Technology Profile

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Connectors for Kitchen Cabinet Producers – A Comparative Study

A recently completed study examined some of the most commonly asked manufacturing questions of Canadian kitchen cabinet and furniture manufacturers (Tremblay, 2010). Namely, which assembly system is the strongest, and which manufacturing process is the most efficient.

Visits to furniture and kitchen cabinet manufacturers' plants revealed that several case assembly systems are currently in use. These systems were evaluated using three mechanical resistance tests involving the application of shear loads and tensile loads. The second part of the report focused on a comparative study of the manufacturing and assembly time for a model kitchen using four different manufacturing processes. Plans for the model kitchen were provided by one of the project partners, a kitchen cabinet manufacturer.

The various systems used by the industry appear to meet sturdiness requirements although variation in performance is expected to a certain extent. With respect to the most appropriate assembly system, manufacturers choose a system based on a combination of perceived value and cost.

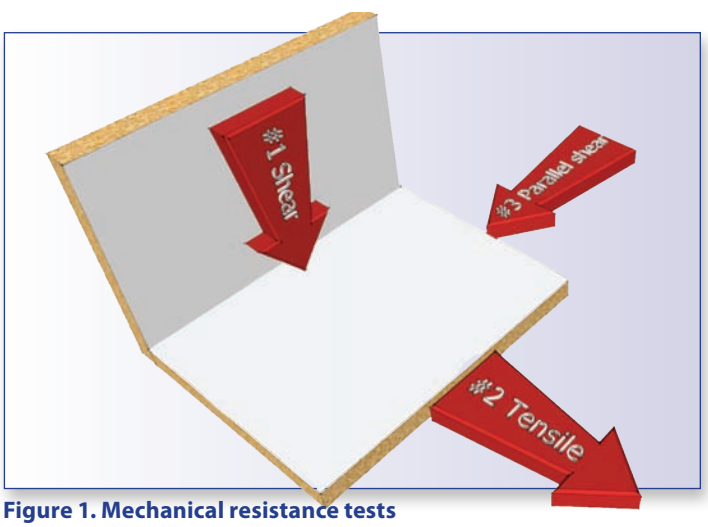
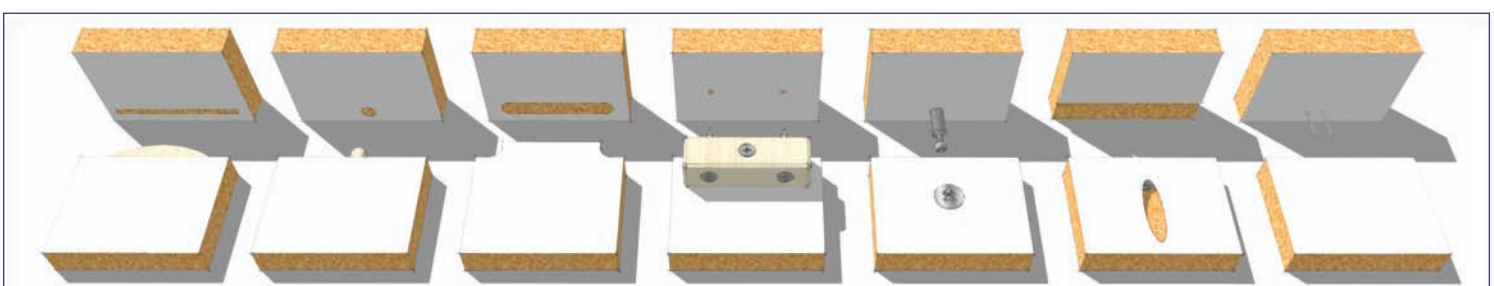


Figure 1. Mechanical resistance tests



Lamello | Dowel | Blind Dado | Nailing Strip | KD Fastener | Pocket Screw | Staple

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Assembly Systems

The tests on the various assembly systems were performed on two grades of $^{5}/_{8}$ thick particleboard; M-2 and LD8 with a melamine overlay. The mechanical properties of the LD8 and M-2 particleboard panels are shown in Table 1. M-2 grade panels are commonly used by manufacturers of factory-assembled furniture and kitchen cabinets. The LD8 grade panels are mainly used for furniture that will be assembled by the consumer.

Grade	Internal Bond Strength (N/mm^2)	MOE (N/mm^2)	MOR (N/mm^2)	Hardness (N)	Screw Retention (N)	
					Face	Edge
LD8	0.30	1,950	9.0	1,900	645	510
M-2	0.40	2,000	13.0	2,225	900	800

Table 1. Mechanical properties of LD8 and M-2 panels

Table 2 shows a summary of the results of the mechanical tests carried out to evaluate the sturdiness of the eight assembly systems. More specifically, the table shows a description of the study system used, the average force which resulted in the breakage of the 15 test components and the result of Duncan's statistical test that makes it possible to separate the systems according to a significant average force deviation.

In Table 2, optimum assembly system strength with M-2 particleboard varied depending on the direction of the force – Shear, Tensile or Parallel. For both grades of panels for example, when the assembly system was tested for its shear strength, 2 nailing strips with 6 screws withstood the greatest force. In testing tensile strength, 2 lamellos (#20) and glue withstood the greatest force, and in the parallel shear test, the blind tenon system was strongest.

The order of ranking remained much the same for both the M-2 and LD8 panel grades, although the LD8 panels performed significantly worse in their overall ability to withstand force.

Assembly Method (M-2) Force (N)	#1 Shear	Rank	#2 Tensile	Rank	#3 Parallel	Rank
2 lamellos #20 with glue	1546	5	3039	1	4246	2
3 dowels with glue	1826	2	2659	2	3265	4
Blind tenon with glue	1589	4	1700	4	6760	1
2 nailing strips with 6 screws	2109	1	1613	5	3340	3
3 kd fasteners	1228	7	1972	3	2904	5
Rabbet and 2 pocket screws	1691	3	1167	6	2195	7
3 pre-glued dowels and water	847	8	841	7	2593	6
3 staples	1242	6	620	8	926	8

Table 2. Summary of results of mechanical tests (M-2 panels)

Conclusions

Test results showed that system performance can vary according to the test used. However, the analysis of the results of the four tests carried out on two grades of panels confirmed:

- overall very good performance of the dowel and glue and of the lamellos with glue assembly systems
- overall good performance of the blind tenon system as well as the nailing strips with screws
- average performance of the cam bolts and of the pocket screws
- very poor mechanical performance of the staple assembly system and the pre-glued dowels.

Results from this study highlight the poor performance of KD fasteners, pocket screws, pre-glued dowels, and especially staples. These less expensive methods of fastening resulted in the lowest performance. In addition, using a lower-grade panel (LD8) had a significant effect on performance, as between 2.6% and 39.6% less force was required to achieve breakage compared to an M-2 grade panel.

Manufacturing Process Time

In the second study, a comparative evaluation of the production time for a model kitchen using four different manufacturing processes was performed. The processes differed in the equipment used for cutting up the melamine panels (4 x 8 ft.) into components, the equipment used to machine the components and the systems used to assemble the cabinet cases.

The study was carried out at the facilities of three kitchen cabinet manufacturers based on their respective manufacturing processes. With the aid of Planit Canada software, plans for the model kitchen (Figure 2) were adapted in order to perform a virtual simulation of the panel-cutting and component-machining steps. The time required for these steps was verified on-site during the simulation operation. The cabinet assembly times were subsequently estimated by observing the assembly times on in-plant industrial production lines.

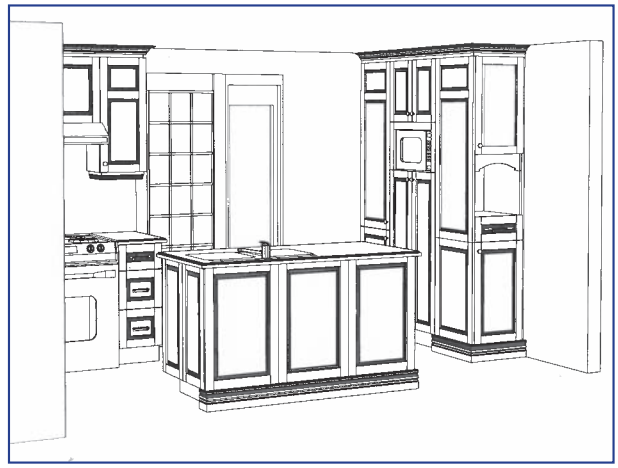

Figure 2. Model kitchen

The four manufacturing processes taken into account in the study are described below.

Process No. 1	Process No. 2	Process No. 3	Process No. 4
Panel saw	Single table nested CNC router	Double table nested CNC router	Double table nested CNC router
Point-to-point CNC	Drilling and dowel insertion	Drilling and dowel insertion	Assembly with blind tenon and glue
Drilling and dowel insertion	Assembly with dowels and glue	Assembly with dowels and glue	
Assembly with dowels and glue			

Table 3. Test processes

	Process	Assembly	Sheets used	Total machine time + assembly	Total time per sheets (min/sheet)	% reduction in time
1	Panel saw, point-to-point, dowel insert, assembly	dowel + glue	20	5:08:09	15:24	0%
2	Nested CNC, dowel insert, assembly	dowel + glue	19	4:45:59	14:57	8%
3	Double-nested CNC, dowel insert, assembly	dowel + glue	19	3:49:59	12:06	25%
4	Double-nested CNC, assembly	blind tenon + glue	20	3:45:09	11:15	27%

Table 4. Summary of evaluation of production time

Conclusions

The results of this study highlighted the specific impact of using a double-table nested router to reduce manufacturing time. In fact, replacing a panel saw and a point-to-point machining centre with a double-table nested router reduces machine operation times by 38.5% for a dowel assembly system, and by 12% in the case of a single-table nested router.

The study determined that using a nested router is a good way to reduce overall machine time in the production of cabinets. When using a nested router, replacing dowels with a blind tenon assembly further reduces machining time by roughly 20%. This occurs because the steps of drilling and inserting the dowels have been completely eliminated.

Tremblay, Carl. 2010. Cabinet and Furniture Assembly Systems.
A Research Project of FPInnovations – Wood Products Division, 32 p.

This study only examined the various assembly systems and manufacturing process times under a limited number of applications. This report is not intended to be inclusive of all potential combinations and products currently being used by manufacturers. For more information, please contact the people listed below.

FPInnovations has a network of Industry Advisors available across Canada that can help to implement this information in your business. For more information on this study, and how the results can be applied in your business, contact your nearest FPInnovations Industry Advisor:

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