News on the Block

Canadian Concrete Masonry Producers Association
Region 6 of the National Concrete Masonry Association
CCMPA
Building Strength

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Welcome to the first 2017 issue of News on the Block. We welcome your feedback and story suggestions — please send them to: info@ccmpa.ca.

ASTC for CMU / Precast Slab Construction

Written by Gary Sturgeon, B.Eng., MSc., P.Eng.

In earlier editions of our newsletter, we described some important changes to airborne sound requirements in the 2015 National Building Code of Canada (NBCC). These included the move to use ASTC (Apparent Sound Transmission Class) rather than STC (Sound Transmission Class), and to set the minimum ASTC compliance value to 47. The STC compliance value of 50 is no longer used. These requirements are true for all wall and floor systems used between dwelling units under the 2015 NBCC. Additionally, it is clear that designers also will rely on ASTC to assign higher acoustical requirements (higher ASTC) for separation between rooms in buildings of other uses and occupancies (that is, for other than between dwelling units).

In earlier editions, we also discussed the differences between ASTC and STC, and briefly described CCMPA's involvement in NRC research projects, these projects deemed by many to be essential to our market, and to explain to designers the nature of the airborne sound changes, the technical aspects of determining and calculating ASTC, undertaking needed sound testing to fill knowledge gaps, and to develop design tools including guides and software that can be used by the designer, construction, and regulatory communities to understand and calculate ASTC for compliance with the new NBCC requirements.

Specific to the concrete block masonry industry, this has resulted in on-going laboratory acoustics research with NRC on CMU walls constructed with flooring systems including wood joist flooring, solid CIP concrete slabs, and precast hollow core planks. Research on wood and concrete slabs is completed, and this has resulted in the publication of NRCC RR-334 Report, "Apparent Sound Insulation in Concrete Block Buildings". The work of this Report has been integral to the development of NRCC RR-331 Report "Guide to Calculating Airborne Sound Transmission in Buildings". Report RR-331 is referenced by the 2015 NBCC for use by designers to calculate ASTC for a variety of wall and flooring systems, including concrete block masonry wall systems bare and with liners constructed with a variety of flooring systems. Both RR-331 and RR-334 are "living documents", and are continually updated as additional airborne sound research is completed. Through its funding and participation, CCMPA also provides input and direction on the development and content of RR-331. Both reports are available for download free of charge from NRC. A more detailed description of NRC and CCMPA acoustics involvement, and of these documents, is provided in our CCMPA article to Construction Canada titled "Canadian Masonry for Sound Buildings", March, 2016: http://www.constructioncanada.net/canadian-masonry-for-sound-buildings/4/

NRC, partnered with construction industry representatives including CCMPA, is presently developing "SoundPATHS". This is free web-application software used to calculate ASTC for many of the various wall and flooring systems commonly used in the construction industry. This software is under continued development and maintenance, however a working edition is available for use presently at http://www.nrc-cnrc.gc.ca/eng/solutions/advisory/soundpaths/index.html

Laboratory testing of CMU walls with precast plank flooring commenced in 2016 and now has been completed by NRC. CCMPA partnered with the Canadian Precast Prestressed Concrete Institute (CPCI) to fund and direct this research. Like earlier our earlier research with CMU + flooring systems, this work required the building and construction of full scale mock-ups for wall/floor cross-junctions and T-junctions (See Illustration and Photos). Both the wall and floor were "bare", that is, without finishes (liners). This tested assembly would provide the least measured ASTC, and thus, a lower baseline of performance. The addition of finishes to the CMU wall or to the precast planks or to both would result in a higher measured ASTC.

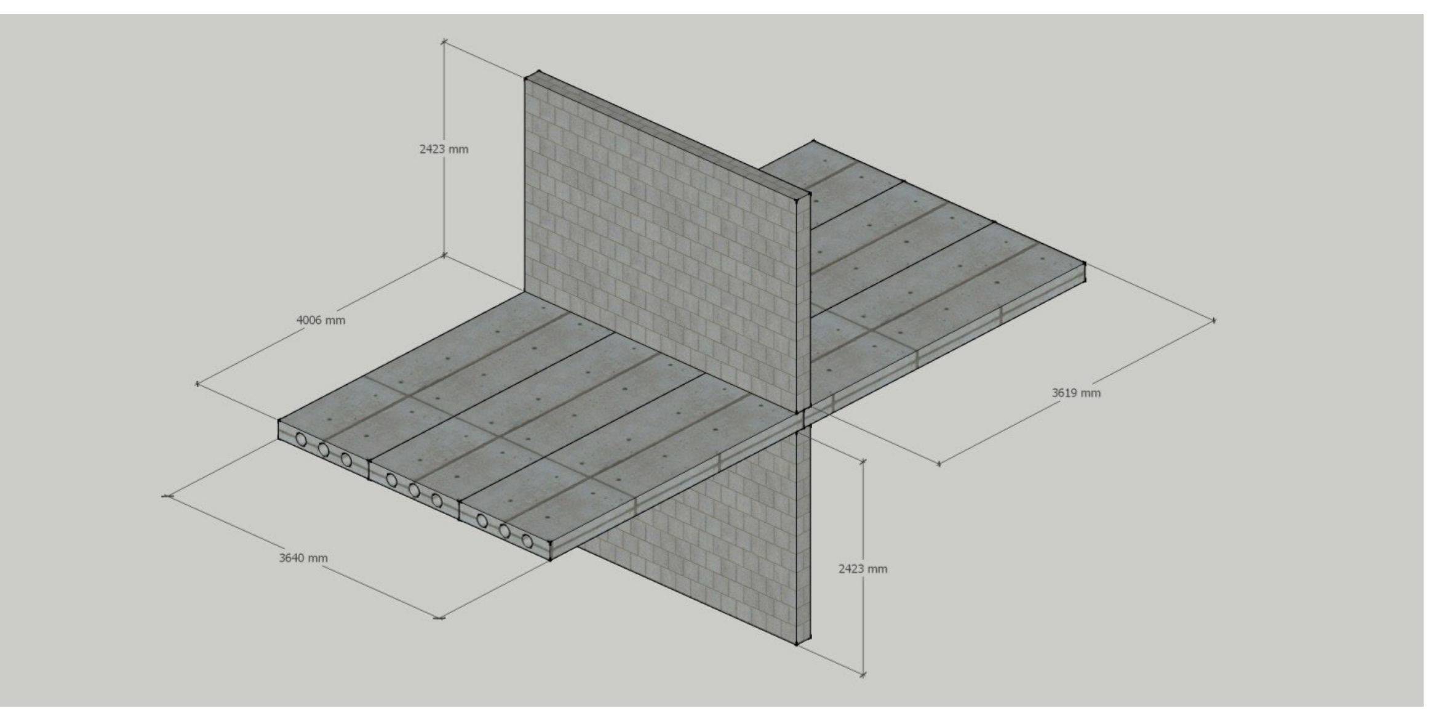

Illustration of the mock-up Cross-Junction between bare CMU walls and bare Precast plank

Constructed mock-up Cross-Junction between bare CMU walls and bare Precast plank

Constructed mock-up T-Junction between bare CMU walls and bare Precast plank

CCMPA is presently reviewing the first draft of the NRC research report which, following review and completion, will be included as an update to a new edition of RR-334, and for a new 2017 edition of RR-331.

Precast plank is not homogeneous or isotropic (because of its directional cores). Of critical importance for predicting acoustics behaviour for these floors with CMU walls…this research confirmed that despite these voids, the hollow core floors behave according to theory and therefore ASTC for CMU/plank flooring is readily predictable using existing models. It followed that planks oriented perpendicular to the masonry wall offer a lower ASTC value than a construction using planks oriented parallel to the masonry wall, and thus, ASTC values for construction with plank oriented perpendicular to the wall provide a conservative estimate of the ASTC for construction using plank oriented parallel to the wall:

"The velocity distribution across the concrete masonry walls and the precast hollow core floors were also fairly uniform. These results indicate that both the concrete masonry walls and the precast hollow core floors behave as homogeneous elements in terms of their vibratory response. Therefore, although the theory for the prediction of the velocity reduction index found in Annex E of ISO 15712-1 is not intended for this type of construction, the theory is nevertheless applicable."

Moreover, the report states with respect to thicker (and heavier) precast plank construction:

"The precast hollow core floors used for this project were 203 mm (8 inch) thick. The theory for the prediction of the velocity reduction index found in Annex E of ISO 15712-1 is also expected to be applicable to thicker floors."

In all cases, for rooms side-by-side and for rooms one-above-the-other, the resulting ASTC for the bare CMU/plank construction exceeded the minimum ASTC of 47 required under the 2015 NBCC, and of course, this is good news for both industries.

The Sawdust is Flying in the Canadian and US Building Codes

It was discouraging enough when the national building codes in Canada and the United States began permitting large 4-story wood framed building for residential uses like apartments and hotels/motels. But then another increase in the height of these buildings emerged when the National Building Code of Canada (NBCC) was further modified in the 2015 edition to permit taller buildings of light wood frame up to 6-stories in height. The sawdust has not even settled from the that last code cycle for the NBCC and already new proposals are being placed in the hopper to further increase the height of buildings using mass timber (MT) wood materials. And these strategies by the North American wood industry for bigger wood buildings is not limited to Canada. Similar MT changes were submitted for consideration in 2015 during the last code cycle of the International Building Code (IBC), the model building code for the United States. Fortunately, the US code change was not approved and the next edition of the IBC regarding taller wood buildings remains the same.

Regarding the Canadian code the new wood industry strategy is to permit taller buildings when the structural system uses heavy timber members such as cross-laminated timber panels referred to in the building community as CLTs (See Figure 1). The proposals seek to permit CLT buildings in the range of twelve (12) stories. The present code permitted height for mass timber buildings is six (6) stories. To exceed six (6) stories the code requires the structure to be constructed primarily of noncombustible materials like concrete, masonry and/or steel. This is a significant deviation of the present code to suggest that taller buildings of heavy wood timber materials will perform like similar buildings of noncombustible materials.

For the reader's information, taller MT wood buildings are not necessarily prohibited in the present Canadian or US building codes. There are no prescriptive provisions in these codes that tell the user what specific requirements must be met to build such buildings above six stories. Thus, designers who wish to provide taller MT wood buildings for their clients instead have several options of design based on the goals and objectives embodied in the provisions of either the NBCC or the IBC. One option is to provide an alternate design that demonstrates equivalent performance to the prescriptive goals and objectives of the code. If a straight-line equivalency cannot be demonstrated the designer may pursue a performance based design approach. With this approach, the project team, comprised of stakeholders establish the performance objectives that the design must meet and the necessary building features required to meet those objectives. Stakeholders commonly include the owner or owner's representatives, the design team (architect, engineers, etc.), the authority having jurisdiction (building and fire officials) and the contractor.

It is through the performance based approach that most tall MT wood buildings have been built in Canada (e.g. Brocks Common, University of British Columbia, Vancouver, Canada) or are being designed in the US (e.g. Framework Building, Portland, Oregon, USA). In the case of Brocks Common, it was designed as an 18-story dormitory on the UBC campus for student housing using encapsulated mass timber elements. It was completed in late 2016. The Framework Building is a 12-story multi-use building with planned retail on floors 1-3, businesses on floors 4-6 and residential apartments on floors 7-12. The Framework building, still under design, is expected to follow an exposed MT wood concept (See Figure 2 for an example of exposed MT).

The Table below shows a simplified comparison of the Canadian Wood Council (CWC) proposals for the NBCC and the American Wood Council proposal for the IBC. From the table, you can see both proposals will require the structural frame of CLT buildings (i.e. load-bearings walls and floors/roofs) to have a 2-hour fire resistance rating. In addition to this fire resistance rating, the interior surfaces of the CLT panels are required to be covered by fire rated gypsum board. By covering all the CLT wood surfaces with gypsum board the wood industry is introducing a new term in the building codes that is called "encapsulated mass timber (EMT)" (See Figures 3). There are several supposed purposes for encapsulating the wood members. One, by covering the wood surface of the CLT building the potential for the wood to contribute directly to a fire event within a room in the early stages of a compartment fire might be minimized. Second, the effects a fire in a room would have on the CLT members may be reduced.

As these proposals are being discussed in the technical committee meetings for the Canadian codes one theme has been consistently occurring. As questions come up it is apparent there are many more unanswered questions to be addressed before the proposed changes in the building code should be approved. Questions include what are the sets of fire tests performed to-date to document meeting fire resistances of the building code in the same manner as masonry, concrete or steel? Knowing wood will burn, what technical documentation and justification exist to support a position that a combustible material like wood, under fire conditions in a building, has the same performance as traditional, time tested noncombustible materials like masonry? Are the effects of mass wood timber elements on fire intensity and total heat release rate within a room with exposed wood sufficiently known? Are there challenges for the fire service who respond and place themselves at risk on floors high above ground in these wood compartments that are different than the experiences they presently know in noncombustible structures? And what about occupant safety – if the taller wood buildings are allowed, should the exit stairs and elevators continue to be placed in shafts enclosed by noncombustible materials like masonry or concrete to maintain levels of safety consistent with existing provisions for the taller noncombustible buildings?

After disapproval of the previous AWC proposal in 2016, the International Code Council (ICC), the entity responsible for development of the IBC in the US, appointed an ad-hoc committee to review the technical merits of taller MT wood buildings. These same unanswered questions of fire resistance, encapsulation, fire performance within compartments, effects on fire service response and occupant safety are cropping up as the ICC technical committee reviews the similar taller MT wood buildings proposals. At present, answers are still unknown.

From what has been discussed in meetings the author has participated in it appears to be premature to place any provisions in the NBCC to permit taller mass timber buildings without further testing and documentation. In addition, the technical data collected needs to be thoroughly examined and vetted to determine what, if any provisions for taller MT buildings be incorporated in the building code. Hopefully the technical committees for the Canadian Commission on Building and Fire Codes (CCBFC) and the Commission itself will take the time to properly evaluate these be proposals before incorporation.

FEATURE	NBCC	IBC
No. of Stories	12	9
Occupancy	Residential and Business	Residential
Structural Fire Resistance	2-hour	2-hour
"Encapsulation" See explanation	Two layers 5/8-inch Type X Gypsum Board	Two layers 5/8-inch Type X Gypsum Board
Exposed Wood Surfaces	Limited amount of exposed surface for walls and ceilings	Not Permitted

Encapsulation is a new concept to eliminate exposure between the wood surfaces of the CLT members and the room. The intent is to limit the contribution of the wood to the fire intensity within the room and reduce the effects of the fire exposure to the wood element.

Figure 1
Cross Laminated Timber (CLT) Panel

Figure 2
Exposed Mass Timber

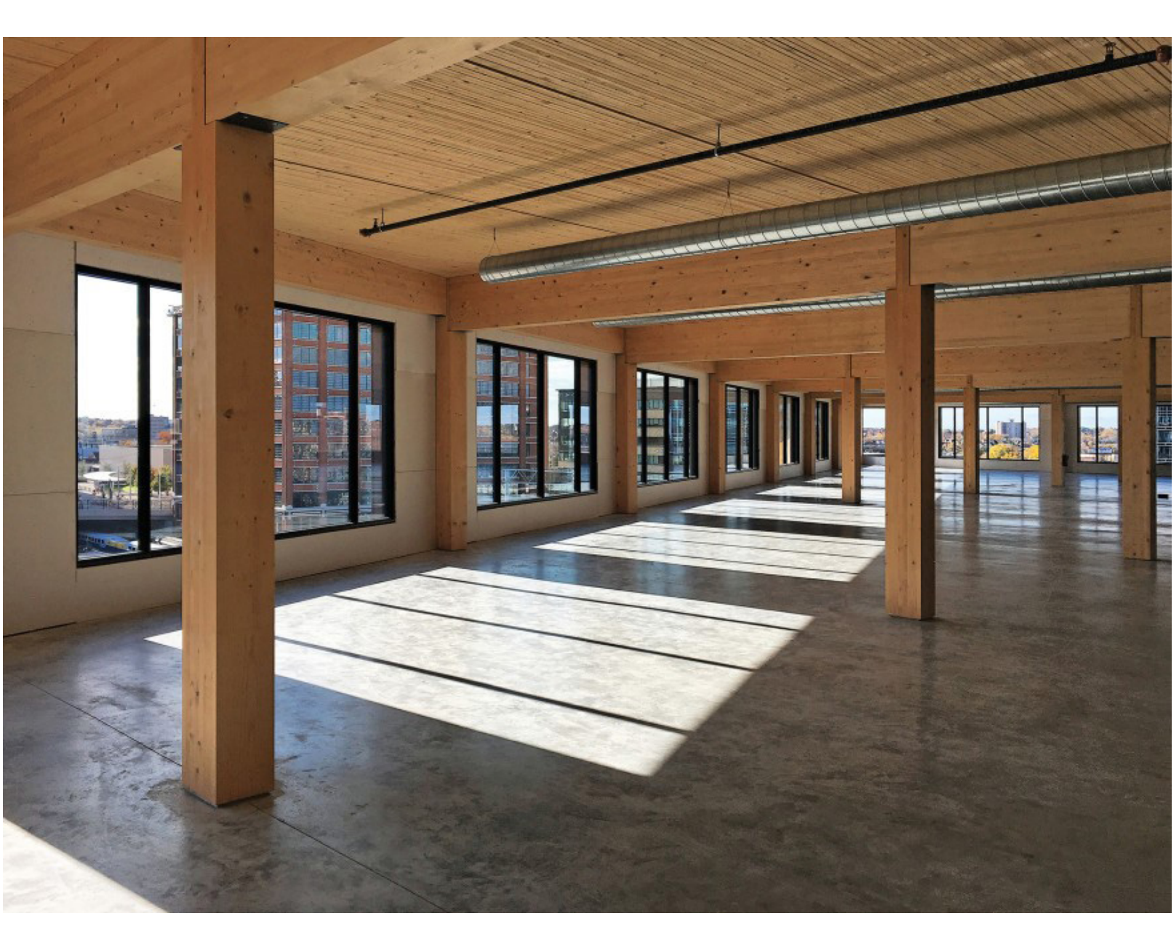

Figure 3
Encapsulated Mass Timber

Figure 4
Proposed 12-Story Mass Timber

2017 CMDC / CCMPA update

Written by CMDC Staff:
Bennett Banting, Ph.D., P.Eng.
Joe Wierzbicki, M.A.Sc., P.Eng.

2017 is shaping up to be a busy year for the Canada Masonry Design Centre (CMDC) and CCMPA research activities. Testing is about to begin at York University on a series of out-of-plane concrete block walls examining an external reinforcement system. A short-term NSERC Engage grant has been secured to provide Dr. Dan Palermo at the newly created Lassonde School of Engineering at York University with funds to create a wall testing set-up at their newly opened laboratory. As part of this initial partnership, we have constructed five walls to be tested at the university to explore an external reinforcement system developed originally at the University Manitoba by Fariborz Hashemian. This project represents the beginning of a new relationship with a start-up civil engineering department at one of the biggest universities in Canada. We look forward to testing to begin in early 2017 and to continue and expand this relationship with Dr. Palermo and his department.

In the fall of 2016 a 5-year research program was begun with Dr. Carl Haas and the University of Waterloo. This research program is supported by CCMPA and CMDC and is examining the stresses placed on masons while laying concrete masonry units. Dr. Haas is an internationally recognized expert on construction engineering, robotics and craft training. He is also the incoming President of the International Association for Automation and Robotics in Construction and has over 145 refereed journal articles and over 350 publications in total. Dr. Haas and his research team are outfitting masons of varying levels of experience with special sensors to monitor their movements and record the stresses in their joints and back as they lay masonry units. The potential outcomes from this research will have far-reaching effects on everything from training, productivity, workplace safety, long-term injuries, block placement and shipment and job satisfaction. Tests are being carried out at the CMDC offices and preliminary test subjects have included apprentices taking classes at the Ontario Masonry Training Centre (OMTC). Initial work has already provided invaluable insight into the effects that proper form and experience have on the stresses experienced by a mason.
Finally, beginning in 2016 Dr. Carlos Cruz-Noguez at the University of Alberta has begun a research program examining the response of tall masonry walls. With initial testing and research focused on assemblage behaviour, Dr. Cruz-Noguez has demonstrated himself to be an incredibly engaged and ambitious researcher. With this initial testing and research project meant to help Dr. Cruz-Noguez and his research team become acquainted with masonry behaviour, plans for long-term research projects are already underway. Through the technical support provided by CMDC and the cash and materials provided by CCMPA and its members, Dr. Cruz-Noguez is another example of how our respective associations have worked together to build up a long-term and sustainable research and education program at a university.

The work being completed at York University, University of Waterloo and University of Alberta could not occur without the partnership between CCMPA and CMDC and the strong commitment from both of these associations and their members. These three projects have all benefited from matching funds from the government and from technical support to help these researchers (who had no previous masonry experience) bring their respective areas of expertise to our industry.
We look forward to the outcomes of these projects and their impacts to future codes, standards, manufacturing and construction practices and training.

TG on Combustible Construction

Written by: Stephen V. Skalko, P.E. & Associates, LLC

Working Group 1 - Construction Type - Encapsulated Mass Timber Buildings

The following are two items covered at the very last part of the recent WG-1 conference call you should find of interest.

1. The WG-1 discussed again the partial encapsulation provisions in 3.1.18.4 (4). Chair Harold Locke questioned what documentation was available to support the percentages of exposed wood in a compartment being suggested by the proposal. Rod McPhee (CWC) acknowledged there is not much but hopes some will be forthcoming. He (Rod) mentioned the fire testing that is in the works here in the States through our ICC Tall Wood Buildings Committee. I reported that testing is expected to be performed in Mid-March. Locke decided that the provisions in 3.1.18.4 (4) should move forward with the expectation that additional research to support these provisions may be forthcoming. This remains to be seen.

Related to that, attached is a summary of a presentation made at the World Conference on Timber Engineering in August 2016 that I have found. The presentation is an overview of CLT research and activities in North America. On page 7, Section 3.3 Fire Performance the presentation also acknowledges the issues of partial encapsulation and delamination of CLT members where portions of multiple room surfaces are left exposed.

2. Item 17 of the WG-1 list of items to review concerns connections. During that discussion I again raised the question that little information has been provided by the wood industry (in the States and Canada) about protection of connections for mass timber from fire. Even proprietary connections approved and used in Europe are not being shared in the meetings I have attended. McPhee's response was that this is an issue for all materials (i.e. concrete, steel) in the Canadian code and wood should not be singled out. However it was pointed out that is not necessarily the case. Common connections of steel members are protected by such things as sprayed fire proofing materials. Concrete by the concrete cover (And masonry in some cases). And I shared how this discussion in the States indicate that the connections for mass timber such a screws and bolts, when exposed to heat from a fire, cause the steel to begin a charring effect on the wood thus weakening the connection. We have also been told at our meetings in the States that products such as intumescents are not a suitable solution because they do not prevent this charring interaction of the steel screws and bolts with wood mentioned above. This was left as an open item. Of note - Dominic Esposito (NRC Staff) mentioned that a report of some type is expected in about a month with more details on connections and the expected research still needed.

CCMPA Members meeting

Halifax
Thursday, June 1st 2017
Dinner
Friday, June 2nd 2017
Meeting

CMCA 50th Anniversary

Convention – Halifax
Friday, June 2nd to
Sunday, June 4th 2017

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