FORTH ROAD BRIDGE

Project	Job Ref
Cable Band Bolt Replacement	
Part of structure	**Calc sheet no** **rev**
Main Cable	

Drawing ref	Calc by	Date	Check by	Date
	[illegible]	10/03/12		

Ref	Calculations	Output

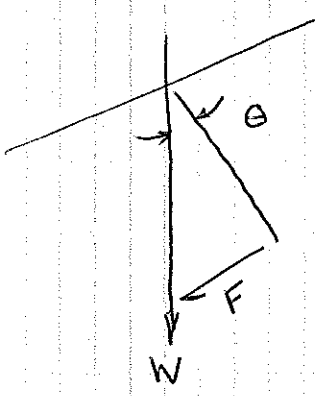
Panel Point S4 NE (4 bolts)

From AECOM Sheet

Hanger DL = 1050 kN
LL = 380 kN
} Σ = 1430 kN

Slope = θ = 17.5487°

FOS assuming 4 bolts have 800 kN tension & μ = 0.3 has been calculated by AECOM as 2.23 (lowest of all)



W = load due to hangers

$W_{DL\ only}$ = 1050 kN

W_{TOTAL} = 1430 kN

sin θ = sin 17.5487°
= 0.3015

$F = W \sin\theta$

$\therefore F_{TOTAL\ LOADS} = 1430 \times 0.3015 = 431$ kN

$F_{DL\ only} = 1050 \times 0.3015 = 317$ kN

We know that two bolts have cracked nuts & it is likely that the tension in the remaining bolts has decreased due to relaxation (but is unknown)

Note: BS4LL used but footway loading could be reduced.

This is looking at a global failure of the cable band

If one of the cracked nuts causes a bolt failure what is the minimum load (R) required in the remaining 3 bolts to prevent the FOS falling below unity.

FOS is simply = $\mu R / F$

Setting FOS = 1 = $0.3 \times R / F$

For the total load case (F_T)

$R_T = F_T / 0.3 = 431 / 0.3 = 1437$ KN

which is 479 KN per bolt.

Therefore, if 800 KN was original tension force then % loss of tension in each bolt would have to be:

$800 - 479 / 800 \times 100 = 40\%$

This assumes the remaining 3 bolts are undamaged (clearly one is damaged)

For the dead load case (F_{DL})

$R_{DL} = 317 / 0.3 = 1057$ KN or 352KN/bolt

Relaxation would be $\frac{800 - 352}{800} \times 100$ %

= 56% for FOS to ~~exceed~~ fall below 1 for DL only.

If both cracked nuts fail & this causes both bolts to fail, what is the minimum tension (R) required in the remaining two bolts to prevent the FOS falling below unity.

For the total load case (F_T)

$R_T = F_T / 0.3 = 431 / 0.3 = 1437$ kN

which is 719 kN / bolt

Therefore % loss in tension from 800 kN would be $(800 - 719)/800 \times 100 = 10\%$

For the dead load case (F_{DL})

$R_{DL} = F_{DL} / 0.3 = 317 / 0.3 = 1057$ kN

which is 528 kN / bolt

Therefore % loss would have to be $\frac{800 - 528}{100} \times 100 = 34\%$.

FORTH ROAD BRIDGE

Project	Job Ref
CABLE BAND BOLT REPLACEMENT	
Part of structure	**Calc sheet no** **rev**
MAIN CABLE	

Drawing ref	Calc by	Date	Check by	Date
	DB	12/03/2012		

Ref	Calculations	Output

PANNEL POINT 24

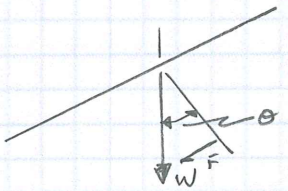
FROM AECOM SHEET

HANGER DL = 1540 kN, LL = 380 kN } Σ = 1920 kN

SLOPE = ANGLE θ = 16.140°

FOS ASSUMING 6 BOLTS HAVE 800 kN TENSION EACH & μ = 0.3 HAS BEEN CALCULATED BY AECOM AS 2.70.

μ = 0.3 (ASSUMED)



W = LOAD DUE TO HANGERS

$W_{DL\ ONLY}$ = 1540 kN

W_{TOTAL} = 1920 kN

$\sin\theta = \sin 16.1402^\circ$
$= 0.27799$

$F = W \sin\theta$

$F_{TOTAL\ LOADS} = 1920 \times 0.27799 = 533.74$ kN

$F_{DL\ ONLY} = 1520 \times 0.27799 = 422.5$ kN

TWO BOLTS HAVE CRACKED NUTS

TENSION IN REMAINING BOLTS DECREASED DUE TO RELAXATION, (RELAXATION UNKNOWN).

AS PREVIOUS — CALCULATE % OF RELAXATION IN 5 BOLTS TO CAUSE FOS $\leq$ 1.0

$FOS = \mu R / F$ (R = LOAD IN BOLT)

$FOS = 1.0 = 0.3 \times \frac{R}{F}$

TOTAL LOAD CASE — $R_T = F_T / 0.3 = \frac{533.74}{0.3} = 1779.13$ kN

WHICH IS 355.8 kN PER BOLT

$\% \Rightarrow \left[1 - \frac{355.8}{800}\right] \times 100 = 55\%$ REDUCTION

5 BOLTS CONTRIBUTING

FORTH ROAD BRIDGE	Project: CABLE BAND BOLT REPLACEMENT			Job Ref
	Part of structure: MAIN CABLE			Calc sheet no / rev
	Drawing ref	Calc by: DB	Date: 12/03/2012	Check by / Date

Ref	Calculations	Output

PANNEL POINT L4 (CONT'D)

FOR DEAD LOAD CASE

$R_{DL} = \left(\frac{422.5}{0.3}\right)/5 = 281$ kN PER BOLT

PERCENTAGE REDUCTION $= \frac{800-281}{800} \times 100 = \underline{64\%}$ (5 BOLTS CONTRIBUTING)

ASSUME 4 BOLTS REMAINING (TOTAL LOAD)

$R_T = \frac{1779.13}{4} = 444.8$ kN (PER BOLT)

PERCENTAG REDUCTION $= \frac{800-444.8}{800} \times 100 = \underline{44.4\%}$

ASSUME 4 BOLTS REMAINING (DEAD LOAD)

$R_{DL} = \left(\frac{422.5}{0.3}\right)/4 = 352.1$ kN (PER BOLT)

PERCENTAGE REDUCTION $= \frac{800-352.1}{800} \times 100 = \underline{56\%}$

Summary Table

Panel Point	Assumption	% of relaxation in remaining bolts required for FOS to be unity	
		Total Load	Dead Load Only
54 NE	1 No. bolt failed (3 No. remaining)	40%	56%
	2 No. bolt failed (2 No. remaining)	10%	34%
24	1 No. bolt failed (5 No. remaining)	55%	64%
	2 No. bolt failed (4 No. remaining)	44%	56%