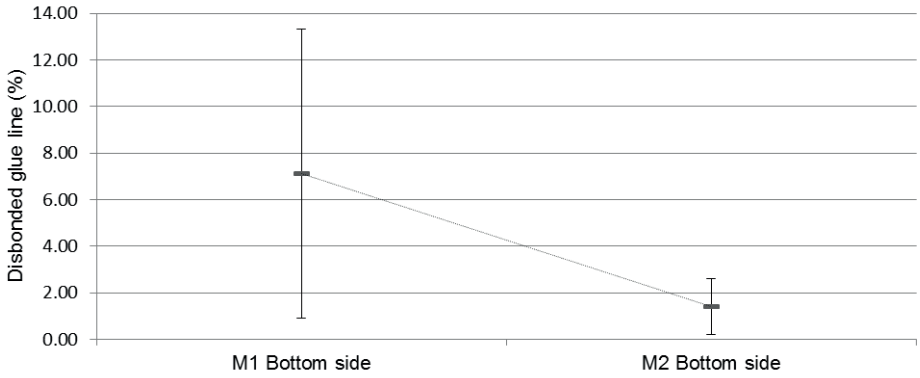
RESULTS

Dis-bonded Glue Line

According to measurements results significant decrease of defects where the ends of the splicing were not bonded together. There were conducted measurements on both surfaces when the effect of gluing can be different according to operating on the splicing machine. M1 Top side were dis-bonded in range 6% were the significant decrease on level 1.17% (Fig. 2) of this defect was by M2 Top side shown. The Bottom side gives the similar results. The M1 Bottom side has dis-bonded line in range



2: *Disbonded glue line at the face edge of veneers – Top side*



3: *Disbonded glue line at the face edge of veneers – Bottom side*

I: *The descriptive statistics of the disbonded glue-line*

Disbonded glue line at face of veneers (%)					
	mean value	**min**	**max**	**st.dev**	
M1 Top side	5.80	1.00	23.00	4.71	●
M2 Top side	1.17	0.00	8.80	1.10	●
M1 Bottom side	7.12	0.80	28.00	6.20	●
M2 Bottom side	1.39	0.00	6.60	1.20	●

● $p < 0.05$

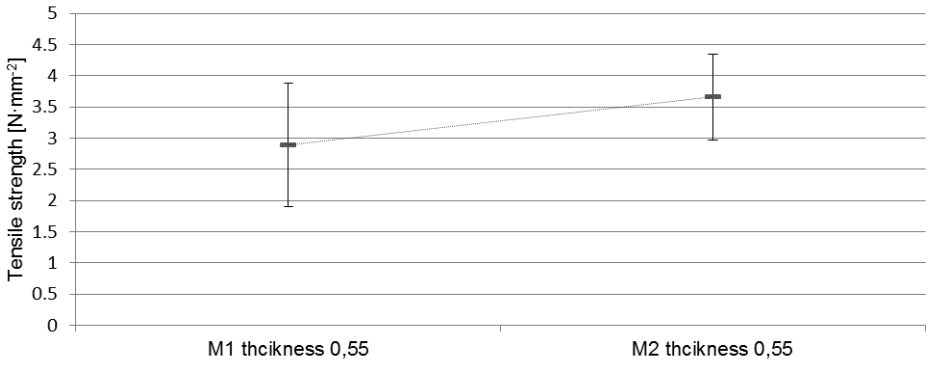
7.12% and significant improvement on level 1.39% (Fig. 3) were by M2 Bottom side introduced. The interesting conclusions can be also be drawn when the standard deviation by both upgraded machines was limited which may result in higher reliability of the production. Descriptive statistics is in the Tab. I.

Tensile Strength of Bond Line

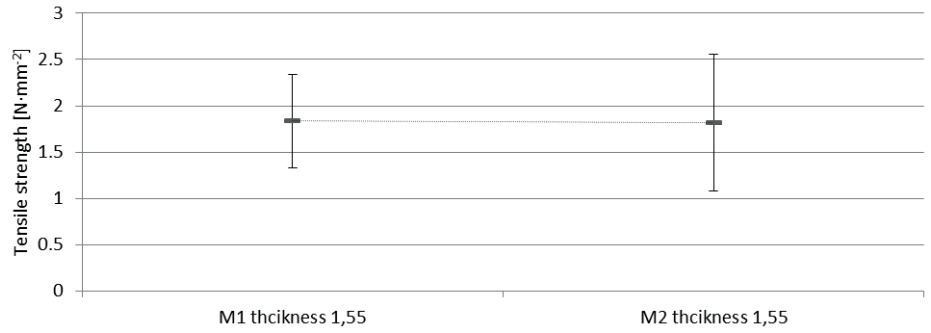
Our experimental method carried out various results along the changed veneer thickness. There were found statistically significant increase of tensile strength when the thickness of veneer 0.55 mm were measured. The tensile strength were significantly increased from 2.89 on 3.66 MPa (+27%). The upgraded machine then is capable of continuous production with increased bonding quality (Fig. 4). On the other hand the tensile strength of veneers with thickness 1.55 mm maintained same (Fig. 5). The descriptive statistics is in Tab. II.

DISCUSSION

Our experimental method carried out various results along the changed veneer thickness. There were found statistically significant increase of tensile strength when the thickness of veneer 0.55 mm were measured. The tensile strength of bonding line was increased by +27%. This increase is assigned to the modification of the machine in the section of adhesive application. On the other hand there were found different values along the veneer thickness. The lower thickness as was mentioned deliver increased values, nevertheless the tensile strength of the bonding of veneer with thickness 1.55 mm remained the same. Is assumed that reference machine without modification is sufficient enough in application of the resin, when the higher thickness is utilized in splicing process since higher area is glued. In the end there were found higher quality of the splicing using modified machine,



4: *Tensile strength of glue line – thickness 0.55 mm*



5: *Tensile strength of glue line – thickness 1.55 mm*

II: *The descriptive statistics of the Tensile strength of glue-line*

Tensile strength of glue line [Mpa]					
	mean value	**min**	**max**	**st.dev**	
M1 thickness 0.55	2.89	1.83	5.51	0.99	●
M2 thickness 0.55	3.66	1.92	4.71	0.69	●
M1 thickness 1.55	1.834	0.80	2.64	0.50	
M2 thickness 1.55	1.82	0.76	3.56	0.74	

● $p < 0.05$

when the standardized evaluation were employed. There were found significant decrease of disbonded glue line nearly on level of 1% considering length of the glue-line. This standardized method correspond with conclusions of tensile strength since lower disbonding of spliced veneers measured by standardized method, delivered higher tensile strength.

CONCLUSION

1. Proposed test provides an additional add-on test for already established standard test, as it provides additional information important for quality control of spliced veneers.
2. Considering the nature of test, it can very useful in comparison of new and upgraded technology with present day technologies when used along with other standard test.

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