



**Report of the Expert Panel
on Glass Panels in Balcony Guards**

March 30, 2012
Toronto, Ontario
Revised: June 5, 2012

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In Balcony Guards**

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Introduction

During 2011, news media reported a number of instances of breakage of glass panels within balcony guards on several residential high rise buildings in Toronto. These buildings were built by separate developers. In each reported failure, numerous small pieces of glass fell to the ground. In one instance, it was reported in the media that a member of the public sustained minor injuries.

In response to requests from the City of Toronto and the Residential Construction Council of Ontario, to amend the Building Code to address the falling balcony glass panel problem, the Ministry of Municipal Affairs and Housing established the Expert Panel on Glass Panels in Balcony Guards.

The Panel's mandate was to make recommendations on whether and how the Building Code may be amended to address the problem of the breakage of balcony glass and its risk to persons nearby. It was not the mandate of the Panel to make findings of fault or assign blame.

The Panel included approximately 25 individuals with representatives from all key stakeholder organizations. Stakeholder interests represented on the panel included: engineering consultants; building code consultants; developers and contractors; professional designers; municipal building departments; the insurance sector (Tarion Warranty Corporation and the insurance provider for Architects); codes and standards (National Building Code and the Canadian Standards Association).

The Panel was chaired by staff from the Building and Development Branch (Ministry of Municipal Affairs and Housing). The Panel held five meetings from January to June 2012. At its final meeting on June 5, 2012, the panel voted unanimously to send the report to the Ministry for consideration.

Reports

A number of presentations were made to the Panel.

Gerald Genge, P. Eng. reported that there were about 30 incidents of glass guard breakage during 2010 and 2011 on 11 buildings in Toronto. His findings were that breakage occurred primarily in guard panels using tempered glass. He noted that earlier breaks were repaired without notice to the City of Toronto Building Department. The frequent glass breakage on buildings in downtown Toronto became a public concern resulting in news reports and industry magazine articles. He reported that the City of Toronto issued 9 "Orders to Remedy Unsafe Building", pursuant to the Building Code Act, between December 2010 and August 2011, to the owners of buildings that experienced balcony glass breakage. The City of Toronto engaged GRG Building Consultants as a "peer review consultant" to examine reports from engineering consultants on 6 of the buildings that experienced balcony glass breakage.

Dylan Aster, City of Toronto, tabled a report, "Report on: Balcony Glass and Guard Matters", dated January 24, 2012, prepared by GRG Building Consultants. This report reviewed engineering consultants' reports on glass breakage that occurred at the following buildings in Toronto:

- 37 Grosvenor Street
- 38 Grenville Street
- 1 Bedford Road
- 246 - 252 Sackville Avenue
- 1 & 25 Cole Street
- 80 John Street

The report identified the glass failure mechanisms as nickel sulphide (NiS) inclusions in the glass and glass-to-metal proximity.

Mark Brook, P. Eng., reported that he had investigated the glass breakages at a number of buildings. His finding was that the primary cause of the glass failures was NiS inclusions. He also identified wind loads on guards and installation defects as secondary risk factors.

Mike D'Agnillo, Vice President of Toro Aluminum Railings Inc., reported that his company installs glass guards in an average of 20 buildings per year and has been in business for 11 years (since 2001). According to him, the glass breakage can be attributed to:

- Deficiencies in railing installation
- Balcony glass is not designed with glass breakage in mind
- Impact-related incidences
- NiS impurities in glass

Design Trends

Gerald Genge, P. Eng. presented an article commenting on the trend to increasing the amount of glass in balcony designs:

“Over the past 20 or so years the amount and prominence of glazing has increased in several ways:

- Balcony length is increasing such that rather than units having individual balconies, the balcony is becoming a continuous perimeter element on some faces.
- Individual glass panels are longer, higher, and thicker. Guard framing has moved from smaller panels mounted on the top of the slab to larger panels mounted on the face of the balcony slab. To sustain specified loads from wind and soft impact, this increase in the height of glass increases the required thickness. The thicker the glass, the more likely it is to include an impurity that can cause breakage.
- Framing around glass panels is reduced or eliminated in some instances. This requires even greater glass thickness to compensate for the reduced structural contribution from framing.”

“With each step in glass balcony guard design, there has been a compensating increase in the glass area and, thus, thickness. From a purely structural perspective, the increase in glass thickness and area is not a serious issue. All aspects of the glass performance in regard to strength and deflection can be accommodated. However, the larger and thicker glass panels are heavier. A panel of 6 mm thick (1/4") glass that was 9 sq ft weighed about 30 lb: whereas the 12 mm (1/2") glass in larger panels spanning over floor slabs and as large as 20 sq ft can weigh over 100 lb. The difficulty in handling of such large pieces of glass on the building, situating those pieces in frames, and assuring appropriate clearances are maintained between glass and metal framing components increases as the mass of glass increases.”

Building Code

Dan Mitta, OAA, reported that Ontario’s Building Code is harmonized with the model National Building Code of Canada with respect to the requirements for glazing in guards in high rise residential buildings. Sentence 4.3.6.1.(1) of Division B of the Building Code requires glass used in buildings to be designed in conformance with the CAN/CGSB-12.20-M89 "Structural Design of Glass for Buildings" standard. This standard requires that glass installed in locations subject to human impact be safety glass conforming to the CAN/CGSB –12.1 –M90 “Tempered or Laminated Safety Glass” standard.

Glass in guards of smaller buildings (subject to Part 9 of Division B of the Building Code) are required to conform to Sentence 9.8.8.7.(1) of Division B of the Building Code. This Sentence requires glass in guards to be laminated or tempered safety glass conforming to the CAN/CGSB-12.20-M89 "Structural Design of Glass for Buildings" standard or wired glass conforming to the CAN/CGSB-12.11-M99 “Wired Safety Glass” standard.

Types of Glass

The Building Code requires glass in balconies to be tempered or laminated safety glass. For a given thickness of glass, tempered glass is less expensive than laminated glass.

Float Glass:

Float glass is a sheet of glass made by floating molten glass, at a temperature of approximately 1200°C, on a bed of molten metal. NiS inclusions can occur if nickel-rich contaminants are present and are combined with sulfur in the manufacture of float glass. A single gram of nickel can contaminate thousands of tonnes of glass. Base float glass is not a safety glass and is not used for balcony guards because it tends to break into large, jagged shards. However, it is the base material that is further processed into tempered glass and laminated glass.

Tempered Glass:

Tempered safety glass is float glass which is heated to a temperature of approximately 600°C and is subsequently cooled rapidly by cold air. Tempered safety glass is much stronger than base float glass. If broken, safety glass tends to shatter into small fragments. Tempered safety glass cannot be cut, ground, or drilled after it is tempered. During the manufacture of tempered glass, the heat treatment causes the NiS inclusions in the glass to change size. When cooled rapidly, the NiS inclusions are unable to change completely back to their original form. Over a period of time (anywhere from a few months to a number of years), the NiS inclusions will slowly convert back to their original form but will increase in volume. That increase in size can cause breakage. However, the mere presence of NiS impurities in a glass panel does not mean that the glass is doomed to break.

Heat Soaked Tempered Glass:

Heat soaked tempered glass is tempered glass that has been treated in a chamber by raising the temperature to approximately 290°C to accelerate the expansion of NiS inclusions. This causes glass containing NiS inclusions to break in the heat soak chamber, rather than on-site in the balcony guard. The heat soaking process is not 100 percent effective and increases the cost of the glazing. European Standard EN 14179 is the most common standard used to specify heat soaking of glass.

Laminated Glass:

Laminated glass is a combination of two or more glass sheets laminated to one or more layers of plastic foil under high temperature and pressure. In case of breakage, laminated glass does not shatter into small pieces. It will break, but the glass pieces remain bonded to the foil.

Prescriptive Solution vs. Risk Assessment Model

Greg Hildebrand, P. Eng., reported that there is no substantive guidance regarding the design and use of balcony guard rail systems other than the information given in the Building Code (i.e., there is no applicable reference standard).

He reported that there is no specific guidance given in existing Building Codes and standards regarding the use of tempered and laminated safety glass for use in balcony guard rail systems. There is no mandated guidance regarding post-breakage retention for glass infill panels or balustrades. Also, there are no mandated test procedures to evaluate a balcony guard system for guard load, wind load and impact testing. There is limited to no guidance regarding the materials and design of balcony guard rail assemblies.

He presented a risk assessment model based on the publication “Guidance On Glazing at Height”. The Expert Advisory Panel found this proposed approach the most valid from a scientific point of view. However, concerns were expressed that the solution should be readily enforceable and that the development of a risk assessment model could not be completed in the time allotted for the Panel to complete its report. The Panel suggests that the risk assessment model be considered by the CSA’s technical committee on the proposed Standard on Balcony Guard Rails.

The Panel reviewed a number of prescriptive approaches, including limitations on balcony glazing based on:

- the location of the balcony in relation to pedestrian areas below;
- the location of the balcony glazing in relation to the edge of the balcony floor;
- the height of the building;
- the occupancy of the building; and
- whether the balcony was on the exterior of the building or inside the building.

In view of time and enforcement limitations, the Panel compromised on making recommendations of a prescriptive nature based on the 4 latter considerations.

The recommendations of the Panel are based on the expectation that any Building Code amendments will be interim solutions until the CSA’s proposed Standard on Balcony Guard Rails is published and adopted by the Building Code.

Structural Design

Although none of the reports received by the Panel identified wind as a direct cause of glass breakage, considerable discussions were held concerning acceptable procedures for structural design of guards.

Greg Hildebrand, P. Eng., reported that designers follow different approaches in the design of their guard rail systems. Some consider the guard loads independently. Others consider guard and wind loads separately while some consider the combination of both.

For wind, two methods are employed to establish load. The first method involves the calculation of the wind load according to the procedure given in Part 4 of Division B of the Building Code. The second method involves obtaining estimates using a wind tunnel study.

The first method would result in a conservative combined wind and guard load if guard elements are not considered “structural components” referenced in 4.1.3.2.(1) of Div. B. Wind tunnel results could result in a lower wind load for the overall structure, and extreme wind loading at the building edges, such as guard locations. It was noted that there are a number of arguments from other jurisdictions that support the practice of employing guard and wind loads independently. It is anticipated that the question will be explored in greater detail by others in the future.

The panel agreed that, due to the divergent views amongst designers on consideration of guard and wind loads, clarification of the Building Code requirements is necessary.

In response to a request from the Panel, Cathy Taraschuk, P. Eng., provided the Panel with a memo, dated March 8, 2012, from the Task Group on Live Loads Due to Use and Occupancy of the Standing Committee on Structural Design on the applicability of the load combinations listed in Table 4.1.3.2.A. of Division B of the 2010 model National Building Code (similar to Table 4.1.3.2. of Division B of Ontario's Building Code).

The memo stated:

“In discussing the appropriate combination, the Task Group noted that case 2, with the full live load coupled with a reduced wind load (via the 0.4 factor) is a plausible scenario. By extension, it is also plausible that some fraction of the live load may be present during the design wind event as per load combination 4. As such, the opinion of the Task Group on Live Load Due to Use and Occupancy regarding exterior balcony guards is that the live load needs to be considered in combination with the wind load via load combinations 2 and 4.

The Task Group did note that the wind load, when combined with the live load, should be the outward wind load (i.e. acting as a suction load on the guard) that is applied in combination with the outward guard load, and as a separate case, the inward wind load (i.e. acting as a pressure load on the guard) that is applied in combination with the inward guard load. The Task Group is in the process of revising Sentence 4.1.5.14.(1) to maintain the outward guard live load at the stated values, but prescribe lower inward guard loads.”

The memo also confirmed that the reference to “structural components” in Sentence 4.1.3.2.(1) of Division B of the Building Code includes guard elements.

The Panel requested that the advice provided in the memo should form part of an Appendix Note to the Building Code to clarify the existing provisions.

Review of Other Jurisdictions

Gerald Genge, P. Eng. reported that the Singapore Building and Construction Authority issued a communication on January 10, 2011 advising that, effective on July 1, 2011, tempered glass is no longer permitted for use as a part or whole of a safety barrier. Laminated glass must be used.

Expert Advisory Panel Recommendations

1. Scope of Building Code Amendment

The Expert Advisory Panel's recommendations for amendments to the Building Code are intended to reduce the probability of:

- (a) breakage of glass panels; and
- (b) injury to persons in the vicinity of a building as a result of falling broken glass.

The Expert Advisory Panel examined a number of approaches to reduce the risk of injury from the breakage of balcony glass, including:

- (a) a matrix-based risk assessment; and
- (b) prescriptive-based solutions.

Building Code enforcement officials expressed the view that there should be a prescriptive option available to allow permit applicants to demonstrate compliance that would allow regulators to verify compliance with any new requirements, on a "go-forward" basis.

Ontario's Building Code is written in an objective-based format in order to facilitate and encourage the use of alternative solutions to the prescriptive solutions contained in Division B of the Code. Therefore, it is expected that the prescriptive-based solutions would form the benchmark for evaluating matrix-based risk assessment alternative solutions. This approach will continue to allow for some flexibility and design choice for architects, engineers, developers, and the construction industry.

The Expert Advisory Panel agreed that the prescriptive-based solutions should apply to all glazing in exterior and interior guards in buildings of all occupancy classifications, except houses.

Panel members agreed that the proposed recommendations would significantly improve existing Building Code requirements and would help ensure public safety by reducing the probability of injury due to glass failure.

The following recommendations were passed by a unanimous vote, unless otherwise noted:

Recommendation # 1

That the Building Code be amended to provide supplementary prescriptive requirements for all glazing in interior and exterior guards in all buildings, except houses (this excludes: detached houses, semi-detached houses, duplexes, triplexes, town houses, and row houses).

2. Glass Contact

The Expert Advisory Panel recognizes that no breakages attributable to glass-to-metal contact were reported. However, it is known that glass-to-metal or glass-to-hard surface contact increases the risk of glass breakage. The glass contact may occur as a result of deflection or installation methods.

The Building Code already mandates that glass be designed to accommodate deflection. Any proposals to amend the Building Code to restate this requirement would be stating the obvious to designers of glass balcony guards. However, it may not be as obvious to guard installers as they may not be aware of the deflection allowance that is incorporated into a given design.

The Expert Advisory Panel agreed that glass to hard surface contact in all deflection cases has to be avoided.

Recommendation # 2

That consideration be given to clarifying that direct glass contact with any metal or similar hard elements is to be avoided and to require sufficient allowances for deflection and movement under loads and temperature changes. This clarification could be included as a note in the Appendix to the Building Code.

3. “Outboard” Glazing

The Expert Advisory Panel agreed that guards incorporating glazing at or beyond the edge of a balcony floor present a greater risk of injury to persons below in the event of failure of the glazing. The arrangement of glazing at or beyond the edge of a balcony floor is known as an “outboard” design. The use of heat strengthened laminated glass, designed to be held in place in the event of breakage, would reduce the risk of injury to persons from falling glass.

Recommendation # 3

Where it is incorporated in a guard, glazing located beyond the edge of a floor, or within 50 mm of the edge of a floor, shall be heat strengthened laminated glass that is designed, fabricated, and erected so that, at the time of failure of the glass, the glazing does not dislodge from the support framing,

Setback for use of Heat Strengthened Laminated Glass: Views expressed by some panel members (6) was that there is no technical rationale for the proposed 50 mm dimension.

4. Glazing Located More than 50 mm to 150 mm Inward of the Edge of a Floor

The risk of injury to persons from balcony glazing located more than 50mm inward from the edge of a floor is less than that from “outboard” glazing. While laminated glass is acceptable for this application, heat soaked tempered glass should also be acceptable because the risk of on-site breakage due to NiS inclusions is significantly reduced as a result of the heat soaking process. Therefore, it was agreed that fully heat soaked tempered glass or heat strengthened laminated glass should be used in these applications.

Recommendation # 4

Where it is incorporated in a guard, glazing located more than 50 mm to 150 mm inward from the edge of a floor shall be fully heat soaked tempered glass or heat strengthened laminated glass that is designed, fabricated, and erected so that, at the time of failure of the glass, the laminated glazing does not dislodge from the support framing.

Distance from Slab Edge: Some panel members (6) did not agree with the rationale for permitting the use of heat soaked tempered glass between 50 and 150 mm in lieu of heat strengthened laminated glass. These panel members recommend that heat strengthened laminated glass be used in any guard condition where the intended location of the glass is within 150 mm of edge of the balcony slab.

5. Glazing Located More than 150 mm Inward of the Edge of a Floor

Where balcony guard panels are located more than 150 mm inward from the edge of the balcony slab, there is less likelihood that glass particles will fall over the edge of the balcony if broken due to spontaneous breakage. Based on information presented, 6mm or thinner tempered glass has a lesser chance of spontaneous breakage due to nickel sulphide inclusions than thicker tempered glass.

Recommendation # 5

Where it is incorporated in a guard, glazing located more than 150 mm inward from the edge of a floor shall be heat strengthen laminated glass or heat soaked tempered glass. However, tempered glass (not heat soaked) is permitted where the glazing does not exceed 6 mm in thickness. Guards using heat strengthen laminated glass must be designed, fabricated and erected so that, in the event of failure of the glass, the glass does not dislodge from the support framing.

Use of 6 mm tempered (not heat soaked tempered): Some panel members (5) did not agree with the use of 6 mm or any thickness of non- heat soaked tempered glass. It was the opinion of these panel members that glazing located 150 mm, or more, inward of the edge of the building, in a guard, should be heat-soaked tempered glass or heat-strengthened laminated glass.

6. Structural Design

Since the publication of the 2006 edition of the Building Code, there have been different interpretations of how combined loads on balcony guards should be considered - whether independently, or in combination. The memorandum provided by Cathy Taraschuk, P. Eng. helped to clarify the intent of the Building Code.

Recommendation # 6

That the memorandum, dated March 8, 2012, from Cathy Taraschuk, P. Eng., reporting on the advice of the Task Group on Live Loads Due to Use and Occupancy of the Standing Committee on Structural Design on the applicability of the load combinations listed in Table 4.1.3.2.A. of Division B of the 2010 model National Building Code be included as an Appendix to the Building Code.

Two panel members abstained from voting.

7. CSA Standard for Guards

CSA Group is a not-for-profit membership-based association serving government, industry, and consumers in Canada and North America. It maintains more than 3,000 accredited, consensus standards, many of which are referenced in Ontario legislation and thus form an essential link in protecting the health and safety of the people of Ontario, quality of life, environment, and facilitating trade. Standards are developed by volunteer subject matter experts who represent various interest groups, ensuring relevant and balanced stakeholder participation. CSA Group's Standards development process and experience adds credibility to the ensuing technical content.

CSA's standards intended for reference in the Building Code are developed using a consensus-based process that is accredited by the Standards Council of Canada. CSA Group has requested major stakeholders to participate in the development of a new CSA Standard on Balcony Guard Rails and will convene the first meeting of the technical committee within the next 60 days. CSA Group will work with this new technical committee to prioritize and address technical issues, so as to ensure that the new Standard substantially augments this Panel's proposals to amend the Building Code. Recognizing that timeliness as well as completeness are important, CSA Group's goal is to release this new Standard within a 24 to 36 month time frame.

Recommendation # 7

That the Ontario Ministry of Municipal Affairs and Housing:

- (a) support the development of the proposed CSA Group Standard on Balcony Guard Rails; and
- (b) will consider referencing the CSA Group Standard on Balcony Guard Rails, once it is published, in the Building Code.

End of Recommendations.

Terms of Reference

Expert Advisory Panel on Breakage of Glass Panels in Balcony Guards

The Ministry of Municipal Affairs and Housing is establishing an Expert Advisory Panel to conduct a review and provide advice to the Ministry on Building Code standards for glass panels in balcony guards. This is to help ensure public safety and provide more clarity and certainty for industry.

These Terms of Reference set out the mandate and scope of the Panel's review.

Mandate

The Expert Advisory Panel ("Panel") will review existing requirements in the Building Code for glass panels in balcony guards and will make recommendations to the Ministry of Municipal Affairs and Housing ("Ministry") concerning possible amendments to the Building Code standards that may be desirable to help provide clarity and certainty and ensure public safety.

The Panel will also provide the Ministry with potential recommendations that may be forwarded to the Canadian Commission on Building and Fire Codes for consideration in the development process for the model National Building Code.

The Panel is to focus its review on the Building Code requirements for glass panels in balcony guards. Other entities are investigating specific occurrences of balcony guard glass panel failures. The Panel's review is not a review of such occurrences and the review will not make any findings of fault.

Scope of the Review

In carrying out its mandate, the Panel will:

- Review relevant information and reports provided by the Ministry;
- Review standards referenced in the Building Code;
- Review reports provided by the City of Toronto prepared in the course of the City's review of occurrences of failures of glass panels in balcony guards and other information provided by the City;
- Collect and review other relevant information including consultant reports and information on international codes, standards and practices; and
- Consult with experts, as determined by the Chair of the Panel.

The Chair may invite experts who are not members of the Panel to make presentations or submit information and reports for consideration by the Panel.

The criteria the Panel will consider when evaluating recommendations include:

- Impact on public safety;
- Impact on building cost and design flexibility; and

- Impact on the building industry's (including designers, contractors, manufacturers and installers) capacity to supply and install the product.

Other Work of the Panel

The Panel will provide a forum for entities participating in the Panel to discuss the Building Code standards for glass panels in balcony guards. Individual Panel members may potentially discuss alternative designs for glass panels in balcony guards and their installation in buildings where balcony guards are being repaired and buildings currently under construction. However, the Panel's report is to be limited to providing recommendations for amendments to Building Code standards for glass panels in balcony guards and providing the Ministry with potential recommendations that may be forwarded to the Canadian Commission on Building and Fire Codes for consideration in the development process for the model National Building Code.

Support to the Panel

Ministry staff will provide technical and administrative support to the Panel as requested by the Chair. The support provided will be subject to Ministry resources available.

Membership

The Panel will be chaired by Alek Antoniuk, Manager, Building and Development Branch, Ministry of Municipal Affairs and Housing ("Chair").

The Ministry of Municipal Affairs and Housing will invite up to two representatives from each of the following entities to sit on the Panel:

- City of Toronto
- Ontario Building Officials Association
- Large Municipalities Chief Building Officials Group
- Building Industry and Land Development Association
- Ontario Home Builders' Association
- Residential Construction Council of Ontario
- Tarion Warranty Corporation,
- Ontario Association of Architects
- Pro-Demnity Insurance Company
- Professional Engineers of Ontario
- Toro Aluminum Railings (Balcony installer)
- Canadian Standards Association (Standards writing association)
- Canadian General Standards Board (Standards writing association)
- EXP. (Engineering Consultants)
- DT Prohaska Engineering (Engineering Consultants)
- BVDA Façade Engineering Ltd. (Engineering Consultants)
- Larden Muniak (Building Code Consultants)
- Randall Brown and Associates (Building Code Consultants).

The Panel will be comprised of the Chair and the representatives of the above entities that accept the invitation to sit on the Panel.

The Chair may establish working groups of the Panel to consider issues and report back to the Panel.

Decision-Making Process

The Panel will endeavour to achieve a consensus on recommendations to the Ministry.

Where consensus is not achieved, the Panel's report to the Ministry will set out recommendations agreed to by a majority of the Panel, and will also set out the positions of the other Panel members.

Timing

The first meeting of the Panel will be convened by the Chair in late December 2011 or early January 2012.

The Ministry will provide background information to the Panel in advance of the first meeting.

The Panel will meet in person every two weeks, or as determined by the Chair, during its mandate. The panel will rely on emails and telephone communication between meetings.

The Panel will provide a report to the Ministry setting out the results of the Panel's review and its recommendations as soon as possible, and no later than March 30, 2012.

Upon the provision of the Panel's report to the Ministry, the work of the Panel will be fully completed.

Other matters

The Panel's discussions will be confidential.

Travel expenses will be reimbursed upon request in accordance with Management Board of Cabinet's Travel, Meal and Hospitality Expenses Directive.

Appendix B

Members of the Expert Advisory Panel

Member	Organization
Alek Antoniuk, Chair	Ministry of Municipal Affairs and Housing
Mark S. Brook	BVDA Facade Engineering Ltd.
Greg Hildebrand	Exp.
David Prohaska	DT Prohaska Engineering
Gerald R. (Jerry) Genge	GRG Building Consultants Inc.
Allen Larden	Larden Muniak Consulting Inc.
Randal Brown	Randal Brown & Associates Engineering Ltd.
Jeff Wilkinson	Concord Adex Developments Corp.
David Spiegel	Tribute Communities
Bruno Giancola	Tridel Corporation
Bernie Torchia	Monarch Corporation
Sam Tassone	The Daniels Corporation
Michael Steele	Residential Construction Council of Ontario
Mike D'Agnillo	Toro Aluminum Railings Inc.
Willy Wong	City of Mississauga
Chung Li	Town of Markham
Wade Tam	City of Toronto
Dylan Aster	City of Toronto
Blandford Gates	Fliess Gates McGowan Easton / Architects Inc.
Tim Gorley	Page + Steele/IBI Group Architects
Bernard Ennis	Professional Engineers Ontario
John Hackett	Pro-Demnity Insurance Corporation
Gabriella Levrero	Tarion Warranty Corporation
Michael Mortimer	Canadian Standards Association
Cathy Taraschuk	Canadian Codes Centre
J.P. Ferron, Secretary	Ministry of Municipal Affairs and Housing

The Panel thanks the following observers who provided valuable information, reports, and comments:

Bhanmik Shah - BVDA Facade Engineering Ltd.

James Lischkoff - EXP.

Dr. Peter Vegh - EXP.

George Douramakos - State Railing Corp.

Mario Angelucci - City of Toronto

Dan Mitta - Ministry of Municipal Affairs and Housing

**TASK GROUP ON LIVE LOADS DUE TO USE AND OCCUPANCY
MEMORANDUM**



National Research Council Canada Conseil national de recherches Canada

Institute for Research in Construction Institut de recherche en construction

MEMORANDUM

DATE March 8, 2012

TO Expert Advisory Panel on Glass Panels in Balcony Guards
via J.P. Ferron

FROM Technical Advisor, Standing Committee on Structural Design
Cathy Taraschuk

RE: **Loads on Balcony Guards**

The Task Group on Live Loads Due to Use and Occupancy of the Standing Committee on Structural Design held their tenth meeting on March 1, 2012, in Toronto. At the request of the Expert Advisory Panel on Glass Panels in Balcony Guards, the Task Group considered the question of which load combinations on exterior balcony guards should be considered.

The relevant load combination table from the NBC 2010 is

Table 4.1.3.2.A.
Load Combinations Without Crane Loads for Ultimate Limit States
Forming Part of Sentences 4.1.3.2.(2) and (5) to (10)

Case	Load Combination ⁽¹⁾	
	Principal Loads	Companion Loads
1	1.4D ⁽²⁾	—
2	(1.25D ⁽³⁾ or 0.9D ⁽⁴⁾) + 1.5L ⁽⁵⁾	0.5S ⁽⁶⁾ or 0.4W
3	(1.25D ⁽³⁾ or 0.9D ⁽⁴⁾) + 1.5S	0.5L ⁽⁷⁾ or 0.4W
4	(1.25D ⁽³⁾ or 0.9D ⁽⁴⁾) + 1.4W	0.5L ⁽⁷⁾ or 0.5S
5	1.0D ⁽⁴⁾ + 1.0E ⁽⁸⁾	0.5L ⁽⁷⁾ + 0.25S ⁽⁶⁾

The question posed was whether or not the live load should be considered in combination with the wind load. The Expert Panel's assertion was that it is unlikely that the full live load will be realized during the design wind event.

In discussing the appropriate combination, the Task Group noted that case 2, with the full live load coupled with a reduced wind load (via the 0.4 factor) is a plausible scenario. By extension, it is also plausible that some fraction of the live load may be present during the design wind event as per load combination 4. As such, the opinion of the Task Group on Live Load Due to Use and Occupancy regarding exterior balcony guards is that **the live load needs to be considered in combination with the wind load via load combinations 2 and 4.**

The Task Group did note that the wind load, when combined with the live load, should be the outward wind load (i.e. acting as a suction load on the guard) that is applied in combination with the outward guard load, and as a separate case, the inward wind load (i.e. acting as a pressure load on the guard) that is applied in combination with the inward guard load. The Task Group is in the process of revising Sentence 4.1.5.14.(1) to maintain the outward guard live load at the stated values, but prescribe lower inward guard loads.

