## HIGH LEVEL SEISMIC UPGRADE COST ESTIMATE FOR CENTRE BLOCK, PARLIAMENT HILL

Prepared for: Public Works and Government Services Canada Parliamentary Precinct Branch



Prepared by: Halsall Associates 210 Gladstone Avenue, Suite 4001 Ottawa, Ontario K2P 0Y6 (613) 237-2462

14Y160-113A

May 2015



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PWGSC Client Reference Number: 20150336

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## 1. INTRODUCTION

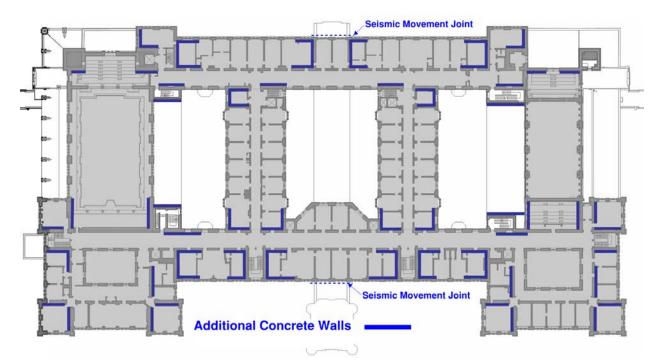
#### 1.1 Objective

This High Level Estimate is intended to provide an order of magnitude cost estimate of the structural cost of both a conventional seismic upgrade and a seismic isolation retrofit of the Centre Block. This estimate should be read in conjunction with the seismic upgrade options described in the Halsall report entitled "Supplemental Seismic Report for Centre Block, Parliament Hill" (Work Package 3).

## 1.2 General Description

## 1.2.1 Conventional Seismic Upgrade

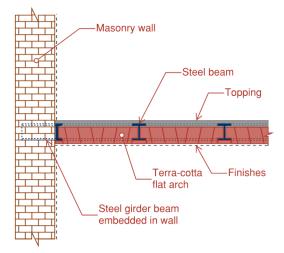
The conventional seismic upgrade consists of inserting approximately 76 new reinforced concrete shear walls throughout the building, each with a reinforced concrete foundation with rock anchors. The design is based on 100% 2010 NBCC loads and includes no provisions for post-disaster performance. An allowance has been made to remove the slab on grade and rock in the basement where it is higher, to allow for sufficient head room for the construction equipment to build the foundations. An example of walls is shown in Figure 1 representing the general extent of the work throughout the building.



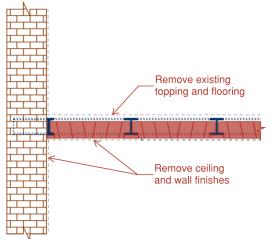
#### Figure 1 – General extent of new concrete shear walls for the conventional upgrade

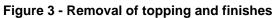
The diaphragm upgrade will involve removing all of the existing topping and non-load bearing partitions and the floors and roof, and replacing the topping with a reinforced concrete diaphragm. An example of a process to install the new shear walls is shown in Figures 2 through 6.











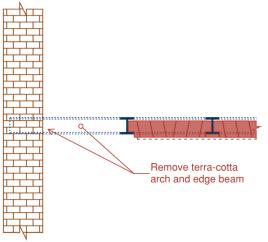
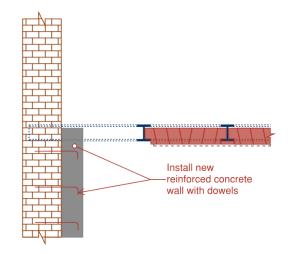
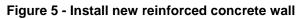
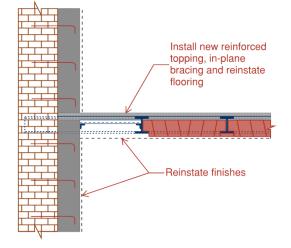


Figure 4 - Removal of floor











An allowance has been made for the reinforcing of the two Water Towers, similar to the work currently taking place on the Ventilation Towers. An allowance for the Peace Tower conventional upgrade consists of reinforcing the piers by installing large steel anchors in the piers and structural steel framing behind the spandrel beams. The installation of the pier reinforcing could involve removing a strip of exterior stone masonry, chipping into the concrete, grouting the anchors in place and reinstating the exterior masonry. An allowance has been made for the reinforcement of the Upper Tower, above the observation deck level. A schematic elevation of the reinforcement of the Peace Tower is shown in Figures 7 and 8.





Figure 7 - Schematic layout of Peace Tower reinforcing

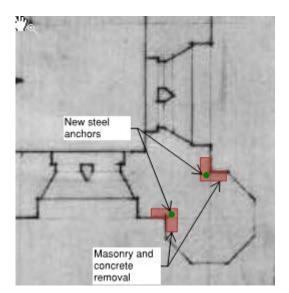


Figure 8 - Section showing steel anchors in Peace Tower piers

An allowance has been made for the seismic restraint of operational and functional components and secondary structural elements.



#### 1.2.2 Base Isolation Seismic Upgrade

For the base isolation seismic upgrade option, the existing structure is sequentially shored in the basement, the existing concrete walls and columns are removed sequentially and new reinforced concrete piers are installed on foundations with small rock anchors. An allowance has been made to remove the slab on grade and rock in the basement where it is higher, to allow for sufficient head room for the construction equipment to build the foundations. An example of a potential isolator layout and schematic installation diagrams are shown in Figures 9 and 10.

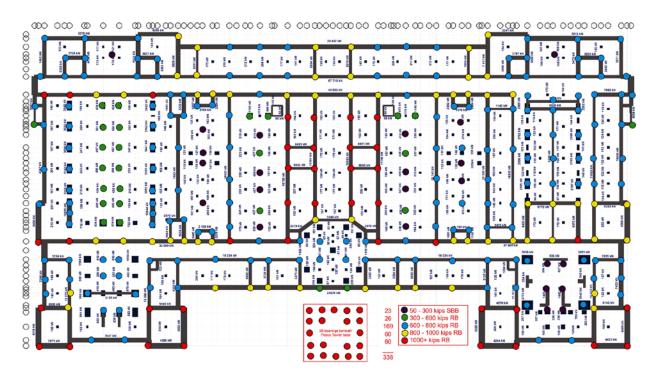


Figure 9 - Base isolator potential layout plan



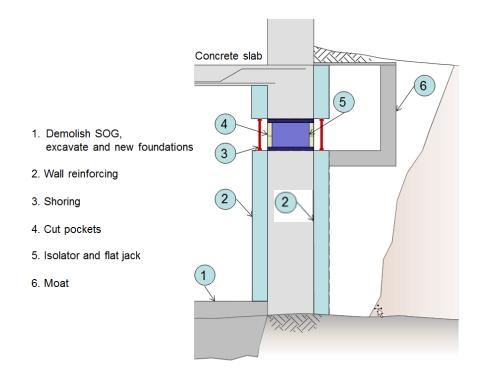


Figure 10 - Schematic diagram of base isolator installation at exterior wall

The isolators are then installed on top of the new concrete piers. A similar process has been allowed for the Peace Tower but with a more complicated shoring procedure. The diaphragm upgrade has included removing some of the existing topping and non-load bearing partitions, and replacing that topping with a reinforced concrete diaphragm. The base isolation seismic upgrade requires the installation of a retaining wall and cover around the building to create a "moat" that allows for the movement of the structure.

An allowance has been made for the reinforcement of the Upper Tower of the Peace Tower and the Water Towers of the Centre Block because these more slender elements often do not benefit from base isolation as much as stiffer components.

An allowance has been made for the seismic restraint of the few operational and functional components and secondary structural elements that would still be required with base isolation.

## 1.3 Methodology

The cost estimate was completed with the assumption that the seismic upgrade would take place in the context of an overall building rehabilitation project. Allowances or costs have not been included for the removal, installation or impact of architectural elements or finishes, or other building systems, for either seismic upgrade option.

A very preliminary structural design was completed in order to arrive at some parameters to be used in the cost estimate. Based upon the preliminary design, quantities of materials were calculated or assessed. Reasonable unit rates, taking into account the quantities and probable level of difficulty were used to arrive at the cost estimate of different components of the structural system. One



exception is the rate of rock excavation within the Centre Block of \$2,400/m<sup>3</sup>, which was provided by PWGSC. Where the quantities or the procedures are not known at this time and more detailed analysis is required, a reasonable allowance has been included.

#### 1.4 Limitations

- No party other than the Client shall rely on the Consultant's work without the express written consent of the Consultant. The scope of work and related responsibilities are defined in the Conditions of Assignment. Any use which a third party makes of this work, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Decisions made or actions taken as a result of our work shall be the responsibility of the parties directly involved in the decisions or actions. Any third party user of this report specifically denies any right to any claims, whether in contract, tort and/or any other cause of action in law, against the Consultant (including Sub-Consultants, their officers, agents and employees).
- The work reflects the Consultant's best judgement in light of the information reviewed by them at the time of preparation. Unless otherwise agreed in writing by Halsall, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. This is not a certification of compliance with past or present regulations. No portion of this report may be used as a separate entity; it is written to be read in its entirety.
- No physical or destructive testing and no design calculations have been performed unless specifically recorded. Conditions existing but not recorded were not apparent given the level of study undertaken. Only conditions actually seen during examination of representative samples can be said to have been appraised and comments on the balance of the conditions are assumptions based upon extrapolation.
- < Only the specific information identified has been reviewed. The Consultant is not obligated to identify mistakes or insufficiencies in the information obtained from the various sources or to verify the accuracy of the information.
- < Halsall is not investigating or providing advice about pollutants, contaminants or hazardous materials. This work is included only in the mandate of the environmental consultant
- Budget figures are our opinion of a probable current 2015 dollar value of the work and are provided for approximate budget purposes only. Accurate figures can only be obtained by establishing a scope of work and receiving quotes from suitable contractors. We have no control over the cost of labour and materials or of market conditions. This report does not guarantee that bids or actual construction costs will not vary from the values given.



## 2. DOCUMENTATION

This cost estimate has been prepared based on the following documents:

- A variety of original architectural and structural drawings prepared by architects John Pearson and Jean-Omer Marchand, dated from 1916 to 1927;
- Original structural steel floor plan shop drawings prepared by the Dominion Bridge Co., dated to 1916;
- Centre Block "As-Found" drawings, prepared by the Heritage Conservation Directorate, Professional and Technical Service Management and PWGSC in 2002;
- Various Centre Block and Peace Tower alteration drawings, including:
  - Centre Block Underground Services Building;
  - Centre Block Chimney Stabilization Phase I;
  - o Alterations & Additions Centre Block (1971 Courtyard Additions);
  - Fullers Gargoyle repair;
  - Extension to East & West Penthouses at South Corridor Elevators;
  - Centre Block South Conservation;
  - Centre Block Phase 1 Renovations (1987 Stairwell extensions);
  - o Centre Block Ventilation Towers Rehabilitation Project;
  - Peace Tower Alteration Parliament Hill (1980); and
  - Peace Tower Conservation of Masonry (1994).
- Scans of selected specifications, construction reports and letters prepared by John Pearson during the original construction;
- Photographs from the original construction period and several more recent restoration and repair projects; and
- Various Centre Block and Peace Tower studies and reports.



#### 3. COST CONSIDERATIONS

#### 3.1 BASE COST

The estimated costs included in this report are based on competitive bids being received by at least six (6) general contractors and at least four (4) sub-contractors for each trade. If the minimum number of general contractors and/or sub-contractors are not met, the bids received could exceed the estimate.

#### 3.2 UNIT RATES

The unit rates used in this report include all labour and material, equipment, and subcontractor's overhead and profit.

#### 3.3 TAXES

Taxes have not been included. It is recommended that PWGSC make provision for this in their project budget.

#### 3.4 OWNER REVIEW

Halsall recommends that PWGSC carefully review this report for scope, individual item descriptions, unit prices and all assumptions stated. Any questions, comments or clarifications should be brought to our attention so the report can be amended as required.

#### 3.5 EXCLUSIONS

The following items are not included in this cost estimate:

- Professional fees and expenses (it should be noted that professional fees may be higher for a base isolation design given the requirement to have the design evaluated by an independent 3<sup>rd</sup> party peer review;
- Design contingency;
- Construction contingency;
- Cost escalation beyond May 2015;
- General requirements;
- General contractor's fees;
- Cost of removal of hazardous materials;
- General demolition costs unless specifically identified in this estimate;
- Protection of heritage fabric of the building;
- Removal or replacement of finishes;



- General repair and rehabilitation of the exterior or interior masonry walls;
- Temporary enclosures;
- PWGSC internal management costs;
- Phased construction;
- Restriction on working hours and overtime;
- Legal fees and costs;
- Building permit fees;
- Taxes;
- Cash allowances; and
- Winter construction.

#### 3.6 Limitations of This Estimate

This High Level Cost Estimate is meant to provide an order of magnitude of cost of only the structural elements of two seismic upgrade options described in Halsall's report: Supplemental Seismic Report for Centre Block (Work Package 3). Halsall has no control over the cost of labour and materials, as these are based on market conditions and pricing strategies of each contractor bidding on the project. Accurate prices can only be obtained by inviting bids based on final plans and specifications. The cost estimate included herein is only our opinion.



## CONSTRUCTION COST ESTIMATE SUMMARY

				1		1	1		1	
OPINION OF PROBABLE HIGH LEVEL										
COST OF CONVENTIONAL UPGRADE OF										
CENTRE BLOCK USING CONCRETE										
SHEARWALLS										
ITEMS	L (m)	W (m)	H (m)	Quantity	Total	Units	ι	Jnit Rate		Cost
Works related to foundations for										
concrete shear walls (76)										
Remove basement slab on grade	144	75			10,800	m²	\$	500	\$	5,400,000
Allow for lowering the existing floor level										
by 1.5 m (interior rock removal)	144	75	1.5		16,200	m³	\$	2,400	\$	38,880,000
Interior basement rock removal at						2				
footings for shearwalls	10	5	1.2	76	4,560	m³	\$	2,400	\$	10,944,000
Concrete for foundations	10	5	1.2	76	4,560		\$	500	\$	2,280,000
Formwork for foundations	30		1.2	76	2,736	m²	\$	250	\$	684,000
Rebar (6400kg per footing)				76	486,400	kg	\$	5	\$	2,432,000
New rock anchors (4 per footing)					304	ea.	\$	15,000	\$	4,560,000
New slab on grade	144	75			10,800	m²	\$	200	\$	2,160,000
Works related to concrete shear walls										
(76)										
Concrete for walls	6	0.5	29	76	6,612	m <sup>3</sup>	\$	500	\$	3,306,000
Formwork for walls	12	1	29	76	28,652		\$	250	\$	7,163,000
Rebar (305kg/m <sup>3</sup> ) including dowels					2,016,660		Ś	5	\$	10,083,300
Area of floor to be removed and re-built					_,,	0	1		Ŧ	
(7 floor levels)	9	1.5		532	7,182	m²	\$	700	\$	5,027,400
							1 ·		·	, ,
Works related to Diaphragm upgrade										
Remove existing topping					42,000	m²	\$	100	\$	4,200,000
Remove terracotta partitions					31,000		\$	300	\$	9,300,000
New concrete for topping					42,000		\$	125	\$	5,250,000
Floor finishing					42,000		\$	25	\$	1,050,000
Rebar (420,00mx0.8kg/m)					336,000		\$	3	\$	1,008,000
Steel angles (20,600mx7.3kg/m)					150,380	-	\$	5	\$	751,900
Steel studs on existing beams					8,900	-	\$	25	\$	222,500
Drilled anchors					68,000	ea.	Ś	100	\$	6,800,000
Sloped roof in-plane bracing and					00,000	cui	Ť	100	Ŷ	0,000,000
anchorage					2,200	m²	\$	1,000	\$	2,200,000
					,		,	,		,,
Works related to Water Tower upgrade										
Total cost from construction estimate for										
Ventilation Towers from Hanscomb									\$	6,000,000
Works related to Peace Tower										
Reinforcement of the Upper Tower									\$	250,000
Pier upgrade (new Dywidag bars each										
pier)					4	ea.	\$	125,000	\$	500,000
Masonry reinstatment after installation of						2				
Dywidag bars		0.8	35	8	224	m	\$	3,000	\$	672,000
Spandrel beam over Porte Cochere										
(590kg/m structural steel for 5m)					1	ea.	\$	50,000	\$	50,000
Spandrel beam over Memorial Chamber					-			FC 005		150.005
(590kg/m structural steel for 5m)					3	ea.	\$	50,000	\$	150,000
Spandrel over Memorial Chamber north										
face(590kg/m structural steel for 5m;										
shoring, anchorage; removal of existing								100 000		100.000
beam) Spandrel beams over Bell Chamber					1	ea.	\$	100,000	\$	100,000
(540kg/m structural steel for 6.0 m)					4	02	4	50.000	\$	200.000
(540kg/m structural steel for 6.0 m)					4	ea.	\$	50,000	Ş	200,000



Seismic Restraint of OFCs and Secondary				
Structural				
Seismic restraint of:				
Partitions	31,000	m <sup>2</sup> Ş	5 5	\$ 155,000
Sculptures	500	ea. 🤤	\$ 1,000	\$ 500,000
Terra cotta fireproofing tiles	33,300	m² Ş	5 50	\$ 1,665,000
Existing heritage ceilings	8,000	m <sup>2</sup> Ş	5 100	\$ 800,000
New suspended ceilings	34,400	m <sup>2</sup> \$	5 5	\$ 172,000
Heavy light fixtures	70	ea. Ş	\$ 1,000	\$ 70,000
Grotesques	30	ea. Ş	5,000	\$ 150,000
Skylights	4	ea. 🤤	\$ 25,000	\$ 100,000
Cantilevered masonry walls (anchors)	610	ea. Ş	500	\$ 305,000
Sub-total (Structural costs only)				\$ 134,869,100



## Project No: 20150336 Preliminary Seismic Assessment Centre Block, Parliament Hill, Ottawa, ON

OPINION OF PROBABLE HIGH LEVEL										
STRUCTURAL COST OF SEISMIC										
ISOLATION RETROFIT OF CENTRE										
BLOCK										
ITEMS	L (m)	W (m)	H (m)	Quantity	Total	Units	U	nit Rate		Cost
Exterior moat to allow seismic movemen	t									
Exterior soil excavation	474	4	4		7,584	m <sup>3</sup>	\$	50	\$	379,200
Exterior rock excavation (allowance)					100	m <sup>3</sup>	\$	300	\$	30,000
Backfill	474	3	4		5,688		\$	100	\$	568,800
Moat cover	474	4			1,896		\$	200	\$	379,200
Retaining wall formwork (2 surfaces)	948		4		3,792		\$	250	\$	948,000
Concrete for retaining wall and footing	474	8	0.4		1,517		\$	500	\$	758,400
Rebar (60kg/m <sup>3</sup> of concrete)	., .	Ū	011		91,008		\$	5	\$	455,040
					51,000	6			Ŷ	135,010
Works related to exterior basement wall	·									
New continous concrete beam below										
ground floor										
Concrete	474	1	0.6		284		\$	500	\$	142,200
Formwork (3 faces: 1.2+.6+.6=2.4m)	474	2.4			1,138	m²	\$	250	\$	284,400
Rebar (60 kg/m <sup>3</sup> of concrete)					17,064	kg	\$	5	\$	85,320
Dowels across existing wall (at 600mm										
c/c)					790	ea.	\$	200	\$	158,000
New piers at isolator location (68 piers)										
Rock excavation	1.5	1.5	0.3	68	46	m³	\$	300	\$	13,770
Concrete	1	1	3	68	204	m³	\$	500	\$	102,000
Formwork	4		3	68	816	m²	\$	250	\$	204,000
Rebar (60 kg/m <sup>3</sup> of concrete)					12,240	kg	\$	5	\$	61,200
Rock anchors (4 each pier.)					272	ea.	\$	3,000	\$	816,000
Works related to the interior basement										
Replace existing columns with new										
concrete piers supporting isolators										
Remove existing basement slab	144	75			10,800	m <sup>2</sup>	\$	500	Ś	5,400,000
Allow for lowering the existing floor level	144	/5			10,000		7	500	Ç	3,400,000
by 1.5 m. This includes hand-held										
compresser tools for removal of rock.	144	75	1.5		16,200	m³	\$	2,400	\$	38,880,000
Install shoring at each column (104										
columns)					104	ea.	\$	10,000	\$	1,040,000
Remove columns in the basement in pre-										
designed sequence					104		\$	2,000	\$	208,000
Rock excavation for new piers	2	2	0.3	104	125		\$	2,400	\$	299,520
Concrete for new piers	1	1	3	104	312		\$	500	\$	156,000
Formwork for new piers	4		3	104	1,248	m²	\$	250	\$	312,000
Rebar (60 kg/m <sup>3</sup> of concrete)					18,720	kg	\$	5	\$	93,600
Rock anchors (4 each pier.)					416		\$	3,000	\$	1,248,000



## Project No: 20150336 Preliminary Seismic Assessment Centre Block, Parliament Hill, Ottawa, ON

Formwork [3 faces: 1+.8+.8 = 2.6m]   1136   2.6   Image: 1   2.954   m²   5   2.200   5   7.38,400     Rebar (60 kg/m² of concrete)   1136   2   2,272   m²   5   3.000   5   681,600     Remove existing walls   1136   2   2,272   m²   5   300   5   681,600     New piers supporting concrete beams   1   1   3   166   498   m³   5   5   2.49,000     Rebar (60 kg/m² of concrete)   1   1   3   166   498   m³   5   5   1.49,400     Rock anchors (4 each per.)   1   1   3   166   1.400   m²   5   3.000   5   4.80,000     Works related to diapargem upgrade of upper levels   1.400   m²   5   1.000   5   2.200,000   m²   5   2.200,000	Replace existing walls (1136m) below										
New Concrete beams below ground floor   Image of the second se	ground floor with new concrete beams										
Concrete   1136   1   0.8   909   m²   S   500   S   454,400     Formwork (3 faces: 1+.8+.8= 2.6m)   1136   2.6   2,954   m²   S   500   S   723,800     Rebar (60 kgm² of concrete)   0   5,528   kg   S   5   S   222,42   m²   S   300   S   681,600     Remove existing walls   1136   2   2,272   m²   S   300   S   681,600     Remove existing walls   113   166   1992   m²   S   50   S   149,400     Rebar (60 kg/m² of concrete)   0   1600   e.3   3,000   S   149,400     Work related to diaggragm upgrade of upper levels   20,000   m²   S   100   S   200,000   m²   S   100   S   20,000   m²   S   25   500,000     Remove existing topping   0   12,000   m²   S   100   S   2,000   m²	and piers supporting isolators										
Formwork [3 faces: 1+.8+.8 = 2.6m]   1136   2.6   Image: 1   2.954   m²   5   2.200   5   7.38,400     Rebar (60 kg/m² of concrete)   1136   2   2,272   m²   5   3.000   5   681,600     Remove existing walls   1136   2   2,272   m²   5   300   5   681,600     New piers supporting concrete beams   1   1   3   166   498   m³   5   5   2.49,000     Rebar (60 kg/m² of concrete)   1   1   3   166   498   m³   5   5   1.49,400     Rock anchors (4 each per.)   1   1   3   166   1.400   m²   5   3.000   5   4.80,000     Works related to diapargem upgrade of upper levels   1.400   m²   5   1.000   5   2.200,000   m²   5   2.200,000	New Concrete beams below ground floor										
Rehar (60 kg/m <sup>2</sup> of concrete)   Image of the section of t	Concrete	1136	1	0.8		909	m³	\$	500	\$	454,400
Rehar (60 kg/m <sup>2</sup> of concrete)   Image of the section of t	Formwork (3 faces: 1+.8+.8= 2.6m)	1136	2.6			2,954	m²	\$	250	\$	738,400
Install shoring (166 locations)   Image of the support of											
Remove existing walls   1136   2   2,272   m <sup>2</sup> \$ 300   \$ 681,600     New piers supporting concrete beams   1   1   3   166   498   m <sup>3</sup> \$ 500   \$ 249,000     Concrete   1   1   3   166   498   m <sup>3</sup> \$ 500   \$ 249,000     Rock anchors (4 each pier.)   4   3   166   1992   m <sup>2</sup> \$ 250   \$ 448,000     Remove existing topping   4   6   1600   ea.   \$ 3,000   \$ 4,800,000     Works related to diagragm upgrade of upper levels   14,400   m <sup>2</sup> \$ 100   \$ 2,000,000     Remove existing topping   1   20,000   m <sup>3</sup> \$ 125   \$ 2,500,000     Remove existing topping   1   20,000   m <sup>3</sup> \$ 125   \$ 2,500,000     Remove existing topping   1   20,000   m <sup>3</sup> \$ 125   \$ 2,500,000     Step angles (9,700m x 2,38/m)   1   20,000   m <sup>3</sup> \$ 125   \$ 340,055     Shear 30,0000 x0,38,kg/m)   1							-				-
New plers supporting concrete beams   Image: Concrete in the image: Conconcrete in the image: Concrete in the image: Conco		1136		2					-		
Concrete   1   1   3   166   498   m <sup>3</sup> S   500   S   249,000     Formwork (4 faces)   4   3   166   1,992   m <sup>2</sup> S   250   S   449,000     Rebar (60 kg/m <sup>3</sup> of concrete)   1   1   1   1   1   1   3   166   1,992   m <sup>2</sup> S   250   S   449,000     Works related to diapgragm upgrade of upper levels   1		1150		2		2,272		, ,	500	Ŷ	001,000
Concrete   1   1   3   166   498   m <sup>3</sup> S   500   S   249,000     Formwork (4 faces)   4   3   166   1,992   m <sup>2</sup> S   250   S   449,000     Rebar (60 kg/m <sup>3</sup> of concrete)   1   1   1   1   1   1   3   166   1,992   m <sup>2</sup> S   250   S   449,000     Works related to diapgragm upgrade of upper levels   1	New piers supporting concrete beams										
Formwork (4 faces)   4   3   166   1.992   m²   \$   250   \$   498,000     Rebar (60 kg/m² of concrete)   1,600   ea.   \$   3.000   \$   149,400     Rock anchors (4 each pier.)   1,600   ea.   \$   3.000   \$   4.800,000     Works related to diapgragm upgrade of upper levels   14,400   m²   \$   3.000   \$   2.0000,000     Remove existing topping   14,400   m²   \$   3.000   \$   2.0000,000     Place new concrete topping (65mm thick, 2000,9,m.)   20,000   m²   \$   2.0000,000   m²   \$   2.5   5.000,000     Rebar (200,000m x 0.8 kg/m)   160,000   kg   \$   3   4.800,000   m²   \$   3   4.800,000     Steel angles (9,700m x 7.3 kg/m)   70,810   kg   \$   3   5   3.60,000     Steel angles (9,700m x 7.3 kg/m)   70,810   kg   \$   3.200,000   ea.   \$   3.200,000     Stoped rofin-plane bracing and a		1	1	3	166	498	m <sup>3</sup>	Ś	500	Ś	249.000
Rebar (60 kg/m <sup>3</sup> of concrete) 29,880 kg \$ \$ \$ 11,600 ea. \$ 3,000 \$ 4,800,000   Works related to diapgragm upgrade of upper levels 20,000 m <sup>2</sup> \$ 100 \$ 2,000,000   Remove existing topping 20,000 m <sup>2</sup> \$ 300 \$ 4,320,000   Remove existing topping 20,000 m <sup>2</sup> \$ 300 \$ 4,320,000   Place new concrete topping (65mm thick, 20000 sq.m.) 20,000 m <sup>3</sup> \$ 125 \$ 2,500,000   Rebar (200,000m x 0.8 kg/m) 160,000 kg \$ 3 \$ 480,000   Steel angle (9,700m x 7.3 kg/m) 70,810 kg \$ \$ 3,200,000   Steel angle (9,700m x 7.3 kg/m) 70,810 kg \$ \$ 3,200,000   Steel angle (9,700m x 7.3 kg/m) 70,810 kg \$ \$ 3,200,000   Steel angle (9,700m x 7.3 kg/m) 70,810 kg \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$<			-								
Rock anchors (4 each pier.)   1,600   ea.   \$ 3,000   \$ 4,800,000     Works related to diapgragm upgrade of upper levels   20,000   m <sup>2</sup> \$ 100   \$ 2,000,000     Remove terracotta partitions   14,400   m <sup>2</sup> \$ 300   \$ 4,320,000     Place new concrete topping (65mm thick, 20000 sq.m.)   20,000   m <sup>3</sup> \$ 125   \$ 2,500,000     Concrete finishing   20,000   m <sup>3</sup> \$ 125   \$ 2,500,000     Rebar (200,000m x 0.8 kg/m)   160,000   kg   \$ 32   \$ 4,800,000     Steel angles (9,700m x, 7, 8kg/m)   70,810   kg   \$ 25   \$ 354,053     Sharar studs on existing steel   4,200   ea.   \$ 215   \$ 3,200,000     Stoped roof in-plane bracing and anchorage   2,200   m <sup>2</sup> \$ 900   \$ 1,980,000     Works related to Water Tower upgrade        \$ 5,400,000     Works related to Pace Tower       \$ 5,400,000   \$ 5,400,000   \$ 5,400,000   \$ 5,200,000   \$ 5,200,000   \$ 5,200,000   \$ 5,200,000 <td< td=""><td></td><td></td><td></td><td>5</td><td>100</td><td></td><td></td><td></td><td></td><td></td><td>-</td></td<>				5	100						-
Works related to diapergam upgrade of upper levels   Image: Constraint of the new concrete topping Place new concrete topping (65mm thick, 20000 sq.m.)   Z0,000   m <sup>2</sup> \$   100   \$   2,000,000     Place new concrete topping (65mm thick, 20000 sq.m.)   Z0,000   m <sup>3</sup> \$   125   \$   2,000,000     Concrete topping (65mm thick, 20000 sq.m.)   Z0,000   m <sup>3</sup> \$   125   \$   2,000,000     Concrete topping (65mm thick, 20000 sq.m.)   Z0,000   m <sup>3</sup> \$   125   \$   2,00,000     Concrete Inishing Reaber (200,000m x 0.8 kg/m)   Info,000   kg   \$   3   4400,00   \$   3   3 440,00   \$   2,200   m <sup>2</sup> \$   9,000   \$   1,980,000     Steel angles (9,700m x 7.3 kg/m)   Z0,000   ea.   \$   100   3,200,000   aa.   \$   100,000   \$   3,200,000   \$   1,980,000   \$   3,200,000   \$   \$   1,980,000   \$   \$   5,000,000   \$   \$   \$   5,000,000   \$   \$   5,000,000							-				
upper levels   Image: Control of the second seco						1,000	ea.	ç	3,000	ې	4,000,000
Remove existing topping   20,000   m²   \$ 100   \$ 2,000,000     Remove terractata partitions   14,400   m²   \$ 300   \$ 4,320,000     Place new concrete topping (55mm thick, 20000 sq.m)   20,000   m³   \$ 125   \$ 2,000,000     Concrete finishing   20,000   m³   \$ 125   \$ 2,000,000     Rebar (200,000m x 0.8 kg/m)   160,000   kg   \$ 3   \$ 480,000     Scheel angles (9,700m x 7.3 kg/m)   70,810   kg   \$ 5   \$ 5,00,000     Shear studs on existing steel   4,200   ea.   \$ 2,200   \$ 3,200,000     Siloped rofi n-plane bracing and anchorage   32,000   ea.   \$ 3,200,000   \$ 3,200,000     Works related to Water Tower upgrade   2,200   m²   \$ 900   \$ 1,980,000     Works related to Peace Tower   2   2   2   2   2   2   2   2   2   2   2   2   2   2   3,200,000   3   3   2   2   2   2   2   2   2   3   3											
Remove terracotta partitions   Image: mark of the second constraint of the second c						20.000	m <sup>2</sup>	ć	100	ć	2 000 000
Place new concrete topping (65mm thick, 20,000 m³ \$ 125 \$ 2,500,000   Concrete finishing 20,000 m² \$ 25 \$ 5,00,000   Concrete finishing 100,000 kg \$ 3 \$ 480,000   Steel angles (9,700m x 7.3kg/m) 70,810 kg \$ 3 \$ 480,000   Shear studs on existing steel 4,200 ea. \$ 25 \$ 105,000   Dilled anchors 32,000 ea. \$ 100 \$ 3,200,000 \$ 3,200,000   Sloped roof in-plane bracing and anchorage 2,200 m² \$ 900 \$ 1,980,000   Works related to Water Tower upgrade 2,200 m² \$ 900 \$ 1,980,000   Works related to Pace Tower 2,200 m² \$ 5,400,000   Works related to Pace Tower 2 2 \$ 5,400,000   Works related to Pace Tower 2 2 2 \$ 5,400,000   Works related to Pace Tower 2 2 5 \$ 5,400,000   Works related to base isolators 2 2 5 \$ 5,400,000   Works related to base isolators 2 2 5 \$ 5,000,000											
20000 sq.m.) 20,000 m <sup>3</sup> \$ 125 \$ 2,0000   Rebar (200,000 m 0.8 kg/m) 160,000 kg \$ 3 \$ 5 5 500,000   Rebar (200,000 m 0.8 kg/m) 160,000 kg \$ 3 \$ 480,000   Scheal angles (9,700m x 7.3kg/m) 0 70,810 kg \$ 5 \$ 354,051   Shear studs on existing steel 0 70,810 kg \$ 2.250 \$ \$ 3,200,000   Sloped roof in-plane bracing and anchorage 2,200 m <sup>2</sup> \$ 900 \$ 1,980,000   Works related to Water Tower upgrade 0<						14,400	m	Ş	300	Ş	4,320,000
Concrete finishing 20,000 m <sup>2</sup> \$ 25 \$ 500,000   Rebar (200,000 x 0.8 kg/m) 160,000 kg \$ 3 \$ 480,000   Steel angles (9,700 m x 7.3kg/m) 70,810 kg \$ 5 \$ 354,055   Shear studs on existing steel 4,200 ea. \$ 25 \$ 105,000   Drilled anchors 32,000 ea. \$ 100 \$ 3,200,000   Sloped roof in-plane bracing and 2,200 m <sup>2</sup> \$ 900 \$ 1,980,000   works related to Water Tower upgrade 2,200 m <sup>2</sup> \$ 900 \$ 1,980,000   Works related to Water Tower upgrade 2,200 m <sup>2</sup> \$ 5,400,000 \$ 5,400,000   Works related to Peace Tower 2 2 \$ 5,000,000 \$ 5,000,000   Underground foundation work to install isolators 2 2 \$ 5,000,000   Reinforcement of the Upper Tower 2 2 \$ 5,000,000   Supply and delivery of isolators (338) 2 2 \$ 5,000,000   Supply and delivery of isolators (338) 2 2 5 \$ 5,000,000   Seismic restraint of OFCs and Secondary 2 2 5 \$ 5,000,000 \$ 5,000,000						20.000	m <sup>3</sup>	ć	125	ć	2 500 000
Rebar (200,000m x 0.8 kg/m) Image: Second angles (9,700m x 7.3 kg/m) Image: Secon	. ,										
Steel angles (9,700m x 7.3kg/m) m 70,810 kg \$ \$ 354,050   Shear studs on existing steel 4,200 ea. \$ 25 \$ 105,000   Drilled anchors 32,000 ea. \$ 100 \$ 3,200,000   Sloped roof in-plane bracing and anchorage 2,200 m² \$ 900 \$ 1,980,000   Works related to Water Tower upgrade         1	0										
Shear studs on existing steel 4,200 ea. \$ 25 \$ 100,500   Drilled anchors 32,000 ea. \$ 100 \$ 3,200,000   Sloped roof in-plane bracing and anchorage 2,200 m² \$ 900 \$ 1,980,000   Works related to Water Tower upgrade 2,200 m² \$ 900 \$ 1,980,000   Works related to Water Tower upgrade 2,200 m² \$ 5,400,000   Works related to Peace Tower 2 2 2 2   Underground foundation work to install isolators 2 2 2 2   Works related to base isolators 2 2 2 2 2   Supply and delivery of isolators (338) 2 2 2 2 2   Seismic Restraint of OFCs and Secondary Structural 3 3 2 2 2   Seismic restraint of: 2 3 3 3 3 3 3 3   Seismic restraint of: 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3											
Drilled anchors 32,000 ea. \$ 100 \$ 3,200,000   Sloped roof in-plane bracing and anchorage 2,200 m <sup>2</sup> \$ 900 \$ 1,980,000   Works related to Water Tower upgrade 2,200 m <sup>2</sup> \$ 900 \$ 1,980,000   Works related to Water Tower upgrade        Revised cost from Hanscomb estimate for Ventilation Towers        Works related to Peace Tower          Underground foundation work to install isolators							-				
Sloped roof in-plane bracing and anchorage 2,200 m² \$ 900 \$ 1,980,000   Works related to Water Tower upgrade											
anchorage Image: Constraint of OFCs and Secondary Structural Secondary Structural Secondary Structural Secondary Structural Secondary Skylights Image: Constraint of OFCs and Secondary Skylights Image: Constraint of Const						52,000	cu.	, ,	100	Ŷ	3,200,000
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Revised cost from Hanscomb estimate for Ventilation TowersImage: Solution of Solution for Sol	Works related to Water Tower upgrade										
for Ventilation Towers Image: Sector Sec											
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Seismic restraint of:Image: ceilingsImage: c	Seismic Restraint of OFCs and Secondary										
Existing heritage ceilings Image: Ceilings											
New suspended ceilings   Image: Marcol of the system   Sec: Sec: Sec: Sec: Sec: Sec: Sec: Sec:	Seismic restraint of:										
Heavy light fixtures Image: Constraint of the system Image	Existing heritage ceilings							\$	100	\$	800,000
Heavy light fixtures Image: Constraint of the system Image	New suspended ceilings					34,400	m²	\$	5	\$	172,000
Grotesques Image: state square Skylights <td< td=""><td>Heavy light fixtures</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1,000</td><td>\$</td><td>70,000</td></td<>	Heavy light fixtures								1,000	\$	70,000
Cantilevered masonry walls (anchors) Image: Canter of the second sec	Grotesques					30	ea.	\$	5,000	\$	150,000
	Skylights					4	ea.	\$	25,000	\$	100,000
Sub-total (Structural costs only) \$ 99,212,140	Cantilevered masonry walls (anchors)					610	ea.	\$	500	\$	305,000
	Sub-total (Structural costs only)									\$	99,212,140

