High-Rise Apartment Repair

Needs Assessment

by
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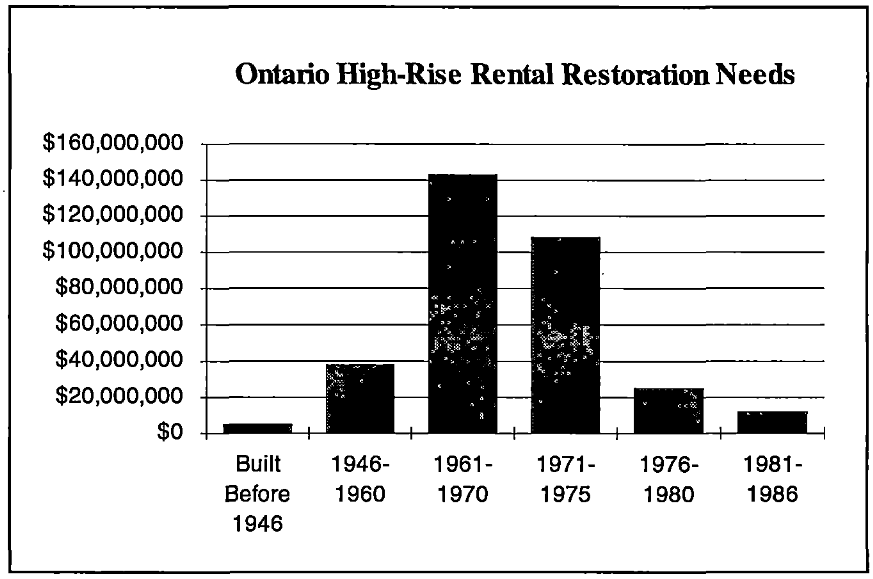
Impediments to Effective Repair

The Scope of The Problem

The majority of the housing stock has reached an age of 25 to 30 years and is in need of high levels of capital investment. This work is distinct from normal maintenance because, eventually, building components wear out or become deteriorated or become obsolete. Then major repairs and/or replacements of components and systems must be performed in these aging buildings. A study performed for the Fair Rental Housing Organization (FRPO) in 1991 concerning Ontario high-rise housing determined that $350 Million ought to be spent on an annual basis on private rental buildings. The majority of these buildings were constructed in the 1960s and 1970s.

The chart opposite indicates the study results. These are annual costs for repair. The study also pointed out that on a per building basis, it should not be unusual to have to spend in excess of $1.3 Million toward capital repair or replacement for a building constructed in between 1971 and 1975. Similarly, because of increased age and other features of the building that are capital repair intensive, the cost for capital repair or replacement of buildings constructed between 1961 and 1970 could be expected to be in excess of $2.3 Million. Since that study was an assessment of high-rise rental buildings only, the impact of the condominium and cooperative and non-profit housing repair costs is not shown. It is probable that the costs for repair of the average condominium or private or public non-profit housing building is only marginally less than that of high-rise rental buildings of comparable age and type. Repairs would, however, likely be performed more frequently on high-rise condominium and non-profit housing possibly due to the existence of reserve funds for condominiums and private non-profit cooperatives and, perhaps due to pressure on 'government' funded buildings to maintain at least a minimum standard. There is no substantive body of evidence to support this speculation and it is expected that there will be considerable variation in the repair needs for buildings of all owner groups.



The trend to lesser costs in the late 1970s and 1980s shown in the FRPO study should be not be interpreted as an indication of better buildings in those years. The reduction in costs shown for the 1976 to 1986 period is due to the substantial reduction in high-rise rental building construction brought on by rent regulations in Ontario. High-rise buildings continued to be constructed and, as rent regulations came into place in 1975, the construction of condominium buildings increased to keep pace with the need for high-rise apartments and lower cost housing. As such, the costs for repair in the late 1970s and 1980s should be on the increase purely because more buildings were being built.

Using the Building Typology Approach to Repair Assessment

Initial Building Design Characteristics are the Key to Repair Needs

In a study performed for the City of Toronto on high-rise rental buildings, a different approach was used to evaluate the probable costs for repair. On the basis of the objective of understanding the scope of the repair needs and the overall costs for the population of 464 high-rise rental properties, a typology approach to repair needs was established. On the basis of the consultant's experience and recognizing that certain aspects of design resulted in certain typical repair requirements, buildings of different age groups were characterized and expected repair needs were assessed. From this, costs were applied and aggregate expenses were computed. The costs were assessed in terms of the initial costs to bring buildings back to a satisfactory level of performance and then the expected ongoing costs for maintaining buildings at that level.

The characteristics found to most influence the repair costs were associated with specific elements of the building. In particular, Cladding, Windows, Roofs, Balconies, Garage and Exposed Structural Elements tended to dictate the level of expenditure. Other items, such as elevator control modernization, and heating system retrofits and replacement of domestic water systems were also included when appropriate; however, the cost of these items did not affect the overall costs to the same degree as the envelope issues.

The costs determined using this approach follow.

Per Unit Conservation Costs (City of Toronto Apartment Conservation Study)

Typical Building Age	Average Start-Up Costs	Annual Ongoing Costs
1950s	$8,600 per Unit	$510 per Unit
1960s	$7,200 per Unit	$500 per Unit
1970s	$1,400 per Unit	$390 per Unit
1980s*	less than$1,000 per Unit	$495 per Unit

* Estimate by GRG Building Consultants Inc.

Projected Costs for All Private Rental Buildings (City of Toronto Apartment Conservation Study)

Age	Total Start-Up Costs (Millions)	Total Annual Ongoing Costs (Millions)
pre 1950s	$42.2	$3.5
1950s	$106.1	$11.9
1960s	$218.2	$14.6
1970s	$24.8	$7.0
1980s*	$5 to $10	$1.5
Total	**$400**	**$38.5**

* Estimate by GRG Building Consultants Inc.

These estimates are based on the repair of material deterioration and the work needed to comply with safety issues often cited as the basis of municipal work orders. The work did not include aesthetic repairs or upgrades to new standards.

This approach is useful if the objective is to establish the cost impact on a large portfolio. It is not applicable to individual buildings and should not be considered to be an appropriate method of assessing the costs for repair of a specific property. If a specific property is to be assessed, appropriate means of investigation of the particular performance problems would be required together with the relevant cost assessments.

Appendix A at the end of this paper gives three examples of buildings from three different owner groups. These are presented to illustrate the impact of the various building components and systems on the overall costs.

Example 1: A 23-Year Old Condominium Building in Good condition

This 20-storey condominium building has 273 units and is constructed with systems typical of a building of the vintage. The walls are brick masonry with block back-up, the windows are single glazed with separate storms and large operable sliders, the garage has two-levels below grade and each Unit has an exposed balcony. The roof was repaired at 20 years and the garage was repaired after 15 years on unprotected use. The building's reserve fund stands at over $1 Million.

The more significant expenses that this building will incur over the next 20 years include the repaving of the driveways and parking, replacement of the garage waterproofing and slab repairs, replacement of HVAC systems, domestic water systems and plumbing, modernization of the elevator controls and refinishing the common area rooms. This will involve over $4 Million in capital expenditure; however, the building has been putting over $600 per month for each Unit into the reserve fund for these expenses and will have no trouble paying for the needed work as it becomes necessary including the upgrade of finishes. The building would be considered to be in the low end of the 'luxury'-style of condominium.

Example 2: A 25-Year Old Public Housing Apartment Complex in Fair-to-Poor Condition

This complex of 4 buildings houses over 1,500 Units. It is constructed in much the same way as the condominium noted above having brick and block walls, single-glazed plus storm windows with operable sliders, a two-level garage, and balconies. The garage was not repaired at the time this complex was examined in 1986.

The windows were considered by the owner/agency to be in need of replacement at an expected cost of $3.75 Million. This decision was based on poor condition and operation and anticipated energy efficiencies. A simple payback for energy savings was not performed as part of this study. Other major expenses included the appliances in the apartments which, unlike condominium corporations, are not the resident's responsibility, the garage slab and roof slab, the balconies and the elevator control modernization. Corridor refinishing was also deemed to be necessary. These repairs and the other lesser cost items were projected to cost over $4.3 Million and were to be phased in over a six-year period. The cost was calculated at $1,439 per Unit per year. There was no reserve fund. Any repairs would be financed from public funds.

Example 3: Two 25-Year Old Apartment Buildings in Poor Condition

These two buildings represent a probable extreme condition. They include 231 Units in two 20-storey buildings. The buildings are largely exposed concrete with minimal brick infill panels. The majority of the non-concrete walls are insulated metal panel and glazing. The garage, unlike the other two examples was constructed above-grade thus avoiding the expense of waterproofing repairs for the garage roof slab.

The buildings had been transferred through several owners over the past ten years and were only 40 percent occupied. In order to make use of the building, the mortgage holder attempted to convert the property to cooperative housing. The costs for repair of material deterioration were expected to be over $15,000 per Unit; the costs to comply with building regulations were calculated at over $5,000 per Unit and the costs to convert the building to accommodate Ministry of Housing requirements were calculated at over $12,000 per Unit. If aesthetic upgrades were also done on the abandoned recreation facilities and the apartment suites at a cost of almost $10,000 per unit, the total expenditure would have been over $9.7 Million or over $42,000 per Unit. The conversion to cooperative housing did not proceed. The building was sold at a cost of less than $20,000 per Unit to cover the outstanding mortgage. The building is still only partially occupied.

These three examples illustrate the range of possible situations that face owners of buildings of similar age and type. In these cases, the typology approach to cost assessment would provide relatively accurate values for the public housing complex buildings of Example 2; however, the immediate repair costs for the condominium of Example 1would be greatly overstated and, in contrast, the immediate repair costs for the two rental buildings in Example 3 would be greatly underestimated.

The limitations in the applicability of the typology approach should not discount its value to the assessment of larger portfolios. There will always be some buildings that have greater or lesser costs than the averages deemed appropriate for the "typical" building.

Characteristic Performance Problems are the Key to Future Research and Technology Transfer Needs

Since the costs for repair tend to focus on the building envelope, it would seem reasonable that the research efforts should also focus on the performance and repair of the building envelope. CMHC research has focussed on this area and has published most of the recent information on air barrier systems, exterior masonry, masonry veneer/steel stud walls, rain screen, etc. Research is still needed on the performance of existing envelope systems with a view to developing cost-effective repairs for the typical failure modes.

For instance, brick veneer on block back-up with a partially filled collar joint was used extensively in the 1960s and 1970s. Many of these buildings exhibit leakage and spalled brick. Many are being overclad with metal siding at a cost of $20 to $25/sq ft. This could represent an expense of $4,000 per unit to the owner of the building. A trail repair has been performed on a building in Mississauga that involves air leakage control and isolated brick repairs at a cost of $1,250 per unit. These repairs are based on a site observations of air leakage and patterns of masonry deterioration and to that extent are based on good engineering principals. The repairs are, however, experimental as are many repairs that are first being tested on real buildings using the owner's money. The owner has accepted the risk knowing that the alternative is over three times the cost. The question must be asked though, should it be necessary that the experimental trials for repairs be conducted in this ad hoc manner instead of under controlled, and conditions that ca be monitored to understand the degree to with the repairs are effective and the savings warranted?

Numerous other examples exist wherein the repairs are an experimental in building science. One of the problems that develops out of these experimental repairs is that the contractor engaged to perform the repair begins to perform the same repair on other buildings where appropriate design professionals are not involved. There are cases where polyurethane foam is being installed as air sealant and insulation in locations where it may not be required. In the extreme cases, masonry repairs at the supporting shelf angles are being proposed by contractors who do not understand the nature of the problem. In one case, the absence of the soft joint under the shelf angle had actually prevented serious structural faults in the back-up steel stud wall from manifestation and had the 'soft joints' been installed, the exterior walls would be in danger of collapse. The contractor's proposal would initially cost the owners $1,600 per unit; however, after the wall failed, the repairs would cost another $8,000 per Unit. If performed in a manner that strengthens the back-up wall and provides the required 'soft joints', the costs would be $6,500 per Unit.

In addition to short-term durability of materials used in buildings, materials incompatibility has also lead to performance problems. Glass and metal curtainwall systems that employ extruded vinyl blocks as water deflectors are sometimes sealed into place with whatever material is available on the swing stage at the time of installation. There are cases where this sealant incompatibility and specification of inappropriate materials is responsible for repairs costing $1,000 per Unit to correct leakage problems. In these cases the designers, installers and some investigating specialists did not understand the nature and effects of this problem.

If research and technology transfer focusses on the diagnosis and repair of performance problems, the savings to owners could be considerable. The key characteristics described above, Cladding, Windows, Roofs, Balconies, Garage and Exposed Structural Elements, identified in the typology approach to building assessment are also the key issues to be addressed in future research and technology transfer.

Effect of Initial Level of Durability and Type of Ownership on Repair Needs

Initial Durability

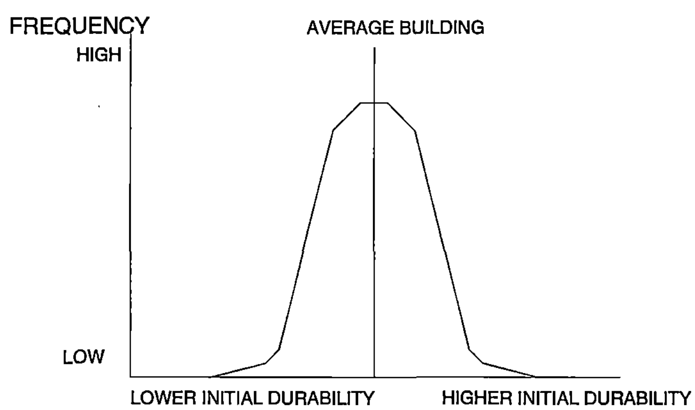
While the typology approach can be useful, it has been noted that each building must be assessed on its own merits and for its particular faults in order to accurately predict the needed repairs. One major reason for the need to examine individual buildings is that, while similar building systems may be used in buildings of similar age and type, the workmanship, materials properties, construction conditions and use exposure differ to some degree for each building. These factors define the initial level of durability of the building and the degree to which the building is able to withstand loads and environmental factors that tend to lessen the ability of the building to withstand those forces.

In any population of buildings there will be some buildings (or systems in buildings) that are either more or less resistant to loads and environmental or other use factors than the average building. This variation could be described by a probability distribution curve as shown opposite.

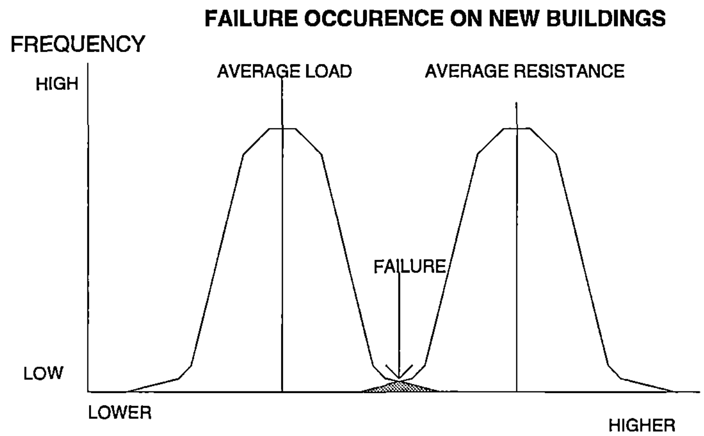
In addition to the initial level of durability being variable, the environmental and other use loads that are imposed on buildings also vary. Thus a second probability distribution curve can be added to the figure showing the probable range loads applied. With the initial level of durability is referred to simply as "Resistance" and the use and environmental forces imposed as "Loads", the figure can be used to depict the condition where the two curves cross and failure occurs as shown opposite.

Obvious construction deficiencies aside, failure is relatively infrequent in new buildings as there is sufficient difference between the building's resistance and the applied loads. This occurs despite the problems noted earlier with material standards and inadequate design guidance.

INITIAL DURABILITY OF BUILDING POPULATION

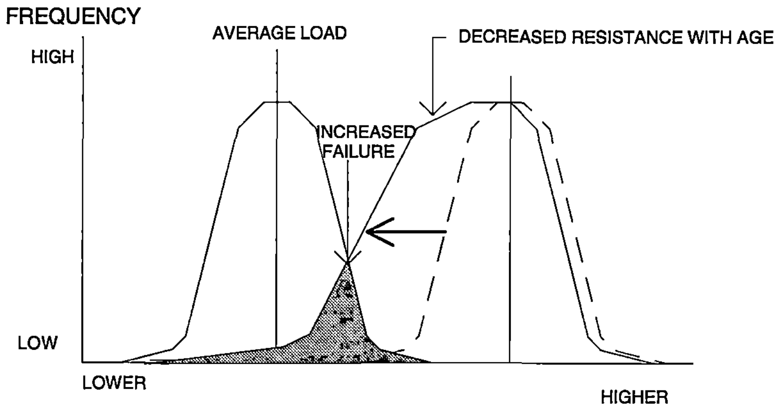


FAILURE OCCURENCE ON NEW BUILDINGS



Most all materials suffer from fatigue or other aging effects under load, so as buildings age the level of durability decreases from that initially built into the building. For buildings with higher levels of initial durability, the effects are likely less pronounced than for buildings that have lower initial levels of durability. The effects can be depicted as shown opposite. Thus, not all buildings will respond in the exact same manner to use loads.

INCREASED FAILURE OCCURENCE IN OLDER BUILDINGS



The impact of these differences in response to load of the various buildings will be most likely noticed in the degree and therefore, costs for repair work rather than the presence or absence of the repair need. On this basis the typology approach to assessment of large portfolios is still a valid assessment tool as it attempts to develop cost scenarios on the basis of averages. Graphically, the Resistance curve will continue to move toward the Load curve over time until failure of all buildings has occurred. The key issue for building owners and managers is to be able to assess the right time to address the repair needs of their building.

Motivation to Repair

Noted earlier was the observation that the costs for repair of condominium and public/private non-profit high-rise buildings is expected to be only marginally less than that of the average high-rise rental building. There are examples to the contrary; however, the motivation and circumstances surrounding the need to repair differ somewhat for the different owner types so that repairs may be performed more frequently for condominium or non-profit high-rise housing. In addition, the average age of rental buildings is assumed to be greater than that of the more recent condominium and non-profit buildings.

There are three basic motivators:

Rulings and Orders

Owners may be forced to repair in order to satisfy Municipal orders to comply with property standards or provincially legislated retrofit requirements.

The Municipal orders to comply with property standards tend to be based on materials deterioration but, more often than not, claim that the "order" is necessary to ensure public safety. Typical cases involve balcony and garage concrete repair. These "orders" typically require that the owner engage a professional engineer to evaluate the conditions and design repairs.

Provincial legislation such as the recent Ontario Fire Code retrofit is based on life safety. For this program, professionals were not required to assess or design repairs. These Rulings and Orders apply to all buildings. In these cases, the repairs may tend to be minimized to the amount needed to comply with the Ruling or Order and may miss opportunities to improve durability, energy use or market value.

Market Forces

Often repair of high-rise rental buildings occurs in conjunction with the purchase or sale of the building. These repairs may be initiated by the vendor in an effort to improve the marketability of the property or in response to a prepurchase inspection or due-diligence inspection in order to correct observed deficiencies. Repairs may also be performed by the purchaser in order to improve marketability or tenant retention.

Condominium and non-profit high-rise are subject to similar motivation in that a deteriorated building will be less desirable than one that has recently had major elements repaired. In addition, notification of pending major repairs is required on the estopple certificate for sale of any condominium unit. This tends to expedite repairs. In some cases repairs may be performed that improve marketability but do not address building durability or safety.

Tenant or Resident Complaints

If occupants perceive that building maintenance is lacking or they are suffering from damages caused by building performance failures, there are formal and informal means for the residents to motivate the responsible owner or manager to implement repairs. Failure to do so may result in Orders to Comply, rent rollback and or political pressure.

Good Management

Not all building owners and managers have to be forced to perform repairs. Some buildings in the 25 to 30 year age bracket are in very good condition and regularly perform planned capital expenditures. Whether the total cost for this manner of building maintenance is less than the repairs initiated by orders and rulings, market forces or Resident complaints is not documented. Most probably, the impact is dependent on the building typology and the initial level of durability.

Areas for Improvement

Education

For the past 15 years there has been various attempts to gain an understanding of the nature and extent of problems plaguing the owners and managers of high-rise buildings. In total, CMHC has a financial interest in roughly 1 Million apartment units across Canada. Many of these units are reaching an age where repairs of a substantial cost are becoming necessary. Costs in the order of $20,000 per unit have been recorded. The owners and managers of buildings are facing not only a potentially huge cost for building repair but are also, to a large extent, victims of a technically immature industry. The nature of the repair needs and the means to assess the distress so that appropriate repairs are performed are rather poorly understood, not only by building owners and managers but also by the professionals who work on these buildings.

In order to try to address these building performance problems, scientists, technologists and engineers, largely from the existing materials, architecture and mechanical disciplines, developed a new speciality service now referred to as the Building Science Specialist. Those with more experienced usually learned (and still learn) their skills through on-the-job-training. This is because the formal training at an academic level typically offered to other professional disciplines such as structural or mechanical engineering or architectural design is largely absent from Canadian universities. Only a few schools offer university-level programs on the diagnosis and repair of building performance problems. This is, seemingly, a lost opportunity for the educators. The general lack of formal training and variable skill level available to building owners affects the credibility of the 'specialists' involved and costs for repair of buildings.

University level education programs must be developed to provide fundamental building diagnosis and repair back ground. In the schools where building science is taught, it is often considered to be "low-tech". While there are some exceptions, often building science programs fall between architecture and engineering and neither deal with the subject matter in sufficient detail to allow students to develop a solid background. Generation of better programs at the University, at least in part, depends on the ability of the "school" to draw research funds an area where there is now considerable competition and limited resources.

Licensing of Specialists

In addition to the lack of academic programs, professional licensing bodies do not consider "Building Science" to be a stand alone discipline (such as structural, geotechnical or mining engineering). A recent survey of members by the PEO in Ontario did not list building or material science among a list of 32 other disciplines. This too is a lost opportunity for the professional associations who have, within their mandate, the capacity to determine the minimum level of quality of the services provided.

Acknowledgment by the professional associations is needed to foster development of more uniform, higher quality professional services in the building science and construction material science disciplines.

Research

In part due to a lack of recognition of the scope of the problems and in part due to a lack of funding, there has been inadequate research on the nature of the problems affecting buildings. The assessment of the problems affecting existing structures is an immense and complex task. Buildings differ in design by age, location and use. They also employ a wide variety of building service, structural and envelope systems. This makes the researcher's task of establishing characteristic performance models or reliable empirical relationships that practitioners could use to predict the interaction between systems and the impact of environmental and use loads on the buildings seemingly impossible. The absence of the performance models and the empirical relationships that are fundamental to other engineering disciplines fosters the "low-tech" attitude of university-level education in building science.

In contrast to the formal research programs, there is a considerable amount of informal research being done daily as engineers, contractors and managers assess the cause of building performance problems and establish repair programs. This informal research body also has good information on the effectiveness of repair strategies and the relationship between repair needs and performance problems. Organizing the results of that 'research' and making the results available to the building science community and to other building owners and managers would be very useful.

Technology Transfer

The research that is being done is not being effectively translated to useful information. Since the "Science" of Building Science has not developed into a mature discipline, much of the formal instruction given at seminars tends to be anecdotal. While sharing of the experiences gained in case studies is an entertaining and effective way to warn the student about the potential for reoccurrence of the problem and possible repair solutions, case studies rarely relate the application of the presently understood scientific principals that caused the fault that in turn caused the performance problem. As a result, there is often a lack of skill transfer between the speaker and the student.

Industry Standards

For Building Science,there have been no design standards. Standards development in Canada tends to be product-based; that is, the industry has produced National Standards of Canada that related to the materials used in building systems and has not adequately developed similar standards for the performance of the system itself. For instance, insulation used in building envelope construction is cited under ten different material standards in the National Building Code. These standards include the testing of 52 different performance parameters that are measured but there is very poor correlation between standards in the parameter measured, the nomenclature used or the criteria used for evaluation. The result is that designers abandon the standards and absorb the liability associated with specifying products instead in the expectation that the product will satisfy the performance need.

Window systems used in high-rise residential buildings were in a similar situation until 1984 when the omnibus standard replaced six other standards; however, the performance criteria in the current window standard has not kept pace with other envelope performance expectations. The criteria in the 1995 NBC that the envelopes have a maximum air leakage of $0.1 L/s/m^2$ is lost in operable windows which allow as much as 17 times that amount. The air leakage losses on a unit area basis increase to 30 times the code allowable when the newer smaller windows are considered. In addition, while the technology for wall systems is heavily weighted toward the pressure equalized rain screen wall, window systems are still employing the face-seal approach that was used over 20 years ago. The glazing tape used for water tightness and the hidden caulking between metal-to-metal joints in composite metal panel, fixed window and slider window systems can only be expected to last 8 to 10 years before resealing is required. Long-term performance has been and still is absent from window standards.

Brick masonry on buildings in the 25 to 30 year range is spalling due to freeze-thaw. Some are deteriorating from the back side due to inadequate air barrier construction. There have been tests for freeze thaw durability for many years and, presumably, the bricks in place met a standard of performance at the time. This calls into question the level of durability to be expected of building products and the adequacy of the performance standards used to evaluate products.

Concrete deterioration associated with parking garages and balconies was not considered by the design community in the 1970s yet every high-rise building with a garage and exposed balconies can expect to perform repairs

As a result of weaknesses in existing standards and lack of system-performance standards, the performance levels of existing buildings have not been as high as initially hoped. The existing standards writing process is a based on industry consensus. One step to correcting the situation caused by inadequacies in standards is to ensure that the owners and managers of buildings have a strong voice on codes and standards committees.

Awareness of the Problems

At the root of the dilemma affecting research, technology transfer, education and industry standards is the general lack of awareness of the scope of the problem of poor building performance and the need for capital intensive repair as the building approaches 20 to 25 years. Building owners and managers may feel that their buildings are suffering from some isolated problem that can be 'fixed' and no longer dealt with. Most understand that roofs will require replacement but some are shocked to learn that the problems that they are experiencing with their walls, garage, windows and balconies are systemic and experienced to varying degrees across the Country.

As noted above, in Ontario alone $350 Million ought to be being spent annually. Across Canada, the value of repairs could approach $1 Billion annually - sufficient funds to build 50 new apartment buildings . These estimates are not verified because no adequate assessment has been performed to establish the nature of the repair needs and total costs Canada-wide. However, the values are not beyond reason. The size of this repair industry would seem to suggest that research into performance problems, development of improved building systems and design standards, education programs and technology transfer would be a high priority and receive ample industry support; but this is not the case. The scope of the problem is not widely known and while $1 Billion per year seems like a large industry, the actual work is scattered in small amounts across Canada in such a way that the impact is diluted.

The cost estimates given above for repair of buildings were developed using a building typology approach and need to be reconciled against actual buildings. Publication of the results of the verification program would raise the awareness of the problem to a higher level and, perhaps, act as 'seed money' to foster other research, improved education and technology transfer, improved standards for buildings and more durable buildings.

Appendix A

Three Case Studies

Restoration Cost Summary

Three 25-yr Old Public Housing Apartments (Fair-to-Poor Condition)

Structure and Building Envelope	Work Description	Life	Costs ($1986)	Costs per Unit
Garage - Interior General	Expansion joint resealing, column base and soffit patching	20	$790,000	
Garage Roof Slab	Concrete and waterproofing repair	25	$600,000	
Balcony	Concrete & slab edge repair	20	$850,000	
Balcony Guards	Upgrade/replace to Code	30	$250,000	
Brick Maintenance	Isolated replacement and repointing as necessary	10	$200,000	
Exterior Caulking	Replacement at window and door perimeters and expansion joints	20	$150,000	
Window and Frames	Replacement	30	$3,750,000	
Exit Doors	Replacement	25	$90,000	
Roof Replacement	New 4-ply BUR	25	$360,000	
Subtotal Structure and Building Envelope		**$7,040,000**		**$4,693**

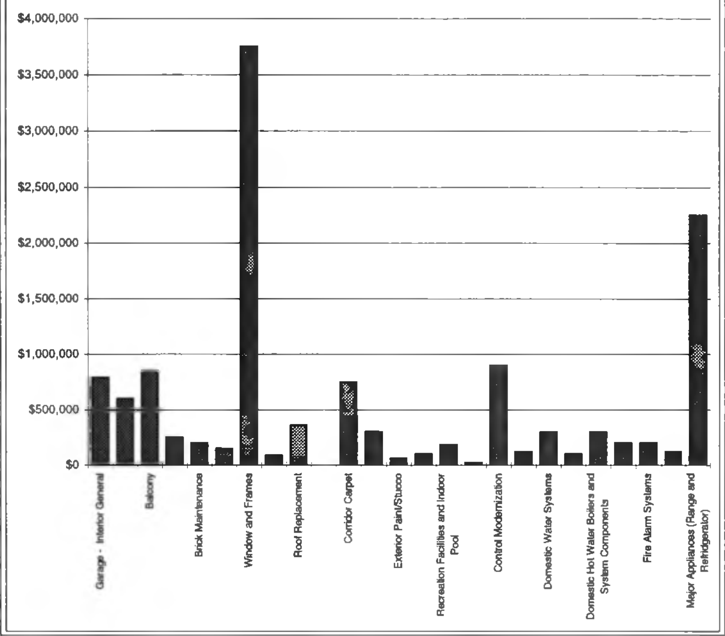
Interior and Exterior Finishes	Work Description	Life	Costs ($1986)	Costs per Unit
Corridor Carpet	Replacement with underpad	10	$750,000	
Unit Finishes	Repair and paint Gypsum board	25	$300,000	
Exterior Paint/Stucco	Refinish	10	$60,000	
Walks, Curbs and Pavement on Grade	Repair or partial replacement	15	$100,000	
Recreation Facilities and Indoor Pool	Repair or partial replacement	15	$185,000	
Subtotal Finishes		**$1,395,000**		**$930**

Elevator	Work Description	Life	Costs ($1986)	Costs per Unit
Response to Code changes	Contingency	10	$23,000	
Control Modernization	Obsolescence replacement	25	$900,000	
Car Refurbishing	Restore/replace finishes	25	$120,000	
Subtotal Elevators		**$1,043,000**		**$695**

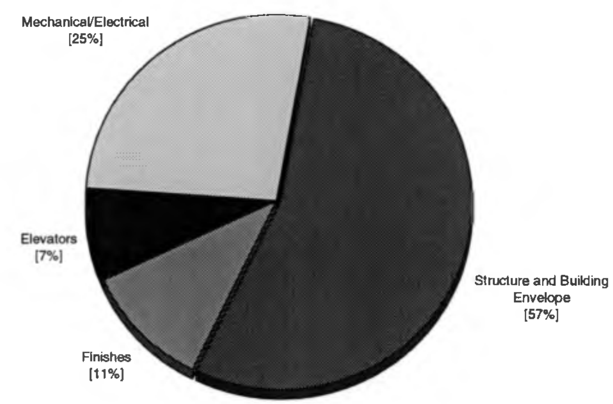
Mechanical & Electrical	Work Description	Life	Costs ($1986)	Costs per Unit
Domestic Water Systems	Valve replacement plus isolated pipe replacement	25	$300,000	
Fire Protection Systems	Valve replacement plus isolated pipe replacement	25	$100,000	
Domestic Hot Water Boilers and System Components	Replacement of boiler and isolated components	25	$300,000	
Electrical Supply Systems	Replacement/major repair/upgrade of main panels and risers	30	$200,000	
Fire Alarm Systems	Upgrade/replacement to Code requirements	20	$200,000	
Enterphone and Security Systems	Replacement	15	$120,000	
Major Appliances (Range and Refrigerator)	Replacement	15	$2,250,000	
Subtotal Mechanical/Electrical		**$3,470,000**		**$2,313**
Total			**$12,948,000**	**$8,632**

Average Number of Units/Building	***375***
Number of Buildings	***4***
Average Cost per Building	***$4,316,000***
Period of Repair (Years)	***6***
Average Annual Cost/Unit	***$1,439***

Three 25-Year Old Apartments (Public Housing) in Fair-to-Poor Condition



Three 25-Year Old High-Rise Public Housing Buildings (Fair-to-Poor Condition)



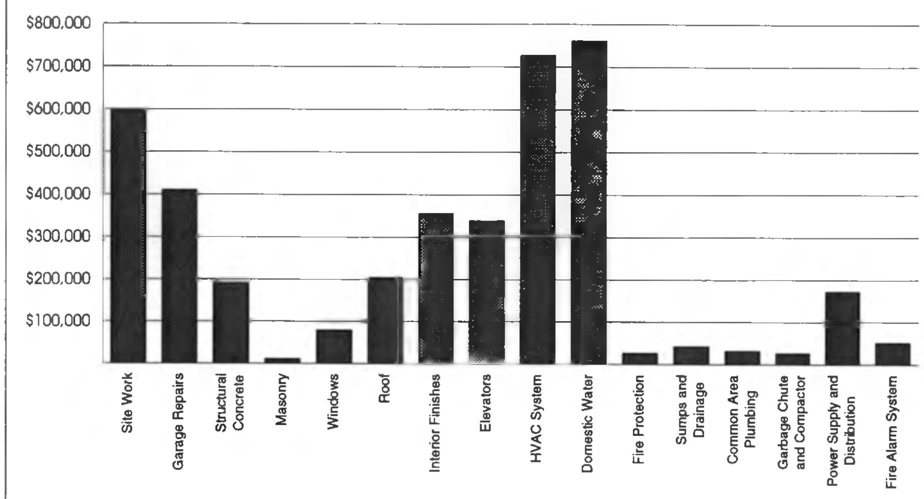
Repair Cost Summary

23-Year Old High-Rise Condominium Apartment

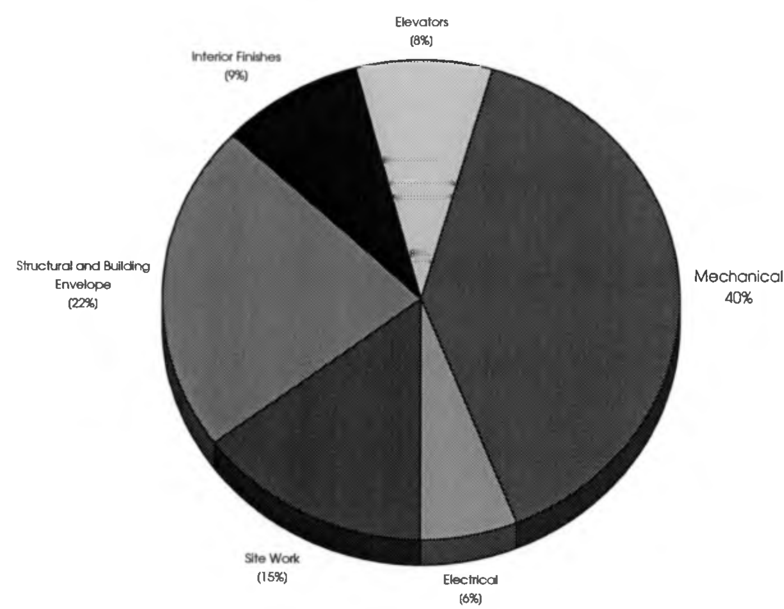
Site Work	Site Work	$595,000
Structural and Building Envelope	Garage Repairs	$409,000
	Structural Concrete	$190,000
	Masonry	$10,000
	Windows	$78,000
	Roof	$203,000
Interior Finishes	Interior Finishes	$354,500
Elevators	Elevators	$337,500
Mechanical	HVAC System	$726,000
	Domestic Water	$760,000
	Fire Protection	$25,000
	Sumps and Drainage	$41,000
	Common Area Plumbing	$30,500
Electrical	Garbage Chute and Compactor	$25,000
	Power Supply and Distribution	$171,000
	Fire Alarm System	$50,000
Total		$4,005,500

Number of Units	***273***
Cost per Unit	***$14,672***
Period of Repair (years)	***20***
Average Annual Cost/Unit	***$734***

23-Year Old Condominium in Good Condition

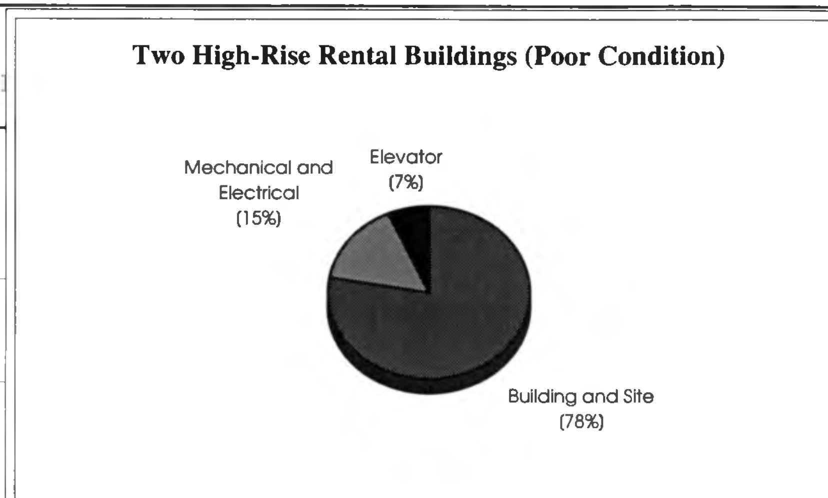


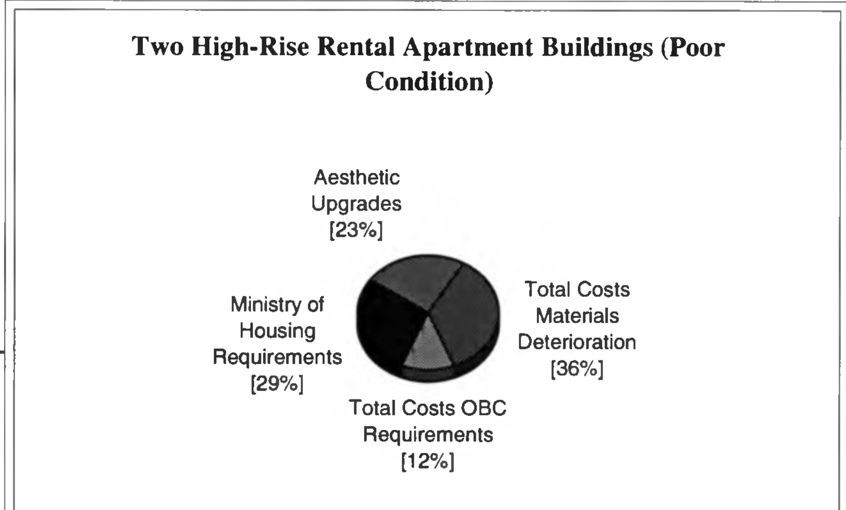
23-Year Old High-Rise Condominium Apartment in Good Condition



Restoration Cost Summary - Two High-Rise Rental Apartment Buildings (Poor Condition)

Category	Total Costs Materials Deterioration	Total Costs OBC Requirements	Total Costs Ministry of Housing Requirements	Subtotal Costs	Aesthetic Upgrades
Building and Site	$2,373,938.00	$383,910.00	$2,410,569.00	$5,168,417.00	$1,541,133.00
Mechanical and Electrical	$732,000.00	$599,000.00	$77,000.00	$1,408,000.00	None
Elevator	None	$108,000.00	Included	$108,000.00	$512,000.00
Total Costs	**$3,105,938.00**	**$1,090,910.00**	**$2,487,569.00**	**$6,684,417.00**	**$2,053,133.00**
Construction Cost per Apartment Based on 231 Apartments	$13,445.62	$4,722.55	$10,768.70	$28,936.87	$8,888.02
Contractor's Mark-up	$616.61	$99.72	$626.12	$1,342.45	$400.29
GST	$984.36	$337.56	$797.64	$2,119.55	$650.18
Total Costs per Apartment	**$15,046.58**	**$5,159.83**	**$12,192.46**	**$32,398.87**	**$9,938.50**





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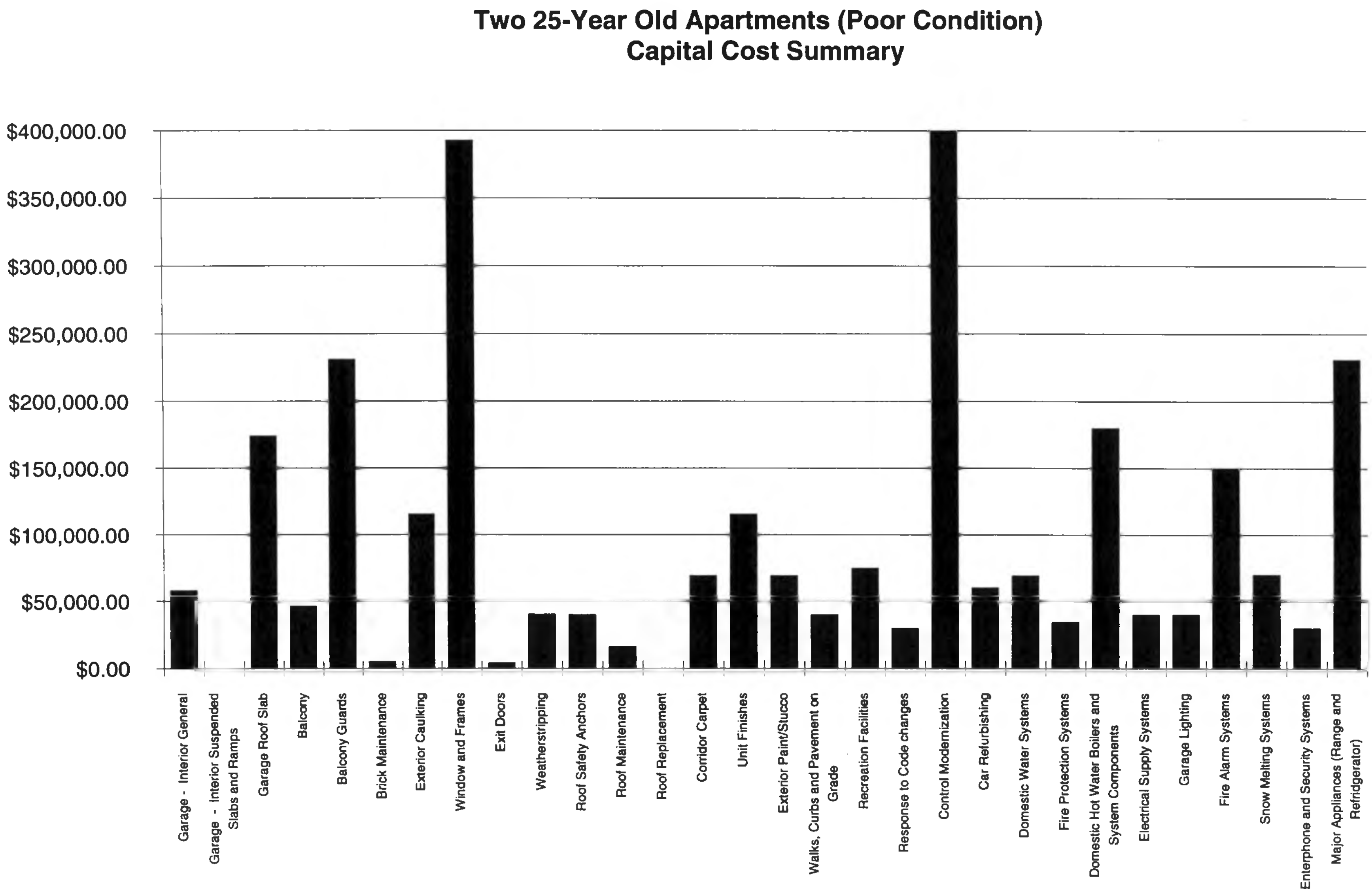
Two 25-Year Old Apartments (Poor Condition)
Capital Cost Summary
$400,000.00
$350,000.00
$300,000.00
$250,000.00
$200,000.00
$150,000.00
$100,000.00
$50,000.00
$0.00
Garage - Interior General
Garage - Interior Suspended Slabs and Ramps
Garage Roof Slab
Balcony
Balcony Guards
Brick Maintenance
Exterior Caulking
Window and Frames
Exit Doors
Weatherstripping
Roof Safety Anchors
Roof Maintenance
Roof Replacement
Corridor Carpet
Unit Finishes
Exterior Paint/Stucco
Walks, Curbs and Pavement on Grade
Recreation Facilities
Response to Code changes
Control Modernization
Car Refurbishing
Domestic Water Systems
Fire Protection Systems
Domestic Hot Water Boilers and System Components
Electrical Supply Systems
Garage Lighting
Fire Alarm Systems
Snow Melting Systems
Enterphone and Security Systems
Major Appliances (Range and Refridgerator)