CARLOS FERNANDEZ CASADO, S.L.
OFICINA DE PROYECTOS

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HOJA ______ DE ______
FECHA ______

PROYECTO Chacanto

Chacanto Aerodynamic excitation:

(Formwork + Arches
cestay)

Summary:

Criterion		Conclusion
2.1 – Susceptibility:	X	In Range (further checks)
2.1.1 – vortex excitation:	X	might be problematic (if $v_r \geq 23$ m/s)
2.1.2 – turbulence:	✓	Not in Range: may be ignored.
2.1.3.2 – Galloping & stall flutter	X	Critical!!
2.1.3.3 – classical flutter	X	Does Not satisfy the condition!!

– Suspitability to Aerodynamic excitation:

2.1 : $P_b = \left(\frac{\rho b^2}{m}\right)\left(\frac{16 V_r^2}{b L f_B^2}\right)$

$\xrightarrow{V_r = 40 m/s}$ 0,4739
$\xrightarrow{V_r = 20 m/s}$ 0,1184

$0,04 \leq P_b \leq 1$

⇓

Check for
- 2.1.1
- 2.1.2
- 2.1.3

$\rho_{Air} = 1,2256$ kg/m³

$b = 12,6$ m

$d_4 = \underbrace{1,8}_{Form} + \underbrace{1,7}_{Arch} + \underbrace{0,3}_{Dist}$ m
$= 3,8$ m

$f_B = 1,17$ Hz

$f_T = 1,3$ Hz

Bridge Type 1A.

$L = 96,673$ m

$m = 2 \times \left[(0,5944\ m^2 \times 7850) + (1\ m^2 \times 2400\ kg/m^3)\right]$
$= 6306$ kg/m

2.1.1. Limited Amplitude response – Vortex excitation.

$$\frac{b^*}{d_4} = \frac{12{,}6}{3{,}8} = 3{,}31 \quad \boxed{\begin{array}{c} \leqslant 5 \\ \& \\ \text{Type 1A} \end{array}} \Rightarrow V_{cr} = 6.5\, f d_4$$

Critical wind speed
$$\begin{cases} \xrightarrow{f_B = 1{,}17\,Hz} V_{cr} = 28{,}899 \text{ m/s} \\ \xrightarrow{f_T = 1{,}3} V_{cr} = 32{,}11 \text{ m/s} \end{cases}$$

a) $f < 5\ Hz$ ✗

b) $V_{rs} = 1{,}25\, V_r \xrightarrow{V_r = 40\text{ m/s}} V_{rs} = 50$ m/s

$\xrightarrow{V_r = 20\text{ m/s}} V_{rs} = 25$ m/s

if $V_r \geqslant 23{,}1192$ m/s

Vortex excitation may happen in bending mode.

c) ?

2.1.2 Limited Amplitude Response

$f_B, f_T > 1\,Hz \Rightarrow$ the effect is neglected.

2.1.3 Direct Amplitude Response.

2.1.3.1 : galloping & stall flutter

a) vertical motion ⟶ not in categoris ⇒ neglected

b) Tortional motion:

$$V_g = 3.3 f_T b \Rightarrow V_g = 3.3(1.3\,Hz)(12,6\,m)$$

$$\boxed{V_g = 54,054 \ m/s}$$

2.1.3.3 classical flutter

$$V_{Rf} = 1,8\left(1 - 1,1\left(\frac{f_B}{f_T}\right)^2\right)^{1/2}\left(\frac{m\,r}{\rho b^3}\right)^{1/2},$$

$$r = \sqrt{\frac{I_z}{A}} = 5.985 \ m$$

$$V_{Rf} = 2,3316 < 2,5 \Rightarrow V_{Rf} = 2,5$$

$$V_f = V_{Rf}\, f_T \cdot b = \boxed{40,95}$$

$I_y = 6,9232e13 \ mm^4$

$I_x = 9,2815e12 \ mm^4$

$I_z = I_x + I_y = 78,51 \ m^4$

$A = 2,1918 \ m^2$

2.1.3.4 Limiting Criteria

Assumptions

K_{1A} = Assuming 1,25

V_d = " $50 \, m/s$

V_r = " $40 \, m/s$

$$V_{WO} = \frac{1{,}1}{3}(V_r + 2 \cdot V_d) K_{1A}$$

$$V_{WO} = 64{,}1 \, m/s \sim 54 \, m/s$$

$W_0 \approx V_g = 54{,}056$ X Caution!!

& $\gg V_f = 38{,}1925$ X " !!

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HOJA ______ DE ______

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Chencito - Aerodynamic stability (Scaffolding)

Summary:

	Criterion		Conclusion
2.1	- Susceptibility	X	In Range (further check)
2.1.1	- Vortex excitation	X	might be Problematic (if $V_r \geq 34$ m/s)
2.1.2	- turbulence	✓	Not in Range (my be ignored)
2.1.3.2	- Galloping & stall flutter	✓	Satisfies the condition
2.1.3.3	- Classical flutter	✓	Satisfies "

- Suseptibility to Aerodynamic excitation.

2.1

$$P_b = \left(\frac{\rho b^2}{m}\right)\left(\frac{16 V_r^2}{b L f_B^2}\right)$$

$\xrightarrow{V_r = 40 m/s}$ $P_b = 0{,}3618$

$\xrightarrow{V_r = 20 m/s}$ $P_b = 0{,}09045$

$0{,}04 \leq P_b \leq 1$

$\Downarrow$

Check for
- 2.1.1
- 2.1.2
- 2.1.3

$\rho = 1{,}2256\ kg/m^3$

$b = 12{,}6\ m$

$d_4 = 1{,}8\ m$

$m = 2 \times 9{,}5944e{-2}\ m^2 \times 7850\ kg/m^3 = 1506\ kg/m$

$f_B = 2{,}74\ Hz$

$f_T = 3{,}09\ Hz$

Bridge Type 1A.

$L = 96{,}637\ m$

2.1.1 Limited Amplitude response - Vortex excitation

$$b^*/d_4 = \frac{12{,}6}{1{,}8} = 7 \; \boxed{\begin{matrix} >5 \\ <10 \end{matrix}} \longrightarrow f d_4 \left(1{,}1\, b^*/d_4 + 1\right) = V_{cr}$$

$\&$ $\boxed{\text{Type } 1A}$

$\xrightarrow{f = 2{,}74\,Hz}$ $V_{cr} = 42{,}9\ m/s$

$\xrightarrow{f = 3{,}09\,Hz}$ $V_{cr} = 48\ m/s$

a) $f < 5\ Hz$ X

b) $V_{rs} = 1{,}25\, V_r$ $\xrightarrow{V_r = 40\,m/s}$ $V_{rs} = 50\ m/s$

$\xrightarrow{V_r = 20\,m/s}$ $V_{rs} = 25\ m/s$ X

if $V_r \geq 34{,}32\ m/s$ Vortex excitation may happen in bending Mode.

otherwise check with 3.1.

c) ?

2.1.2 Limited Amplitude Response

Both f_B and f_T are greather than 1Hz

Therefore the dynamic magnification effect at Turbulence can be ignored.

2.1.3 Divergent amplitude response

2.1.3.2 Galloping and stall flutter

a) vertical motion.

Type 1A is not included. (Not needed).

b) Torsional motion.

$$V_g = 3{,}3\ f_T\ b \Rightarrow V_g = 3{,}3\,(3{,}09\ Hz)(12{,}6\ m)$$

$$\boxed{V_g = 128{,}48\ \ m/s\ ?}$$

2.1.3.3

$$V_{Rf} = 1.8\left(1-1{,}1\left(\frac{f_B}{f_T}\right)^2\right)^{\frac{1}{2}}\left(\frac{mr}{\rho b^3}\right)^{\frac{1}{2}} \geq 2{,}5$$

$$V_f = V_{Rf}\ f_T\ b \qquad (r = \text{Radius of gyration})$$

(Double Arch)

$$r = \sqrt{\frac{I_z}{A}}$$

$I_t = 6{,}181\,e{-2}$

$A = 1{,}9189\,e{-1}$

$r = 5{,}6672$ m

$\left.\begin{array}{l} I_x = 1{,}07e{-1} \\ I_y = 6{,}056 \end{array}\right\} \boxed{I_z = I_x + I_y = 6{,}163\ m^4}$

$\Rightarrow V_{Rf} = 1{,}2343 < 2{,}5 \Rightarrow \boxed{V_{Rf} = 2{,}5}$

$V_f = (2{,}5)(3{,}09)(12{,}6) = \boxed{97{,}335\ m/s\ ??}$

2.1.3.4 limiting criterion

$$V_{wo} = \frac{1{,}1}{3}\left(V_r + 2V_d\right) K_{1A}$$

Assuming $V_r = 40\,m/s$, $V_d = 50\,m/s$, $K_{1A} = 1{,}25$

$V_{wo} = 64{,}1\,m/s \left.\begin{array}{l} < V_R \\ < V_g \end{array}\right\}$ Satisfies the criterion