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August 1, 2007 OUR REF: BT 3252BTG10

Mr. John Mazhar
Program Manager
Public Works & Government Services Canada
111 Water Street East
Cornwall, Ontario
K6H 6S3

Dear Sir

Re: Burlington Canal Lift Bridge
Span Balance Analysis Report

We are pleased to submit the final report on the recently completed weighing of the lift span of the Burlington Canal Lift Bridge, entitled "Span Balance Analysis Report, July 2007", for your records.

Please note that, as requested, we have included in this revised issue of the report a new appendix entitled Appendix E, Summary of Counterweight Balance Block Adjustments.

If you have any questions regarding this report, please do not hesitate to call the undersigned.

Yours very truly,

W. M. Moore, P.Eng.
Senior Engineer

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Enc.

SPAN BALANCE ANALYSIS REPORT

Burlington Canal Vertical Lift Bridge
Hamilton, Ontario
Canada

Submitted to:

William Moore

Delcan

Prepared by: John R. Williams, P.E.

Approved by: Paul M. Bandlow, P.E.

Stafford Bandlow Engineering, Inc.

Submitted July 2007

INTRODUCTION

This report details balance tests performed at the Burlington Canal Vertical Lift Bridge in Hamilton, Ontario, Canada. The tests were conducted by Stafford Bandlow Engineering, Inc. (SBE) for Delcan to obtain an acceptable final balance condition of the lift span at the conclusion of the sidewalk construction project prior to opening the bridge for marine traffic.

SBE was on site at the Burlington Canal Vertical Lift Bridge on March 16-17, 2003 and May 30-31, 2007 for the purpose of performing balance tests. The tests were conducted on the span drive machinery in the North and South towers simultaneously. Figure 1, Appendix A depicts a general plan of the lift span with identification of directions. Data was recorded in the field utilizing a data acquisition unit. The recorded data was then analyzed in the field to determine the balance condition. Weight changes were performed by Facca as directed by SBE to obtain acceptable span operation to the satisfaction of the Bridgemaster, Public Works Government Services Canada (PWGSC).

At the completion of the balance testing, additional testing and adjustments to the span buffers was performed in an effort to troubleshoot problematic inconsistent seating of the lift span.

TEST PROCEDURE AND EQUIPMENT

The current tests were performed utilizing gages that were installed by SBE as part of prior balance tests at the bridge in December, 2002 as follows: Two 2-element (gage) 90 degree foil type strain gage rosettes were spot welded to each of the eight main pinion shafts that engage the sheave's ring gear. Figure 2, Appendix A depicts the layout of the span drive machinery and shows the location of the strain gage installation. A total of eight rosettes (sixteen gages) were used for each tower. Measurements Group LWK-06-W250D-350 gages were used. Surface preparation of the shaft and mounting of the gages were performed in accordance with the strain gage manufacturer's requirements. Each pair of rosettes was mounted on a circumferential line 180 degrees apart from one another. The gages from each pair of rosettes were wired in a full Wheatstone bridge; the Wheatstone bridge effectively cancels out strain on the shaft surface produced by bending and temperature changes and ensures that the indicated strain is due to torsion only. Once mounted the gages were protected for future use.

Each Wheatstone bridge was hard wired via Belden twisted pair shielded cable to one channel of a four channel Somat e-DAQ-lite bridge expansion board. The gain for each channel was set such that the relation between the output from the system in millivolts and the shear strain at the surface of the shaft in microstrain was established. nCode's Test Control Environment software was used to capture the requisite data.

While recording test data, the brakes were released to relieve any strain in the shafts that might be resultant from residual torque. The motor shaft was then rotated to bring the engaged main pinion tooth in and out of contact with its ring gear. The data was analyzed to determine the strain correlating to the zero torque condition and the signal was offset so that zero strain correlated to zero torque. Once zeroing was completed, the process was repeated to verify and document proper zeroing and the brakes were reset.

Lift height was monitored through event marks indicating revolutions of the pinion shaft. The event marks were provided by a Hall Effect sensor which monitored a magnet affixed to the pinion shaft and provided a voltage output each time a magnet passed the sensor. Calculations were performed to convert revolutions of the main pinion shaft into the change in lift height in feet. One magnet was affixed to the pinion shaft so that each event mark corresponded to 3.2 feet of lift, and 34 events were provided for a normal full lift (110 ft). A separate sensor was utilized in each tower to correlate strain data with span lift height during each test.

Strain measurements for the instrumented shafts were recorded using a DAQ unit in each tower. Each instrumented shaft was provided a dedicated DAQ unit channel. Each channel was sampled sequentially at an effective scan rate of 50 Hz for the duration of each bridge lift. The data was reviewed in the field at the conclusion of each bridge operation to check the integrity of the data and then saved to disk. Three bridge lifts were conducted for each test.

METHOD OF ANALYZING RECORDED DATA

A sample strip charts for one run from the final test are depicted in Appendix B. Each strip chart contains data for the four instrumented shafts in each tower and the Hall Effect event marks during both the raising and lowering cycle for each bridge opening. The data from each test run was analyzed at incremental lift heights which corresponded to the system event marks. 100 data points centered on each event mark are enumerated, summed and then averaged. In this way any periodic fluctuations in the test data (sliding friction on the gear teeth, gear tooth impacts, etc.) will be effectively filtered out. Averaged data points were then selected from the constant velocity region of each test run; the data in the accelerating and decelerating regions were discarded. The averaged data points and their corresponding lift heights were entered into a proprietary balance program and used to determine the balance condition of the lift span according to the governing balance equation. These calculations are described below.

The strain recorded in the shaft relates to the torque in the shaft according to the mechanics of the shaft geometry and material. This allows the shaft torque to be calculated from the recorded strain data. Then, the ratio between the main pinion and the sheave trunnion is used to convert main pinion shaft torque to sheave trunnion torque. An efficiency factor is used to account for the frictional losses between the rack pinion shaft and the sheave trunnion. This factor is calculated using the friction factors provided in the AASHTO Standard Specifications for Movable Highway Bridges, 1988 (hereafter referred to as AASHTO) Section 2.5.6. The sheave trunnion torque was then converted to an equivalent force at the main counterweight ropes.

The imbalance force was determined in the following manner: For a given span position the imbalance assists the machinery in one direction (raise or lower) and resists the machinery in the opposite direction. Friction always opposes the machinery. Therefore, the summation of the raising and lowering force at a given lift height divided by two is equal to the span imbalance force at that lift height. This assumes that the friction is equal in both directions. Since there is no reasonable way to determine the true system friction this assumption must be made.

The span balance changes with lift height as a result of the main counterweight ropes passing over the counterweight sheaves and due to the effect of the auxiliary counterweight system. A mathematical equation for the theoretical change in span balance versus lift height due to both factors was derived based on the geometry and weights provided on the original design drawings, with two noteworthy exceptions.

1. The weight of each auxiliary counterweight has been modified from 18,000 lbs. as indicated on the design drawings to 18,500 lbs. in accordance with changes during a 2002-2003 main counterweight rope replacement project.
2. The weight of the main counterweight rope has been taken as 8.51 lbs. per linear foot in accordance with standard rope manufacturer's information.

The mathematical equation is used in a curve-fitting program to determine the best fit of the theoretical imbalance curve to the imbalance data. The fitted imbalance curve is then used to determine the imbalance at the fully lowered position. Actual imbalance data cannot be obtained in the lowered position due to the acceleration torque. Sample calculations utilizing the balance equation are presented in Appendix C. Figure 3, Appendix A, identifies the auxiliary counterweight system variables used in the balance equation.

PRESENTATION OF WEIGHT CHANGES

The following tables document the weight changes (i.e. assuming 98 lbs per balance block) that were implemented through the course of the balance tests conducted between March 16 and May 30, 2007. None of the balance results from testing performed on March 17 are presented as the results were significantly influenced by wind and ice loading on the span.

North Tower Balance Results

Test ID	Imbalance (lbs)			Friction (lbs)		
	NW	NE	North	NW	NE	North
3/16/2007 Test 1	3204	-3482	-278	2525	4667	7192
Weight Removed from CWT Between Tests (lbs)	2000	6000	8000			

Test ID	Imbalance (lbs)			Friction (lbs)		
	NW	NE	North	NW	NE	North
5/30/2007 Test 1	4317	2518	6756	2153	2416	4570
Weight Removed from CWT Between Tests (lbs)	0	600	600			

Test ID	Imbalance (lbs)			Friction (lbs)		
	NW	NE	North	NW	NE	North
5/30/2007 Test 2	3583	3898	7481	2512	2093	4604
Weight Removed from CWT Between Tests (lbs)	0	600	600			

Test ID	Imbalance (lbs)			Friction (lbs)		
	NW	NE	North	NW	NE	North
5/30/2007 Test 3	3539	4487	8026	1459	3112	4571

South Tower Balance Results

Test ID	Imbalance (lbs)			Friction (lbs)		
	SW	SE	South	SW	SE	South
3/16/2007 Test 1	5670	-5119	551	3518	3219	6738
Weight Removed from CWT Between Tests (lbs)	0	3100	3100			

Test ID	Imbalance (lbs)			Friction (lbs)		
	SW	SE	South	SW	SE	South
3/16/2007 Test 2	3554	114	3668	3163	4115	7278
Weight Removed from CWT Between Tests (lbs)	1000	3500	4500			

Test ID	Imbalance (lbs)			Friction (lbs)		
	SW	SE	South	SW	SE	South
5/30/2007 Test 1	3162	3671	6832	3716	1051	4767
Weight Removed from CWT Between Tests (lbs)	1200	0	1200			

Test ID	Imbalance (lbs)			Friction (lbs)		
	SW	SE	South	SW	SE	South
5/30/2007 Test 2	2868	4930	7798	2700	2047	4747
Weight Removed from CWT Between Tests (lbs)	200	0	200			

Test ID	Imbalance (lbs)			Friction (lbs)		
	SW	SE	South	SW	SE	South
5/30/2007 Test 3	3339	4537	7876	3268	1530	4799

PRESENTATION OF BALANCE RESULTS

The following table documents the final balance condition for each corner of the lift span at the completion of all weight changes. The table presents the seated imbalance (i.e. imbalance with span fully seated) as well as the trunnion friction, which is also determined as part of the analysis. The individual results from each of three tests are provided with the averages of the three tests.

North Tower Balance Results

Test ID	Imbalance (lbs)			Friction (lbs)		
	NW	NE	North	NW	NE	North
5/30/2007 Test 3 Run 1	3561	4428	7989	1967	2615	4582
5/30/2007 Test 3 Run 2	3453	4604	8057	1134	3546	4681
5/30/2007 Test 3 Run 3	3603	4430	8033	1275	3176	4451
Average	3539	4487	8026	1459	3112	4571

South Tower Balance Results

Test ID	Imbalance (lbs)			Friction (lbs)		
	SW	SE	South	SW	SE	South
5/30/2007 Test 3 Run 1	3226	4706	7932	3582	1162	4744
5/30/2007 Test 3 Run 2	3225	4670	7895	3426	1220	4646
5/30/2007 Test 3 Run 3	3566	4235	7801	2970	1639	4610
Average	3339	4537	7876	3326	1340	4667

Note: Positive (+) imbalance indicates span heavy.
Negative (-) imbalance indicates counterweight heavy.

The fitted imbalance curves which yield the above results are presented in Appendix D. Each graph contains the best fit of the theoretical imbalance curve to the imbalance data, the opening force, the closing force and the friction force relative to the main counterweight ropes.

COMMENTARY ON SEATING PROBLEMS AND ADDITIONAL TESTING

The scope of the current work was to return the lift span to a similar balance condition as the existing condition prior to the construction work. The target imbalance was 4000 lbs per corner, 8000 lbs per end of the span. Therefore, iterative weight changes were performed in each tower until this objective was achieved along with satisfactory span operation, as indicated by the Bridgemaster and electrical amperage readings that were consistent with prior readings as recorded by Rondar.

Operational problems were reported starting with the initial span operations performed in March through the final balance test performed on May 30, 2007. The problem reported was erratic seating of the lift span characterized by the northeast (NE) and southwest (SW) fully seated limit switches failing to maintain a steady indication that the span was seated. Inspection of the indicated live load support confirms that when this is the case, there is a gap between the live load support and strike plate. The problem was reported to be intermittent and apparently random. The seating issues are a recurrence of a long term problem at this bridge that was eliminated in 2005 and had not recurred until the present time.

On 5/31/2007 multiple tests were conducted in an effort to correct the problem:

The indexing of the span drive machinery in the south tower was adjusted and equalized with the span seated. Strain gage data was collected immediately prior, during and after performing the adjustments to observe how the adjustments affected the load distribution in the span drive machinery. The adjustments had a negative effect on the distribution of loads in the machinery and caused one quadrant to carry a majority of the load required to operate the span. This affect was extremely short lived with the indexing and the load sharing returning to their prior state through slippage of the clutches and/or slippage of the ropes on the sheaves within 2 lifts. Based on the results of this test, we conclude that the seating problem cannot be corrected through indexing adjustments.

The span buffer valves were adjusted to increase the pressure developed in the buffers during seating. This adjustment was made based on the observation that during seating the momentum of the span is sufficient to cause the span to rebound off the live load supports after the initial contact. The pressure was increased until the buffers provided enough assistance for the span to land softly with no rebound. Although the performance of the span during seating was greatly improved, the seating problem was not eliminated

PWGSC reports that multiple transverse balance changes were implemented as well as overall increases in the end reactions following the tests documented in this report to further test other options for eliminating the seating issues, also without success. Based on the failure of all of these efforts, it is recommended that the strike plates be shimmed to eliminate the gaps.

APPENDIX A

Figures

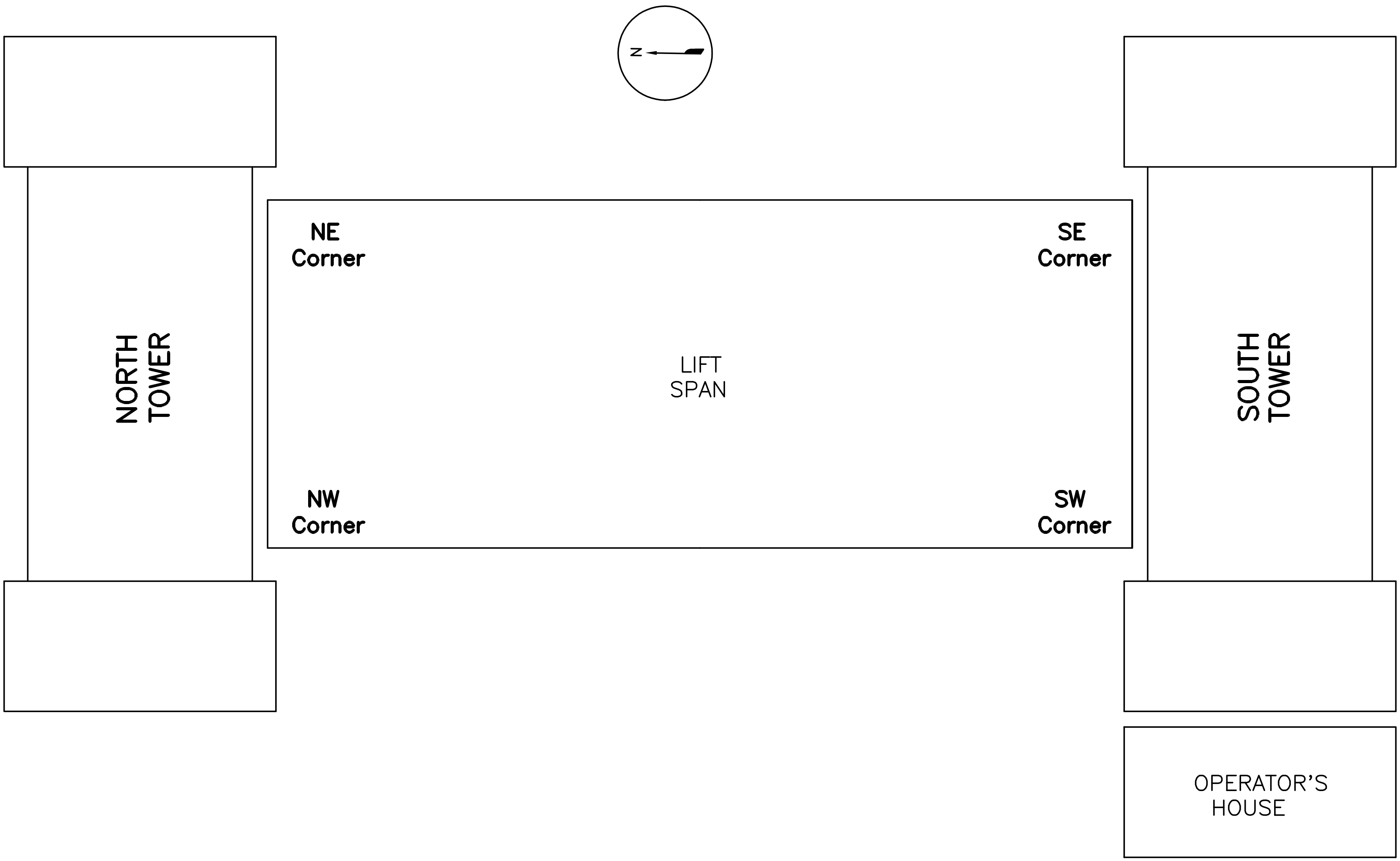
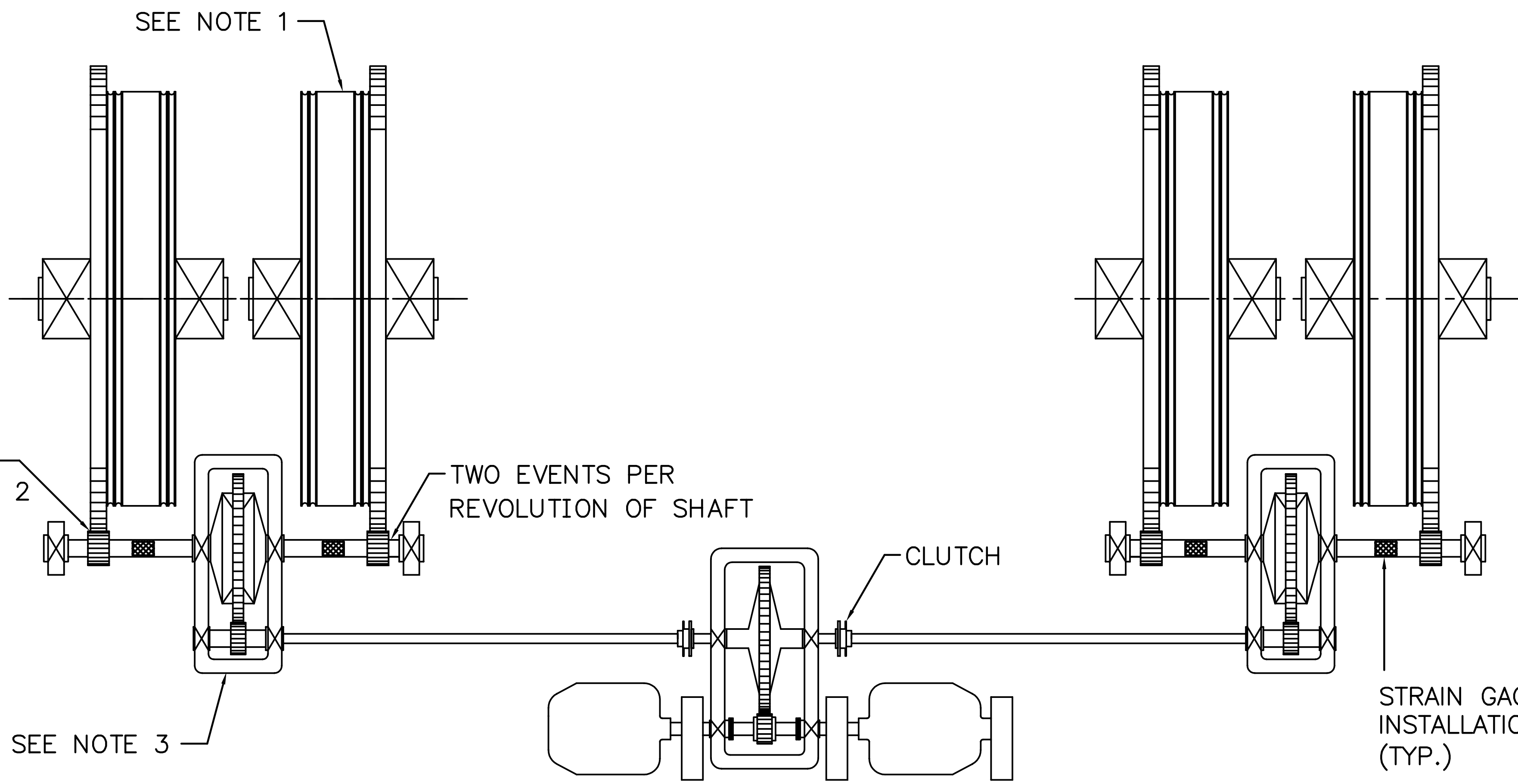


Figure 1. Plan View of Movable Span

Project:
Burlington Canal Lift Bridge
Hamilton, Ontario
Strain Gage Imbalance Tests

Prepared by:
Stafford Bandlow Engineering, Inc.



NOTES:
1. ROPE PITCH DIA. ON SHEAVE = 15'
2. RATIO RACK PINION/RING GEAR = 14.74
3. RATIO SECONDARY REDUCER= 4.21

NORTH TOWER SHOWN
(SOUTH TOWER SIMILAR)

Figure 2. Location of Strain Gage Installation and Event Mark Recording

Project:
Burlington Canal Lift Bridge
Hamilton, Ontario
Strain Gage Imbalance Tests

Prepared by:
Stafford Bandlow Engineering, Inc.

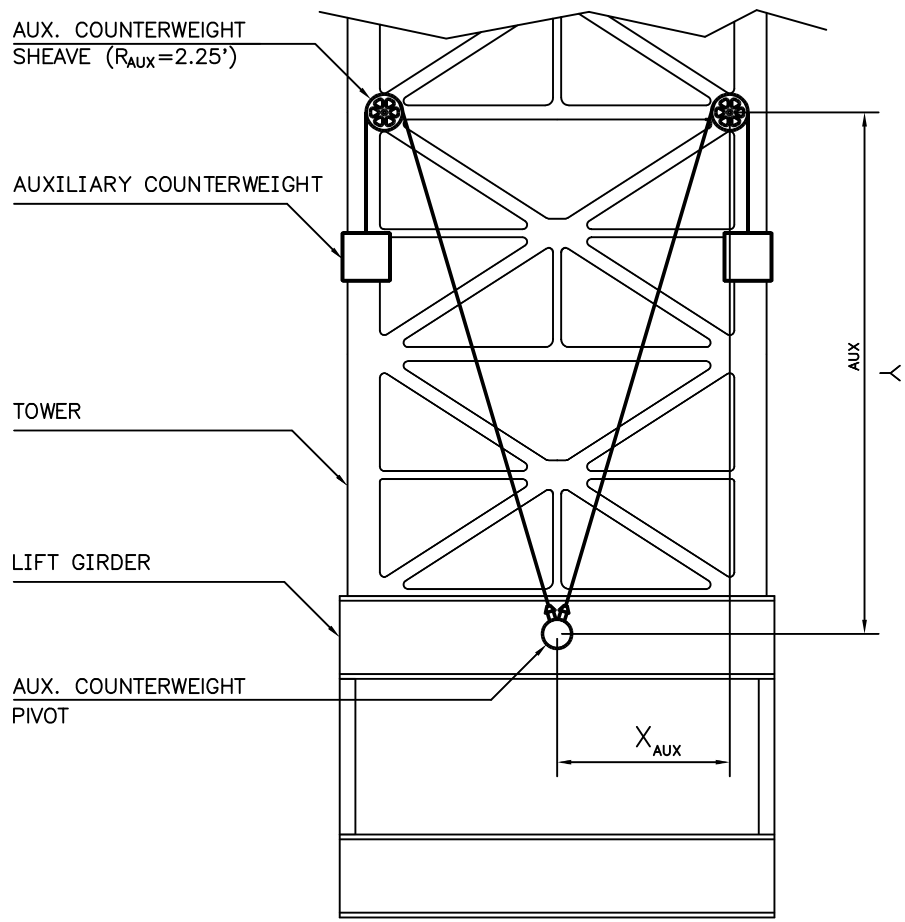


Figure 3. Auxiliary Counterweight Machinery

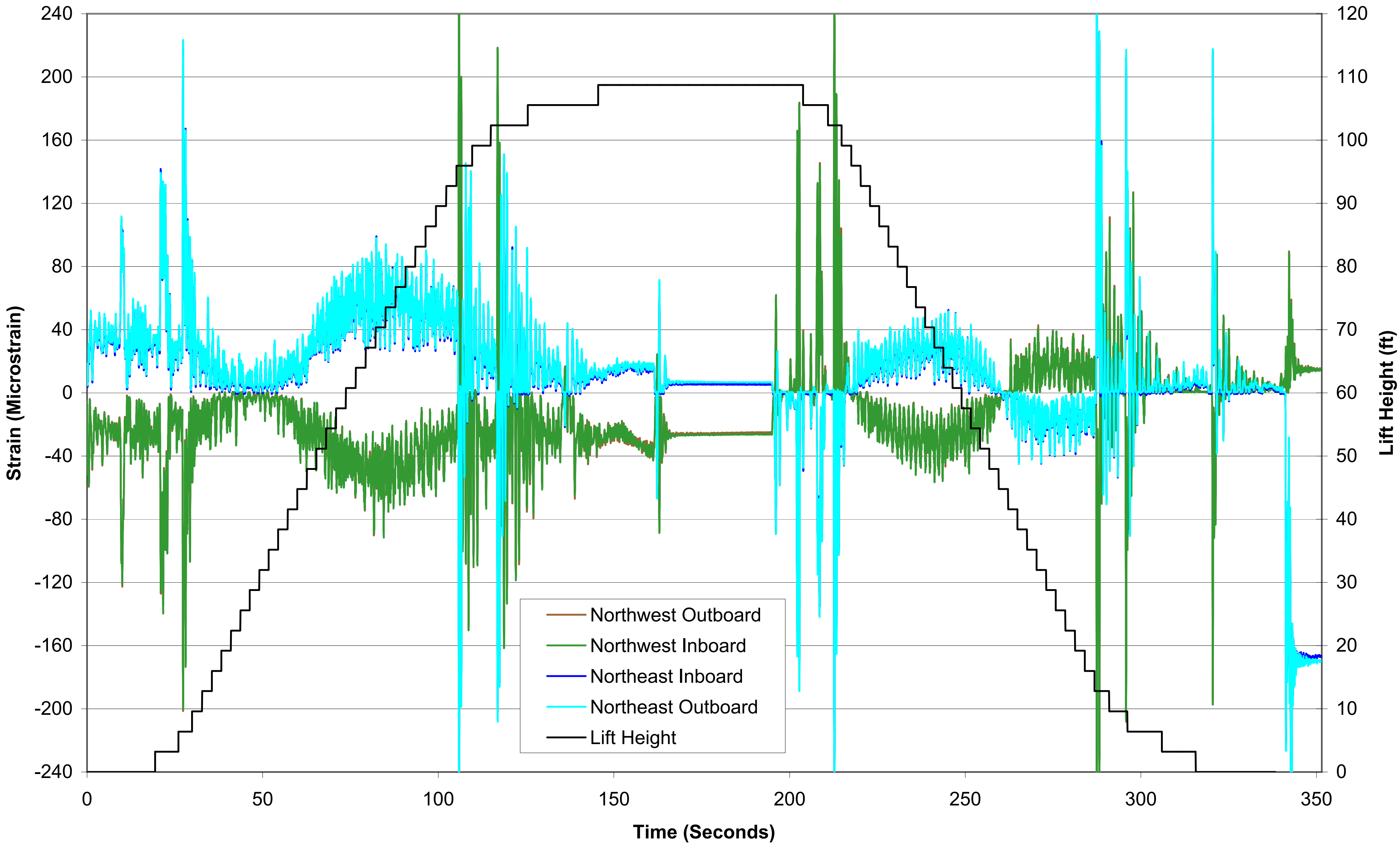
Project:
Burlington Canal Lift Bridge
Hamilton, Ontario
Strain Gage Imbalance Tests

Prepared by:
Stafford Bandlow Engineering, Inc.

APPENDIX B

Strip Chart Recordings

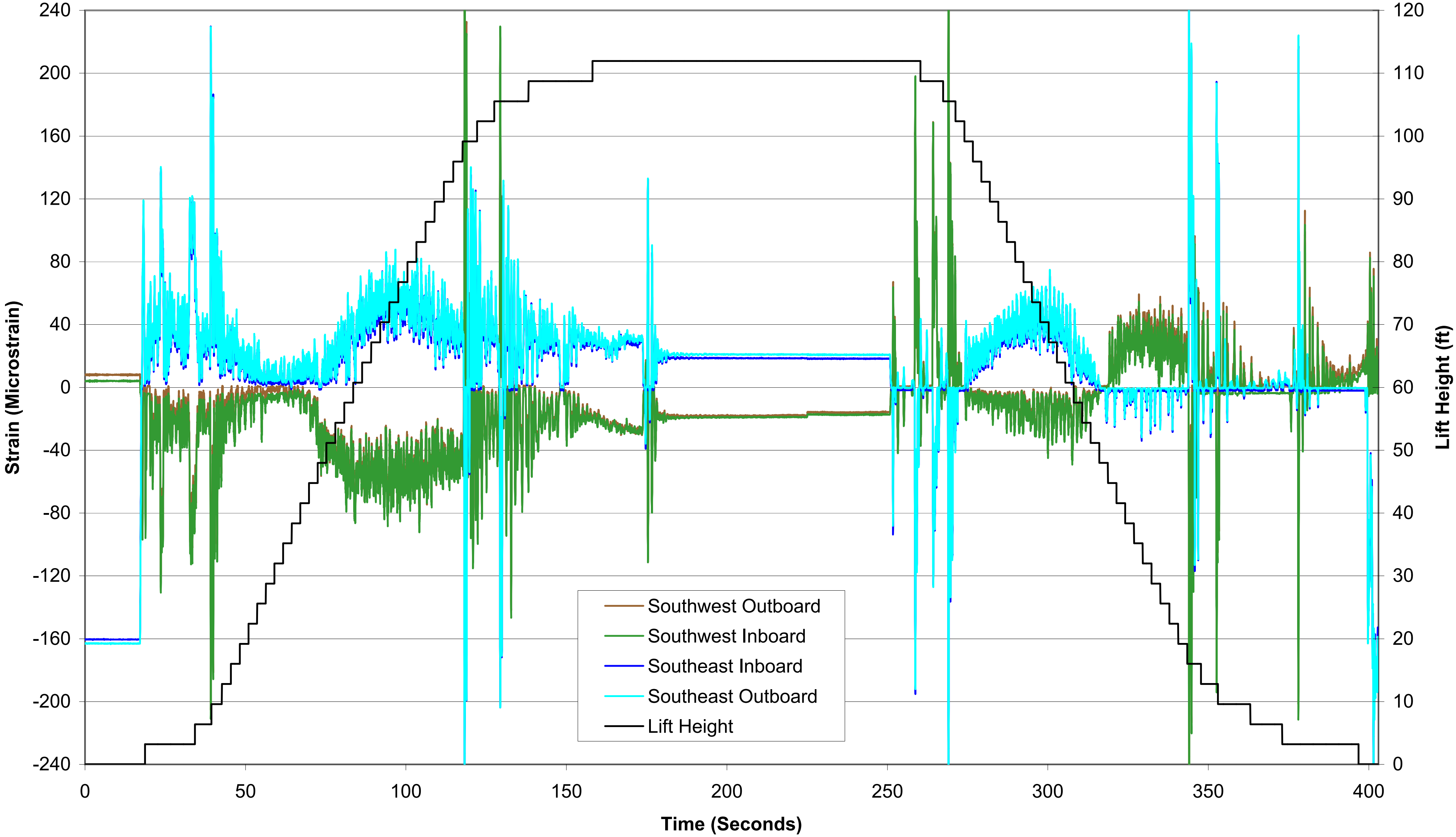
Burlington Lift Bridge
North Tower, Test 3 Run 1



Note:
For the Northeast traces, positive (+) strain is equivalent to torque in the opening direction.
For the Northwest traces, negative (-) strain is equivalent to torque in the opening direction.

Date Recorded: May 30, 2007

Burlington Lift Bridge
South Tower, Test 3 Run 1



Note:
For the Southeast traces, positive (+) strain is equivalent to torque in the opening direction.
For the Southwest traces, negative (-) strain is equivalent to torque in the opening direction.

Date Recorded: May 30, 2007

APPENDIX C

Sample Balance Calculations

Burlington Lift Bridge
Sample Calculations

Prepared By: JRW

Checked By: RJT

Governing Equation
(for each corner)

$$IMB_i = \left[Imbalance_{set} + \left[-2 \cdot \left(corner \cdot Ropes \cdot Mass_{unit} \right) \cdot height_i \right] \ldots \\ + corner \cdot \left[(-1) \cdot F_{cwt} \cdot \left[\sin \left[\operatorname{atan}\left(\frac{y_{aux} - height_i}{x_{aux}} \right) + \operatorname{asin}\left[\frac{R_{aux}}{\left[\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_i}{x_{aux}} \right) \right)} \right]} \right] \right] \right] \right] \right]$$

Known:

$F_{cwt} := 18500$ $\quad$ $Ropes := 20$ $\quad$ $corner = 2$ $\quad$ $x_{aux} := 23.167$

$Mass_{unit} := 8.51$ $\quad$ $R_{aux} := 2.5$ $\quad$ $y_{aux} := 48.286$

*Reference Figure 2 following the sample calculations for descriptions of x_{aux}, y_{aux}, and R_{aux}

Input Data from strip charts:
Note: For presentation, a limited portion of the data used in the calculation is shown below. A total of 69 data points are used in the analysis.

	event	$CH1_{op}$	$CH2_{op}$	$CH3_{op}$	$CH4_{op}$
0	0	35.5	34.97	9.36	1.48
1	1	40.99	39.07	12.5	5.31
2	2	102.51	100.99	74.63	65.37
3	3	31.75	30.35	12.21	4.7
4	4	29.8	29.31	12.2	4.7
5	5	31	29.47	10.39	3.23
6	6	27.59	27.18	11.21	3.78
7	7	27.42	26.4	9.05	1.63
8	8	24.95	24.54	7.72	-0.36
9	9	21.73	20.56	8.53	0.97
10	10	19.68	19.28	7.73	-0.23
11	11	16.94	16.08	7.49	-0.18
12	12	13.84	13.37	7.26	-0.76
13	13	12.37	11.46	7.17	-0.44
14	14	9.8	9.25	7.43	-0.79
15	15	7.94	6.97	7.14	-0.09

$CH1_{cl} =$

	0
0	6.85
1	36.67
2	5.37
3	3.49
4	1.8
5	1.48
6	49.43
7	-1.13
8	-1.43
9	-1.5
10	-2.03
11	-2.1
12	-3.68
13	-2.88
14	-5.42
15	-4.32

$CH2_{cl} =$

	0
0	6.21
1	35.04
2	4.78
3	2.54
4	1.18
5	0.58
6	49.27
7	-1.74
8	-1.91
9	-2.02
10	-2.53
11	-2.6
12	-4.26
13	-3.31
14	-6.01
15	-5.01

$CH3_{cl} =$

	0
0	-6.42
1	15.91
2	4.61
3	2.56
4	0.65
5	-3.72
6	39.4
7	-7.15
8	-9.52
9	-13.08
10	-15.9
11	-18.31
12	-19.56
13	-22.63
14	-21.07
15	-25.87

$CH4_{cl} =$

	0
0	-11.91
1	10.24
2	-1.84
3	-2.68
4	-5
5	-9.49
6	32.38
7	-12.34
8	-15.35
9	-18.83
10	-22.03
11	-24.12
12	-25.86
13	-28.52
14	-27.73
15	-31.18

$$height := event \cdot \left[\frac{\pi \cdot 15}{\left(\frac{280}{19}\right)} \cdot \frac{1}{2} \right]$$

This operation converts the event marks to lift height in feet (2 event marks per revolution of the rack pinion shaft).

The following variables will be used:

G = shear modulus of shaft material (11,500,000 psi for steel)
J = polar moment of inertia
R = total ratio from gages to trunnion including rack and pinion
Ro = radius to outside of shaft on which gages are mounted
Ri = radius of hole through shaft (if applicable)
Ratio = Ratio from pinion to rack
Radius to ropes = Rope pitch radius on sheave
n = efficiency from gages to trunnion

$$G := 11.5$$

$$R_o := \frac{6.5}{2}$$

$$R_i := \frac{0}{2}$$

$$J := \frac{\pi}{2} \cdot \left(R_o^{\,4} - R_i^{\,4} \right)$$

Prepared By: JRW
Checked By: RST

Solve for Torque in shaft on which gages are located:
TOS = opening torque in the shaft on which the gages are mounted
TCS = closing torque in the shaft on which the gages are mounted

$$TOS_{ch1} := G \cdot \frac{J}{R_o} \cdot CH1_{op} \cdot \frac{1}{12} \qquad TCS_{ch1} := G \cdot \frac{J}{R_o} \cdot CH1_{cl} \cdot \frac{1}{12}$$

$$TOS_{ch2} := G \cdot \frac{J}{R_o} \cdot CH2_{op} \cdot \frac{1}{12} \qquad TCS_{ch2} := G \cdot \frac{J}{R_o} \cdot CH2_{cl} \cdot \frac{1}{12}$$

$$TOS_{ch3} := G \cdot \frac{J}{R_o} \cdot CH3_{op} \cdot \frac{1}{12} \qquad TCS_{ch3} := G \cdot \frac{J}{R_o} \cdot CH3_{cl} \cdot \frac{1}{12}$$

$$TOS_{ch4} := G \cdot \frac{J}{R_o} \cdot CH4_{op} \cdot \frac{1}{12} \qquad TCS_{ch4} := G \cdot \frac{J}{R_o} \cdot CH4_{cl} \cdot \frac{1}{12}$$

Solve for Force at Ropes to produce recorded torques
FOS = opening force at ropes
FCS = closing force at ropes
Ratio = Ratio from pinion to rack
Radius to ropes = Rope pitch radius on sheave
n = efficiency from gages to trunnion

$$Ratio := \frac{280}{19}$$

$$Radius_{toropes} := \frac{15}{2}$$

$$n := .98$$

$$FOS_{ch1} := TOS_{ch1} \cdot \left(\frac{Ratio \cdot n}{Radius_{toropes}} \right) \qquad FOS_{ch2} := TOS_{ch2} \cdot \left(\frac{Ratio \cdot n}{Radius_{toropes}} \right)$$

$$FCS_{ch1} := TCS_{ch1} \cdot \left(\frac{Ratio \cdot n}{Radius_{toropes}} \right) \qquad FCS_{ch2} := TCS_{ch2} \cdot \left(\frac{Ratio \cdot n}{Radius_{toropes}} \right)$$

$$FOS_{ch3} := TOS_{ch3} \cdot \left(\frac{Ratio \cdot n}{Radius_{toropes}} \right) \qquad FOS_{ch4} := TOS_{ch4} \cdot \left(\frac{Ratio \cdot n}{Radius_{toropes}} \right)$$

$$FCS_{ch3} := TCS_{ch3} \cdot \left(\frac{Ratio \cdot n}{Radius_{toropes}} \right) \qquad FCS_{ch4} := TCS_{ch4} \cdot \left(\frac{Ratio \cdot n}{Radius_{toropes}} \right)$$

$$FO := FOS_{ch1} + FOS_{ch2} + FOS_{ch3} + FOS_{ch4}$$

$$FC := FCS_{ch1} + FCS_{ch2} + FCS_{ch3} + FCS_{ch4}$$

$$Imb_{total} := \frac{FO + FC}{2}$$

$$Friction := \frac{FO - FC}{2}$$

Equation for the fitting curve:

$$F(Imbalance_{set}, height) := \left[Imbalance_{set} + \left[-2 \cdot corner \cdot (Ropes \cdot Mass_{unit}) \cdot height\right] \ldots \\ + corner \cdot \left[(-1) \cdot F_{cwt} \cdot \left[\sin\left[atan\left(\frac{y_{aux} - height}{x_{aux}}\right) + asin\left[\frac{R_{aux}}{\left[\frac{x_{aux}}{\cos\left(atan\left(\frac{y_{aux} - height}{x_{aux}}\right)\right)}\right]}\right]\right]\right]\right]\right]$$

$i := 12 .. length(height) - 11$ i is a range variable for the number of rows in the above matrices. The points

$$SSE(Imbalance_{set}) := \sum_i \left(Imb_{total_i} - F(Imbalance_{set}, height_i)\right)^2$$

$Imbalance_{set} := 50000$, initial guess

Given

$SSE(Imbalance_{set}) = 0$

$Imbalance_{set} := MinErr(Imbalance_{set})$

$Imbalance_{set} = 41698.145$, Solution

$height := 0$

$$Imbalance_{ini} := \left[Imbalance_{set} + \left[-2 \cdot (corner \cdot Ropes \cdot Mass_{unit}) \cdot height\right] \ldots \\ + \left[corner \cdot \left[(-1) \cdot F_{cwt} \cdot \left[\sin\left[atan\left(\frac{y_{aux} - height}{x_{aux}}\right) + asin\left[\frac{R_{aux}}{\left[\frac{x_{aux}}{\cos\left(atan\left(\frac{y_{aux} - height}{x_{aux}}\right)\right)}\right]}\right]\right]\right]\right]\right]\right]$$

$Imbalance_{ini} = 7628$ $mean(Friction) = 4518$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

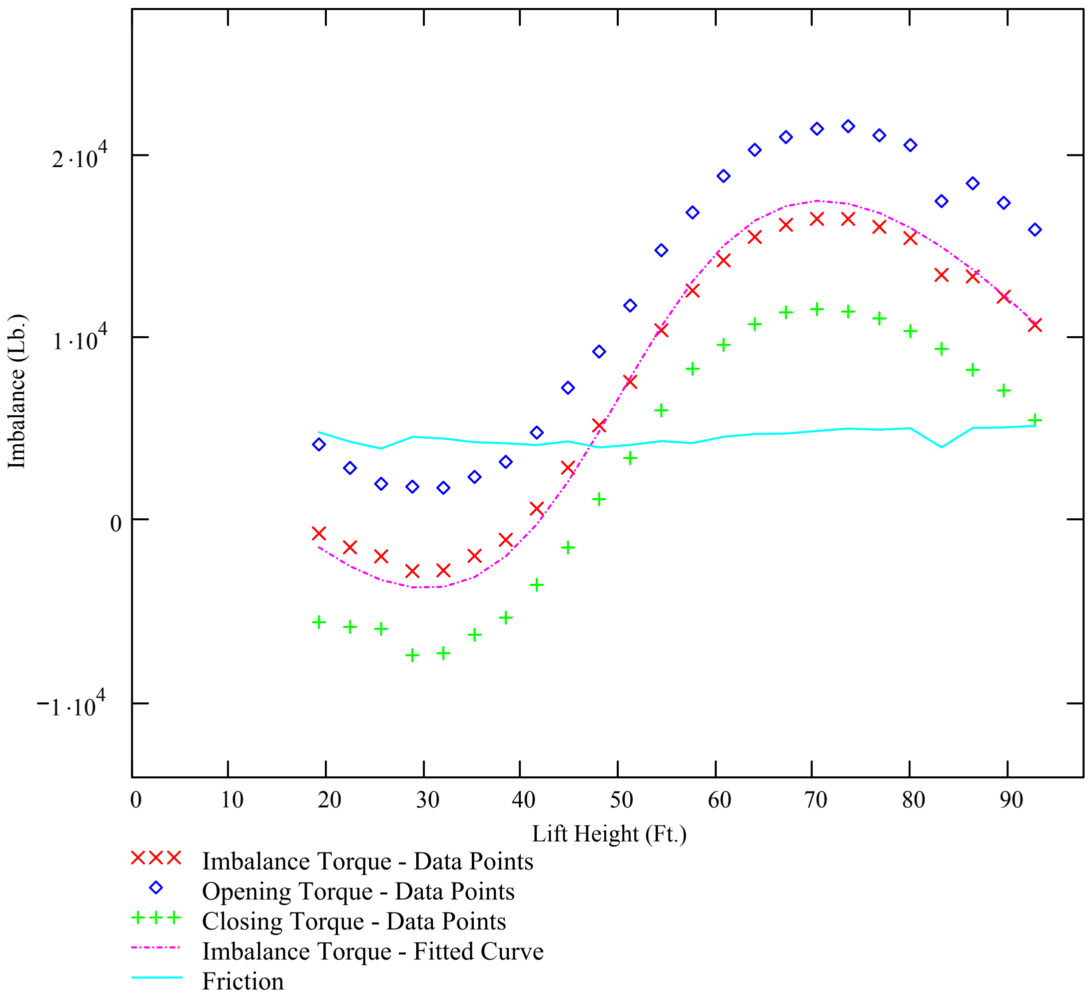
APPENDIX D

Graphical Results
Best Fit of Theoretical Imbalance Curve to Imbalance Data

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario"
TOWER = "North Tower"
TEST_DATE = "May 30, 2007"

BRIDGE_TYPE= "Tower Drive Vertical Lift"
TEST_ID = "Test 3 Run 1"



Average
100 Points

Analyze
$height_{min} = 19.2$
$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{ini} := \left[Imbalance_{set} + \left[-2\cdot(corners\cdot Ropes\cdot Mass_{unit})\cdot height_{ini}\right] \ldots + \left[corners\cdot\left[-F_{cwt}\cdot\left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

$Imbalance_{ini} = 7989$

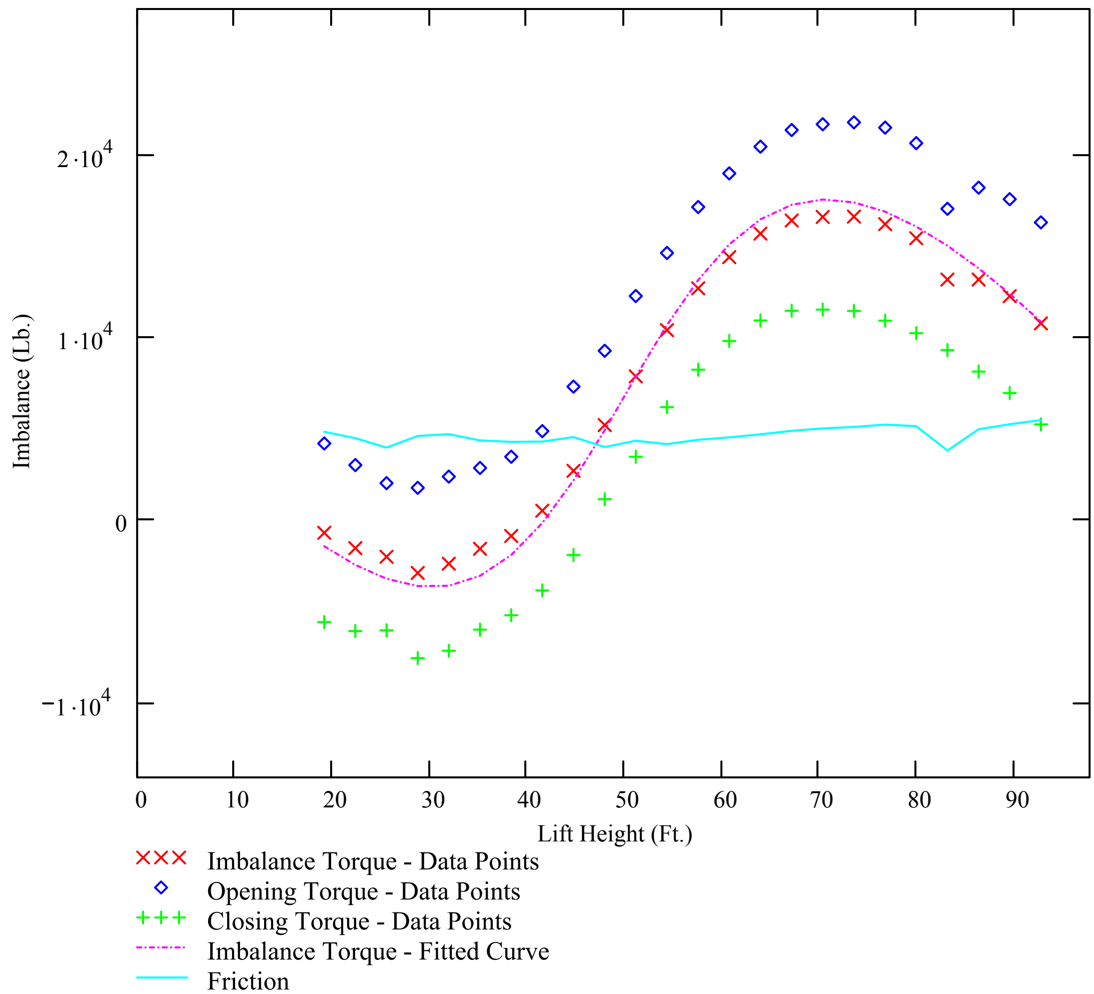
$Friction_{ave} = 4582$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario"
TOWER = "North Tower"
TEST_DATE = "May 30, 2007"

BRIDGE_TYPE= "Tower Drive Vertical Lift"
TEST_ID = "Test 3 Run 2"



Average
100 Points

Analyze
$height_{min} = 19.2$
$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{ini} := \left[Imbalance_{set} + \left[-2 \cdot (corners \cdot Ropes \cdot Mass_{unit}) \cdot height_{ini}\right] \ldots + \left[corners \cdot \left[-F_{cwt} \cdot \left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)} \right)} \right] \right] \right] \right] \right] \right]$$

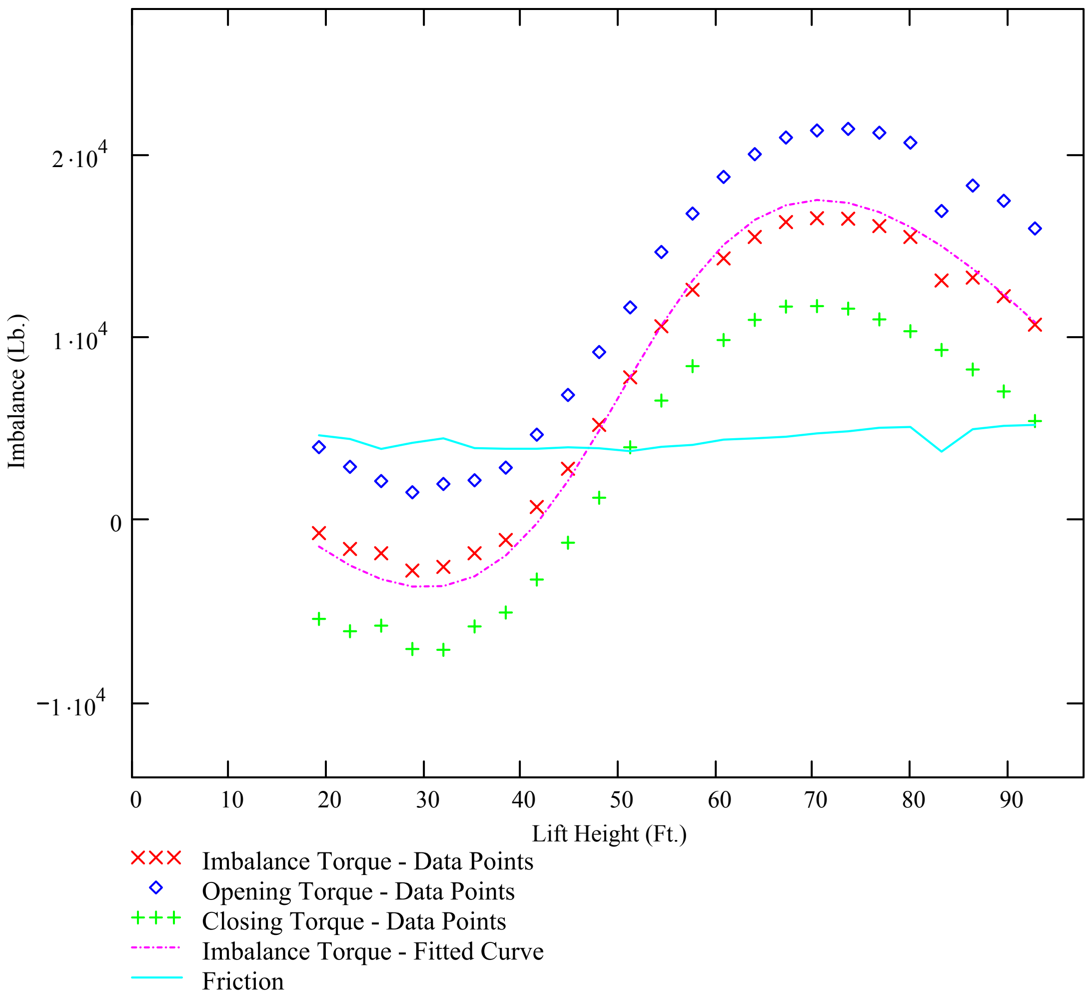
$Imbalance_{ini} = 8057$

$Friction_{ave} = 4681$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario"   BRIDGE_TYPE= "Tower Drive Vertical Lift"
TOWER = "North Tower"
TEST_DATE = "May 30, 2007"   TEST_ID = "Test 3 Run 3"



Average
100 Points

Analyze
$height_{min} = 19.2$
$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{ini} := \left[Imbalance_{set} + \left[-2\cdot(corners\cdot Ropes\cdot Mass_{unit})\cdot height_{ini}\right] \ldots + \left[corners\cdot\left[-F_{cwt}\cdot\left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

$Imbalance_{ini} = 8033$ $Friction_{ave} = 4451$

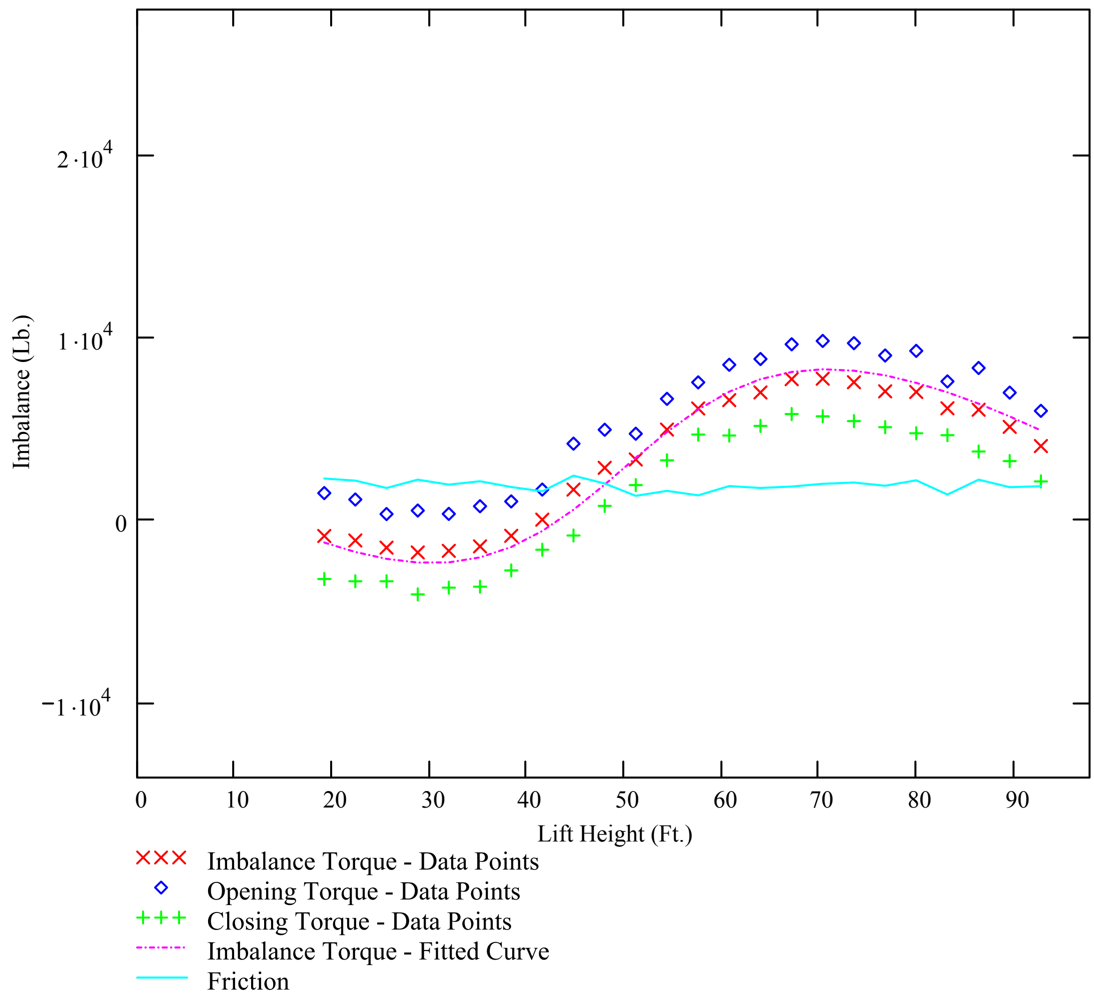
Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario" BRIDGE_TYPE= "Tower Drive Vertical Lift"

Corner1 = "NW Corner"

TEST_DATE = "May 30, 2007" TEST_ID = "Test 3 Run 1"



Average
100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

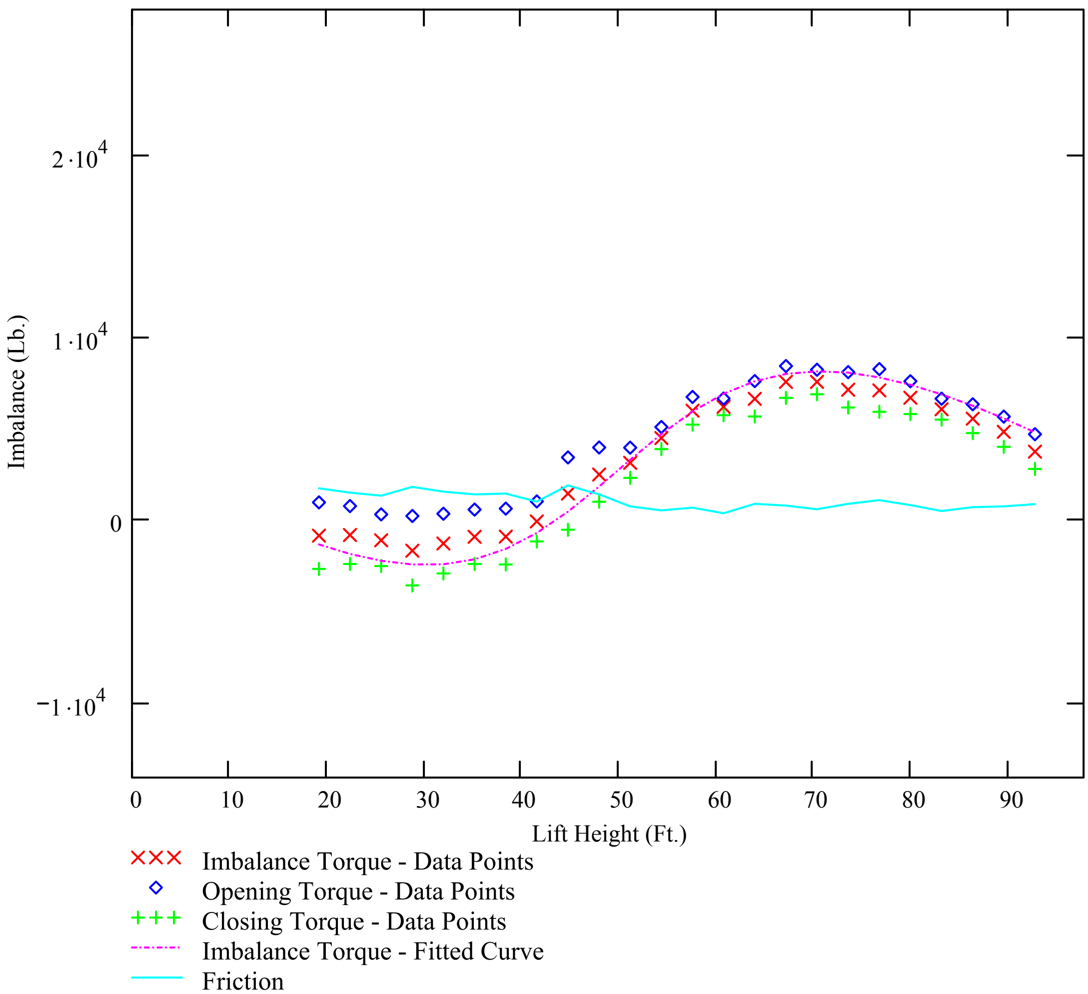
$$Imbalance_{iniC1} := \left[Imbalance_{setC1} + \left[-2\cdot(corner\cdot Ropes\cdot Mass_{unit})\cdot height_{ini}\right] \ldots \\ + \left[corner\cdot\left[-F_{cwt}\cdot\left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

$Imbalance_{iniC1} = 3561$ $Friction_{aveC1} = 1967$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario"
BRIDGE_TYPE= "Tower Drive Vertical Lift"
Corner1 = "NW Corner"
TEST_DATE = "May 30, 2007"
TEST_ID = "Test 3 Run 2"



Average
100 Points

Analyze
$height_{min} = 19.2$
$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC1} := \left[Imbalance_{setC1} + \left[-2 \cdot (corner \cdot Ropes \cdot Mass_{unit}) \cdot height_{ini} \right] \ldots \right.$$
$$\left. + \left[corner \cdot \left[-F_{cwt} \cdot \left[\sin \left[atan\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) + asin\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(atan\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) \right)} \right)} \right] \right] \right] \right] \right]$$

$Imbalance_{iniC1} = 3453$
$Friction_{aveC1} = 1134$

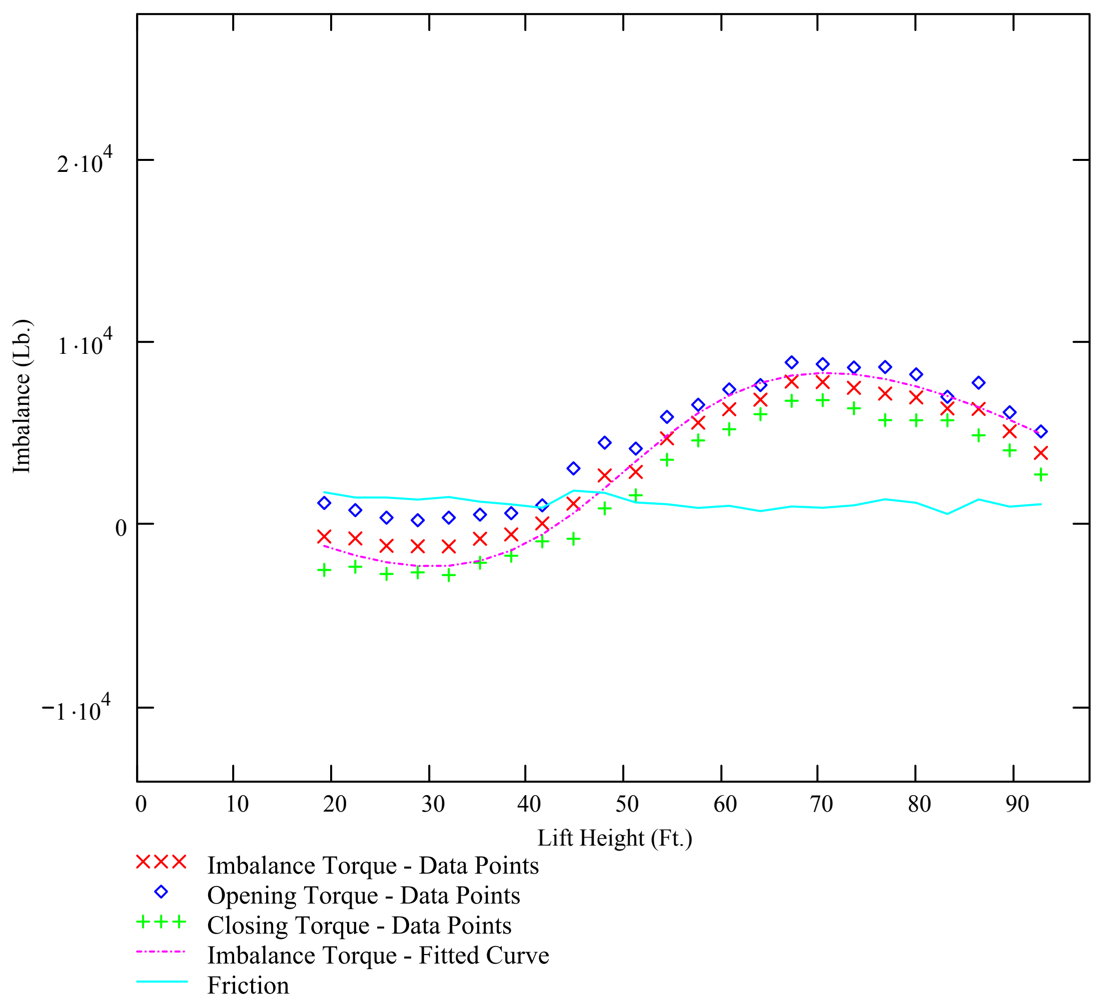
Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE = "Burlington Lift Bridge - Hamilton, Ontario"　　BRIDGE_TYPE = "Tower Drive Vertical Lift"

Corner1 = "NW Corner"

TEST_DATE = "May 30, 2007"　　TEST_ID = "Test 3 Run 3"



Average
100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC1} := \left[Imbalance_{setC1} + \left[-2 \cdot (corner \cdot Ropes \cdot Mass_{unit}) \cdot height_{ini} \right] \ldots + \left[corner \cdot \left[-F_{cwt} \cdot \left[\sin \left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) \right)} \right)} \right] \right] \right] \right] \right] \right]$$

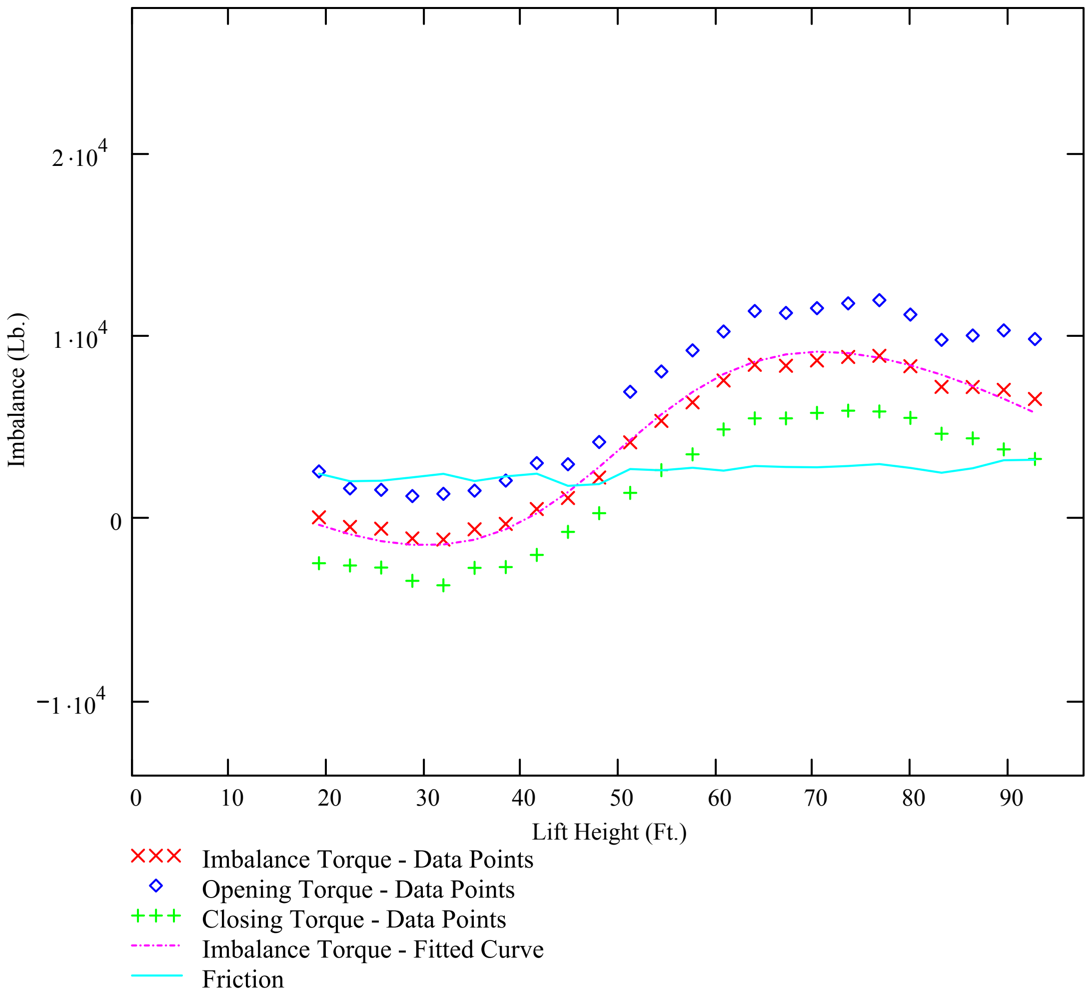
$Imbalance_{iniC1} = 3603$　　$Friction_{aveC1} = 1275$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario"
Corner2 = "NE Corner"
TEST_DATE = "May 30, 2007"

BRIDGE_TYPE= "Tower Drive Vertical Lift"
TEST_ID = "Test 3 Run 1"



Average
100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC2} := \left[Imbalance_{setC2} + \left[-2 \cdot \left(corner \cdot Ropes \cdot Mass_{unit}\right) \cdot height_{ini}\right] \ldots \\ + \left[corner \cdot \left[-F_{cwt} \cdot \left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) \right)} \right)} \right] \right] \right] \right] \right] \right]$$

$Imbalance_{iniC2} = 4428$

$Friction_{aveC2} = 2615$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

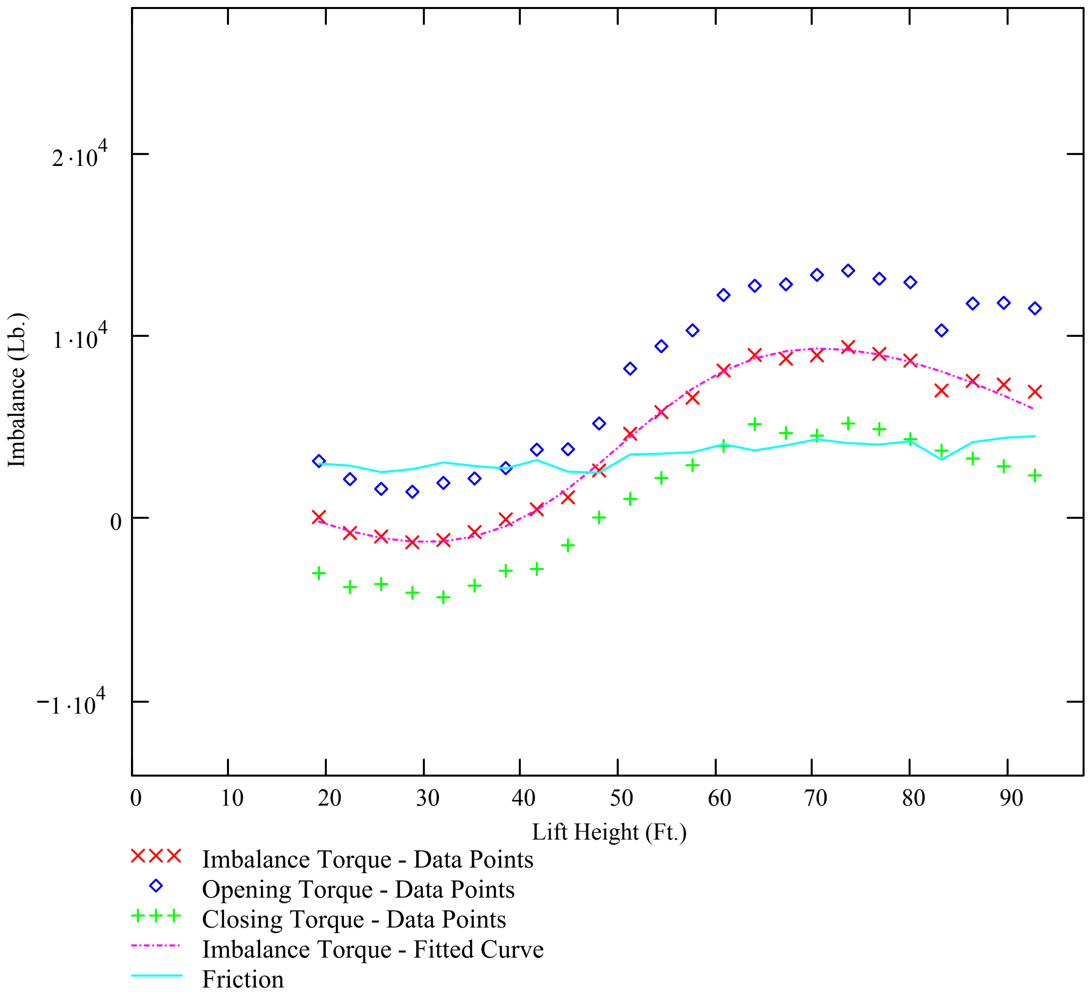
BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario"

Corner2 = "NE Corner"

TEST_DATE = "May 30, 2007"

BRIDGE_TYPE= "Tower Drive Vertical Lift"

TEST_ID = "Test 3 Run 2"



Average
100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC2} := \left[Imbalance_{setC2} + \left[-2\cdot\left(corner\cdot Ropes\cdot Mass_{unit}\right)\cdot height_{ini}\right] \ldots \right.$$
$$\left. + \left[corner\cdot\left[-F_{cwt}\cdot\left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\dfrac{x_{aux}}{\cos\left(\operatorname{atan}\left(\dfrac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

$Imbalance_{iniC2} = 4604$

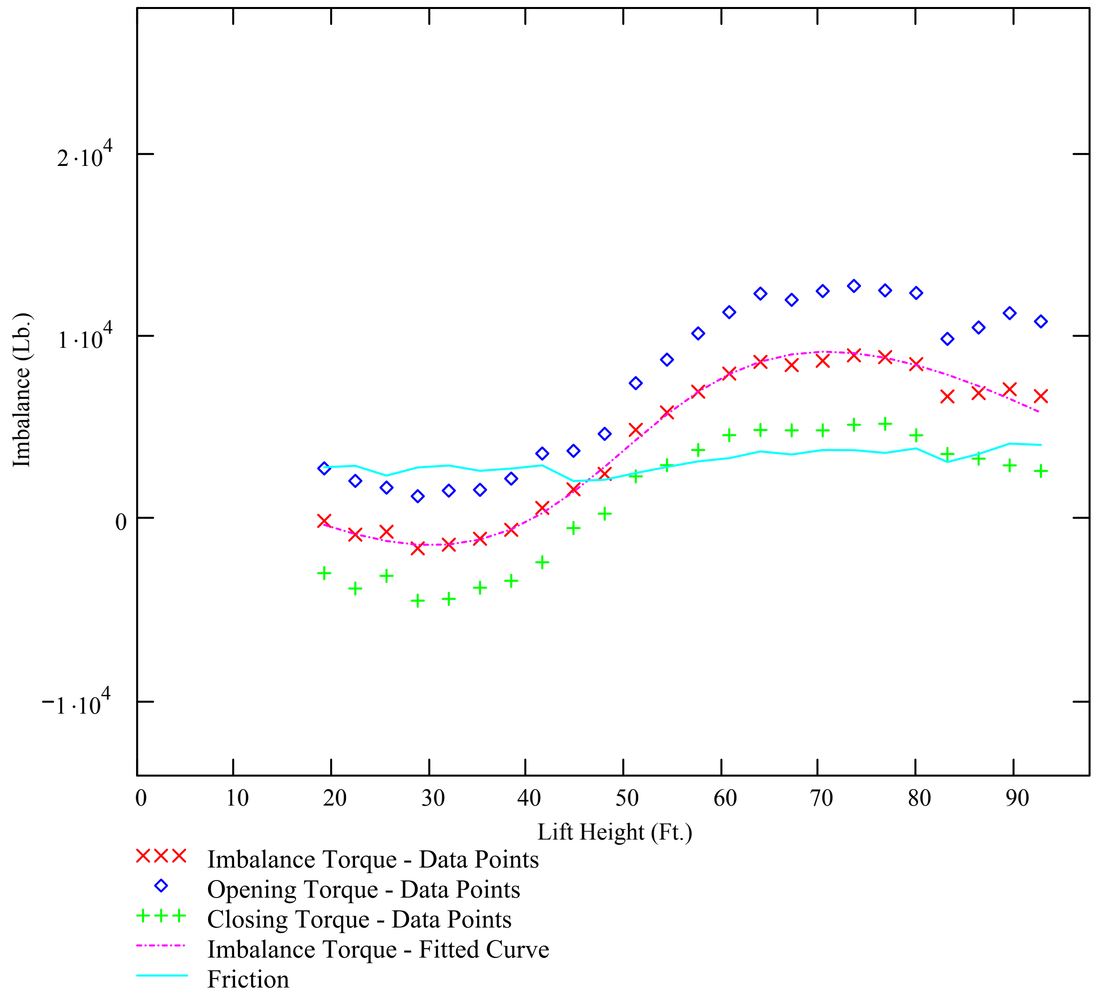
$Friction_{aveC2} = 3546$

Positive imbalance indicates bridge is span heavy.

Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE = "Burlington Lift Bridge - Hamilton, Ontario"
BRIDGE_TYPE = "Tower Drive Vertical Lift"
Corner2 = "NE Corner"
TEST_DATE = "May 30, 2007"
TEST_ID = "Test 3 Run 3"



Average
100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC2} := \left[Imbalance_{setC2} + \left[-2\cdot(corner\cdot Ropes\cdot Mass_{unit})\cdot height_{ini}\right] \ldots + \left[corner\cdot\left[-F_{cwt}\cdot\left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

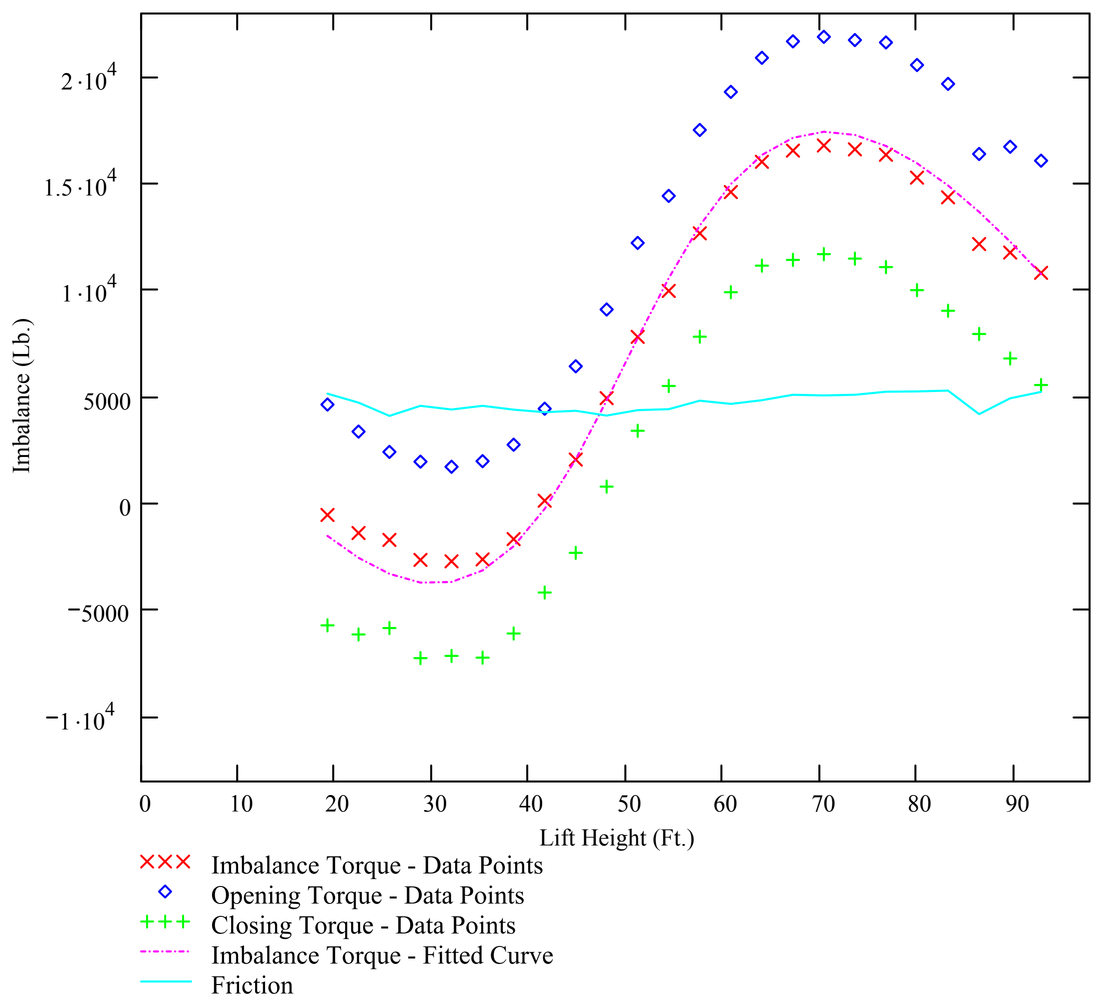
$Imbalance_{iniC2} = 4430$

$Friction_{aveC2} = 3176$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE = "Burlington Lift Bridge - Hamilton, Ontario"
BRIDGE_TYPE = "Tower Drive Vertical Lift"
TOWER = "South Tower"
TEST_DATE = "May 30, 2007"
TEST_ID = "Test 3 Run 1"



Average
100 Points

Analyze
$height_{min} = 19.2$
$height_{max} = 92.7$

$height_{ini} := 0$

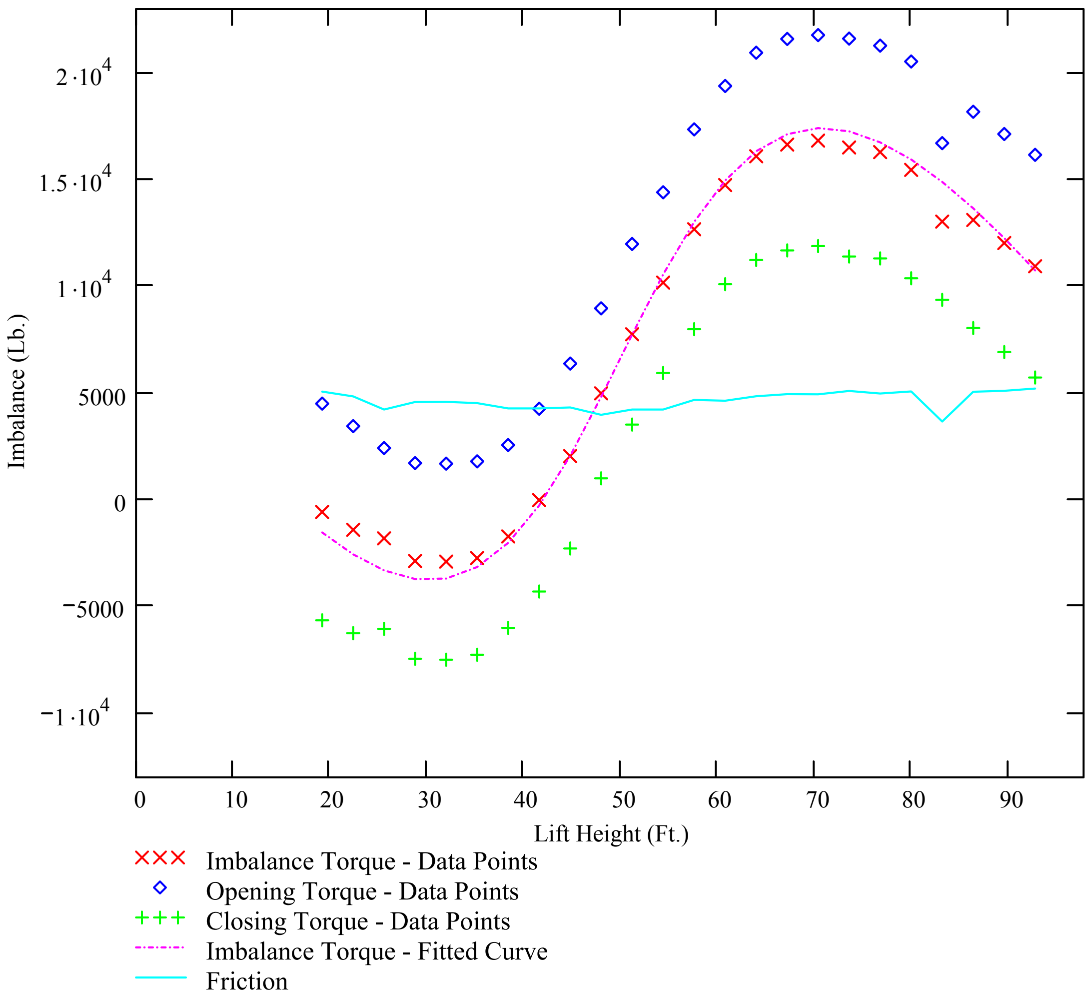
$$Imbalance_{ini} := \left[Imbalance_{set} + \left[-2 \cdot \left(corners \cdot Ropes \cdot Mass_{unit} \right) \cdot height_{ini} \right] \ldots \right.$$
$$\left. + \left[corners \cdot \left[-F_{cwt} \cdot \left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\dfrac{x_{aux}}{\cos\left(\operatorname{atan}\left(\dfrac{y_{aux} - height_{ini}}{x_{aux}} \right) \right)} \right)} \right] \right] \right] \right] \right] \right]$$

$Imbalance_{ini} = 7932$ $\qquad$ $Friction_{ave} = 4744$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario"
BRIDGE_TYPE= "Tower Drive Vertical Lift"
TOWER = "South Tower"
TEST_DATE = "May 30, 2007"
TEST_ID = "Test 3 Run 2"



Average
100 Points

Analyze
$height_{min} = 19.2$
$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{ini} := \left[Imbalance_{set} + \left[-2\cdot(corners\cdot Ropes\cdot Mass_{unit})\cdot height_{ini}\right] \ldots + \left[corners\cdot\left[-F_{cwt}\cdot\left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

$Imbalance_{ini} = 7895$ $Friction_{ave} = 4646$

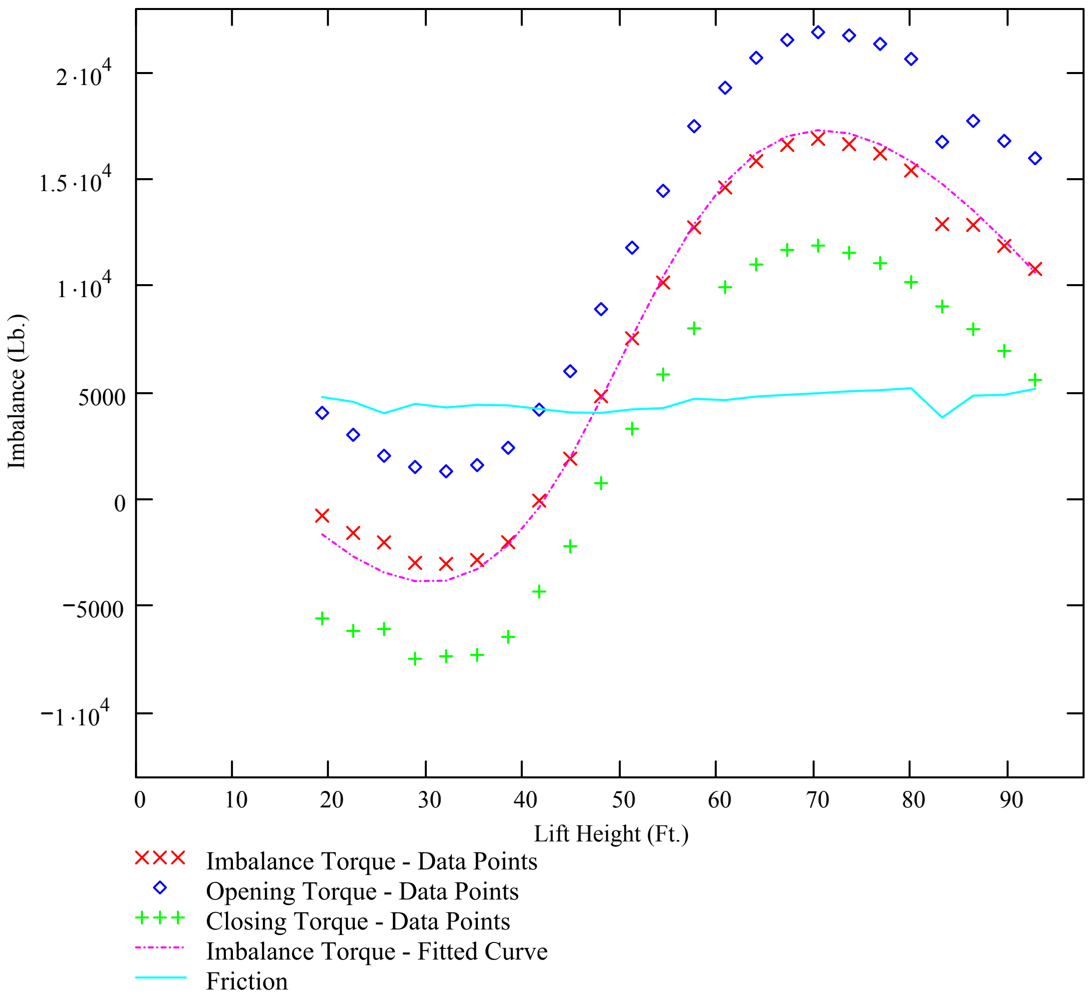
Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario"   BRIDGE_TYPE= "Tower Drive Vertical Lift"

TOWER = "South Tower"

TEST_DATE = "May 30, 2007"   TEST_ID = "Test 3 Run 3"



Average
100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{ini} := \left[Imbalance_{set} + \left[-2 \cdot \left(corners \cdot Ropes \cdot Mass_{unit} \right) \cdot height_{ini} \right] \cdots \\ + \left[corners \cdot \left[-F_{cwt} \cdot \left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) \right)} \right)} \right] \right] \right] \right] \right] \right]$$

$Imbalance_{ini} = 7801$ $Friction_{ave} = 4610$

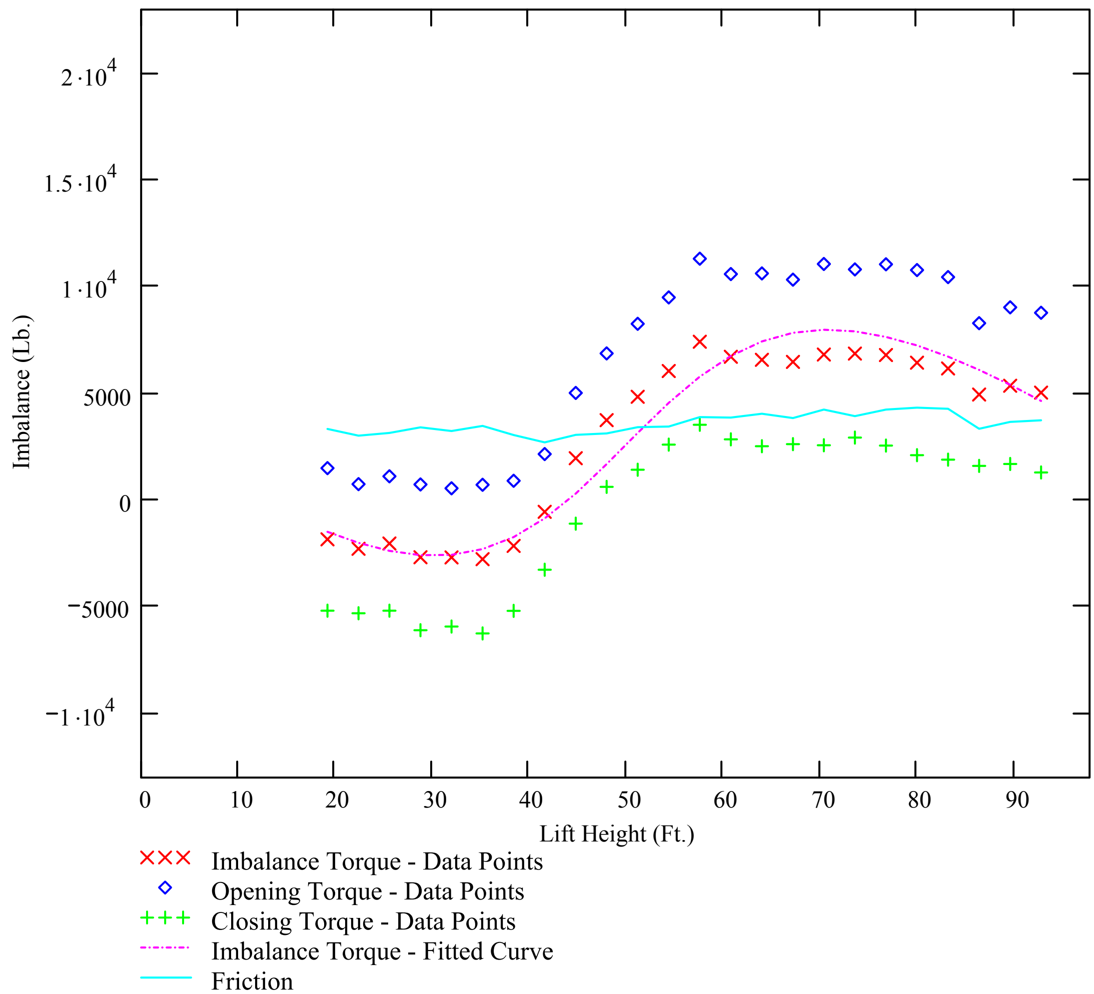
Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE = "Burlington Lift Bridge - Hamilton, Ontario"   BRIDGE_TYPE = "Tower Drive Vertical Lift"

Corner1 = "SW Corner"

TEST_DATE = "May 30, 2007"   TEST_ID = "Test 3 Run 1"



Average
100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC1} := \left[Imbalance_{setC1} + \left[-2\cdot\left(corner\cdot Ropes\cdot Mass_{unit}\right)\cdot height_{ini}\right] \ldots \atop + \left[corner\cdot\left[-F_{cwt}\cdot\left[\sin\left[atan\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + asin\left[\frac{R_{aux}}{\left(\dfrac{x_{aux}}{\cos\left(atan\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

$Imbalance_{iniC1} = 3226$ $Friction_{aveC1} = 3582$

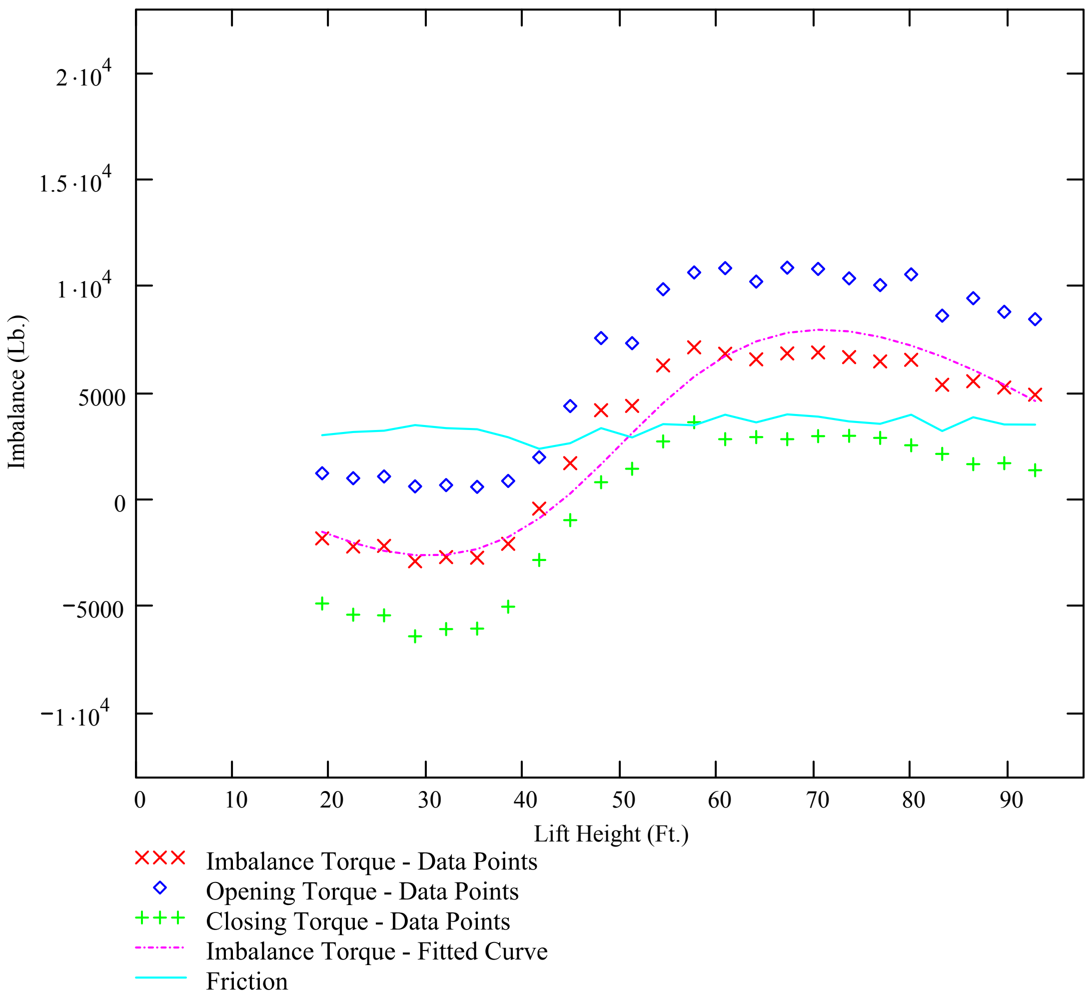
Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE = "Burlington Lift Bridge - Hamilton, Ontario" BRIDGE_TYPE = "Tower Drive Vertical Lift"

Corner1 = "SW Corner"

TEST_DATE = "May 30, 2007" TEST_ID = "Test 3 Run 2"



Average
100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC1} := \left[Imbalance_{setC1} + \left[-2\cdot\left(corner\cdot Ropes\cdot Mass_{unit}\right)\cdot height_{ini}\right] \ldots \\ + \left[corner\cdot\left[-F_{cwt}\cdot\left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

$Imbalance_{iniC1} = 3225$ $Friction_{aveC1} = 3426$

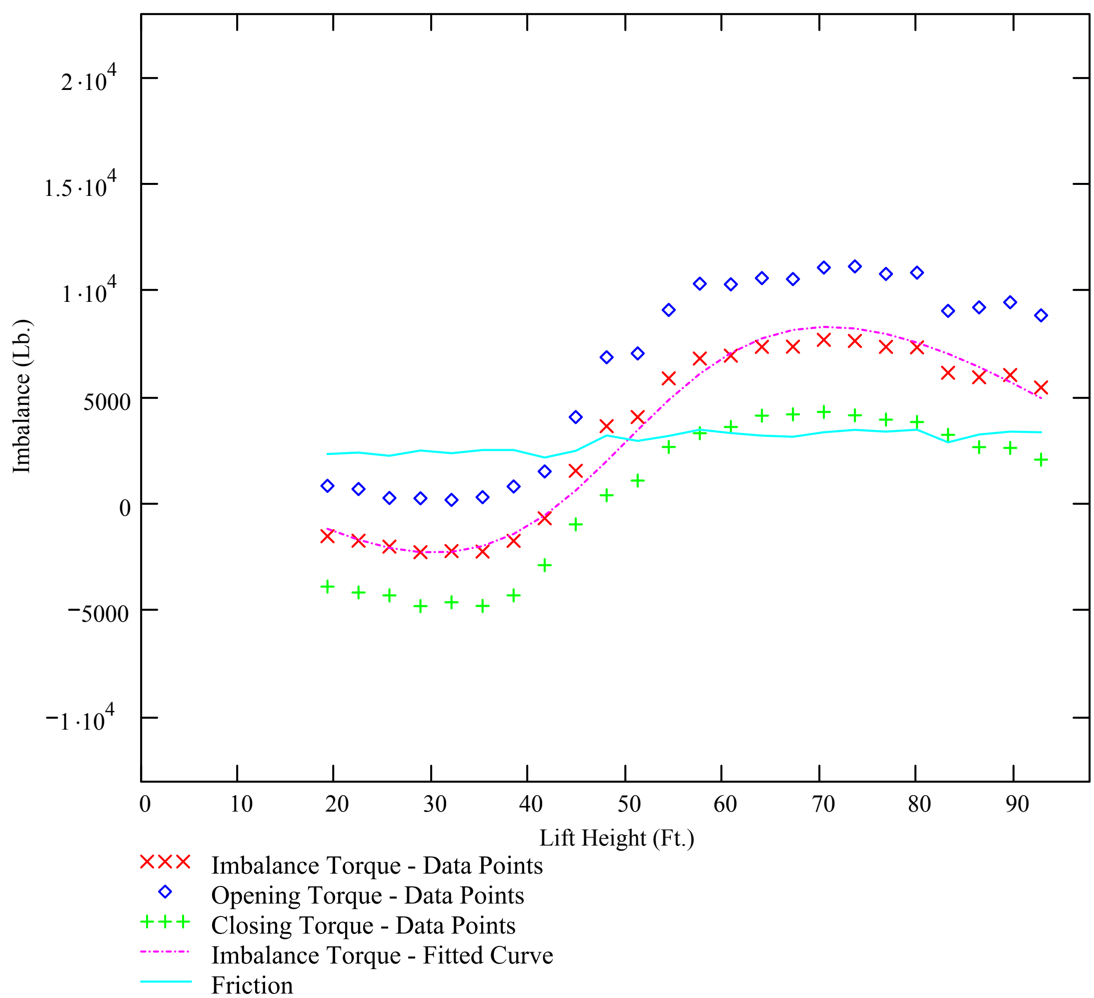
Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario" BRIDGE_TYPE= "Tower Drive Vertical Lift"

Corner1 = "SW Corner"

TEST_DATE = "May 30, 2007" TEST_ID = "Test 3 Run 3"



Average 100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC1} := \left[Imbalance_{setC1} + \left[-2 \cdot \left(corner \cdot Ropes \cdot Mass_{unit} \right) \cdot height_{ini} \right] \ldots \right.$$
$$\left. + \left[corner \cdot \left[-F_{cwt} \cdot \left[\sin \left[atan \left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) + asin \left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos \left(atan \left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) \right)} \right)} \right] \right] \right] \right] \right] \right]$$

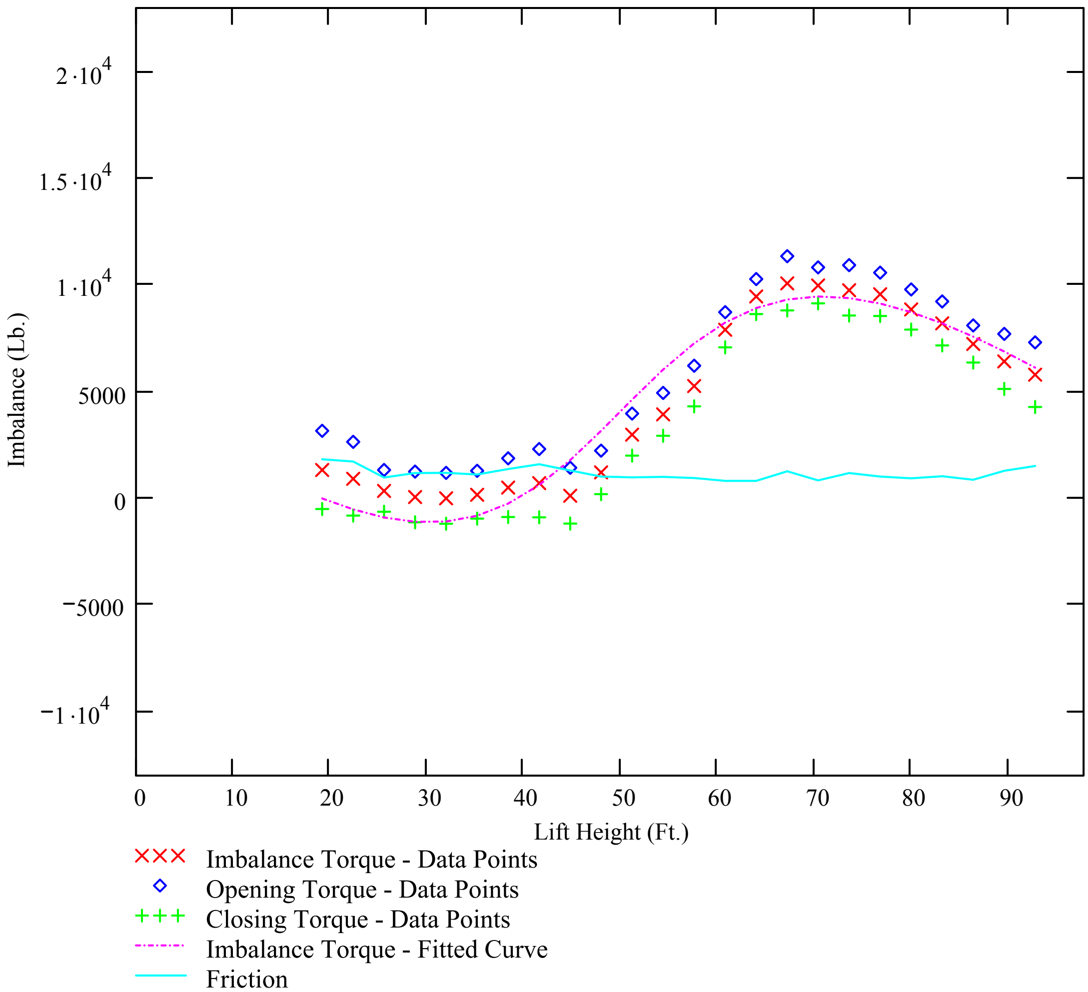
$Imbalance_{iniC1} = 3566$ $Friction_{aveC1} = 2970$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE = "Burlington Lift Bridge - Hamilton, Ontario"
Corner2 = "SE Corner"
TEST_DATE = "May 30, 2007"

BRIDGE_TYPE = "Tower Drive Vertical Lift"
TEST_ID = "Test 3 Run 1"



Average
100 Points

Analyze
$height_{min} = 19.2$
$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC2} := \left[Imbalance_{setC2} + \left[-2\cdot\left(corner\cdot Ropes\cdot Mass_{unit}\right)\cdot height_{ini}\right] \ldots \right.$$
$$\left. + \left[corner\cdot\left[-F_{cwt}\cdot\left[\sin\left[\operatorname{atan}\left(\frac{y_{aux}-height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\dfrac{x_{aux}}{\cos\left(\operatorname{atan}\left(\dfrac{y_{aux}-height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

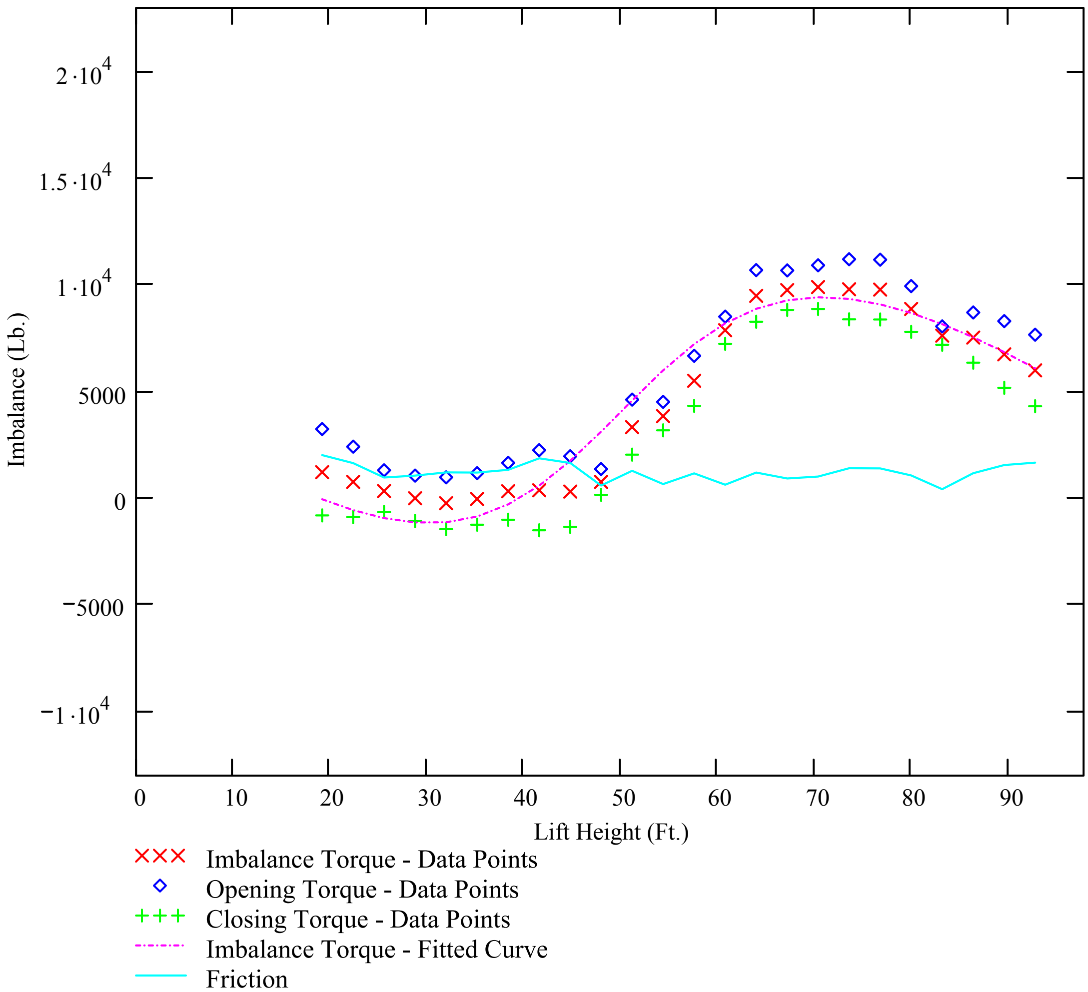
$Imbalance_{iniC2} = 4706$

$Friction_{aveC2} = 1162$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

BRIDGE = "Burlington Lift Bridge - Hamilton, Ontario"　　BRIDGE_TYPE = "Tower Drive Vertical Lift"
Corner2 = "SE Corner"
TEST_DATE = "May 30, 2007"　　TEST_ID = "Test 3 Run 2"



Average
100 Points

Analyze
$height_{min} = 19.2$
$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC2} := \left[Imbalance_{setC2} + \left[-2\cdot\left(corner\cdot Ropes\cdot Mass_{unit}\right)\cdot height_{ini}\right] \ldots \\ + \left[corner\cdot\left[-F_{cwt}\cdot\left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}}\right)\right)}\right)}\right]\right]\right]\right]\right]\right]$$

$Imbalance_{iniC2} = 4670$　　$Friction_{aveC2} = 1220$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

Span Balance Curves
Imbalance Versus Lift Height

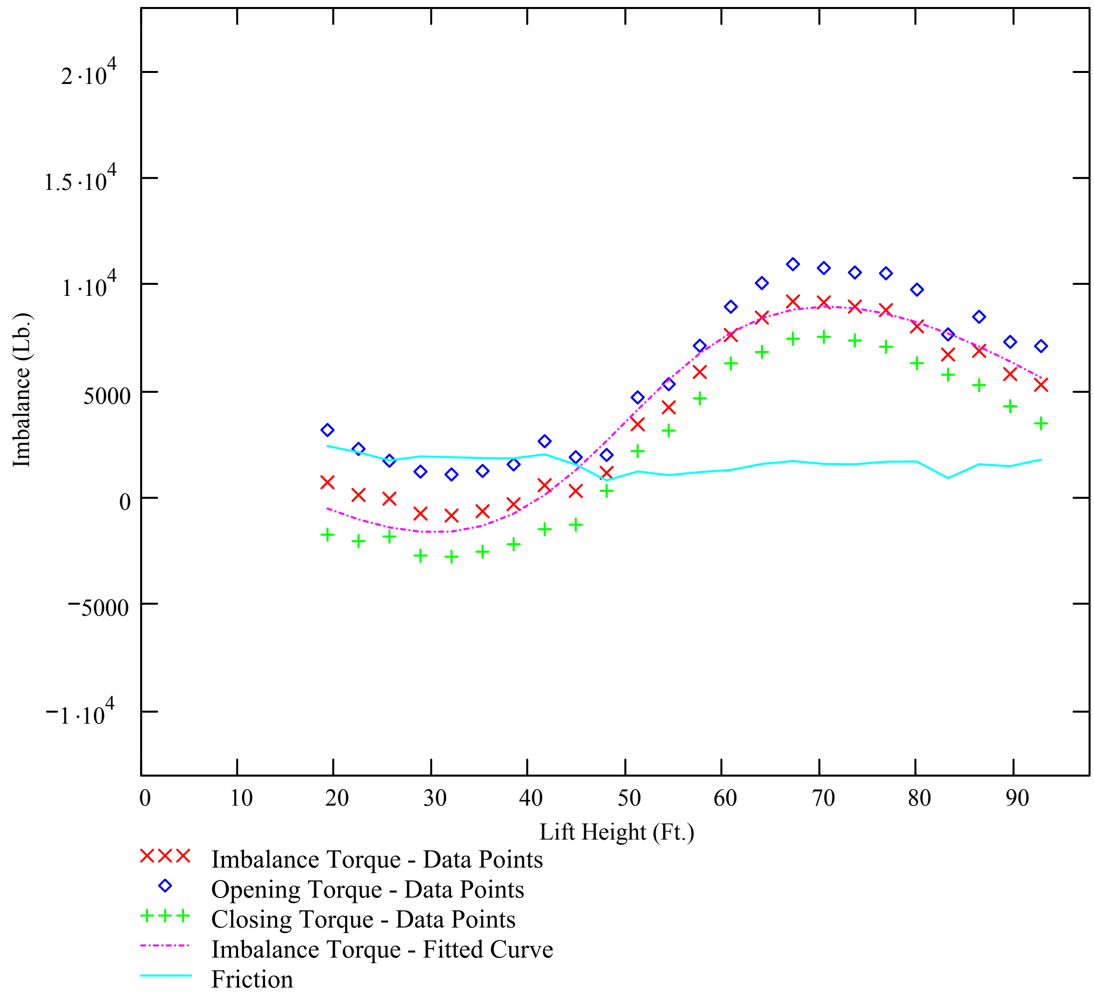
BRIDGE= "Burlington Lift Bridge - Hamilton, Ontario"

BRIDGE_TYPE= "Tower Drive Vertical Lift"

Corner2 = "SE Corner"

TEST_DATE = "May 30, 2007"

TEST_ID = "Test 3 Run 3"



Average

100 Points

Analyze

$height_{min} = 19.2$

$height_{max} = 92.7$

$height_{ini} := 0$

$$Imbalance_{iniC2} := \left[Imbalance_{setC2} + \left[-2 \cdot (corner \cdot Ropes \cdot Mass_{unit}) \cdot height_{ini}\right] \ldots \right. \\ \left. + \left[corner \cdot \left[-F_{cwt} \cdot \left[\sin\left[\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) + \operatorname{asin}\left[\frac{R_{aux}}{\left(\frac{x_{aux}}{\cos\left(\operatorname{atan}\left(\frac{y_{aux} - height_{ini}}{x_{aux}} \right) \right)} \right)} \right] \right] \right] \right] \right] \right]$$

$Imbalance_{iniC2} = 4235$

$Friction_{aveC2} = 1639$

Positive imbalance indicates bridge is span heavy.
Negative imbalance indicates bridge is counterweight heavy.

APPENDIX E

Summary of Counterweight Balance Block Adjustments

APPENDIX E

Summary of Counterweight Balance Block Adjustments

Date of Counterweight Adjustment	**North Counterweight Pocket**				**South Counterweight Pocket**			
	NE	**SE**	**NW**	**SW**	**NE**	**SE**	**NW**	**SW**
Estimated Initial Number of Blocks per Pocket (See Note 1)	*155*	*156*	*106*	*105*	*90*	*89*	*178*	*194*
March 16, 2007	NC	NC	NC	NC	-31	-31	NC	NC
March 17, 2007	-10	-10	-10	-10	-2	-2	-5	-5
May 29, 2007	-11	-11	-11	-11	NC	NC	NC	NC
May 30, 2007	-6	-8	NC	NC	NC	NC	-7	-7
Estimate Final Number of Blocks per Pocket (See Note 2)	*128*	*127*	*85*	*84*	*57*	*56*	*166*	*182*

Notes:

1. Estimated initial number of blocks per pocket not measured but inferred following determination of estimated final number of blocks per pocket after all adjustments completed.

2. Estimated final number of blocks remaining in each pocket calculated by measuring size of typical counterweight block (11.5” x 11.5” x 9”) and size of pocket.

3. Adjustments indicated with minus sign (eg. -10) show adjustment by removal of blocks.

4. “NC” indicates “No Change” to number of blocks.