



Annexes
Renforcement de dalles épaisses
Volet expérimental

Rapport d'étape
Département de génie civil
GCI-2009-01

Présenté à
Sylvain Goulet ing.
Chargé de projet
Ministère des transports du Québec

Par
Josée Bastien, ing. PhD, responsable
Philippe Provencher, étudiant
Marc Jolin, ing. PhD

fevrier 2010

CANQ
UL
505
2010
Ann.



1128095

Annexe A

Caractéristiques sommaires des dalles épaisses

REÇU
Centre de documentation
25 FEV. 2013
Ministère des Transports

CANQ
UL
505
2010
Ann.

Ministère des Transports
Centre de documentation
700, boul. René-Lévesque Est,
21^e étage
Québec (Québec) G1R 5H1

Dalles épaisses en béton armé Types 1A et 1B			
Portée libre 4000 mm	Longueur totale 5000 mm	Largeur 610 mm	Profondeur 450 mm
	Armature de flexion	Sans armature de cisaillement	Avec armature de cisaillement
Type 1A 2 échantillons	14-25M sur 2 rangs $M_r = 770$ kN.m $\rho = 3,10$ % $c/d = 0,574$	$V_r = V_c = 274$ kN $P_{max} = 401$ kN (1/3 portée, $a/d = 3,60$) $M_{max} = 368$ kN.m	N/A
Type 1B 2 échantillons	14-25M sur 2 rangs $M_r = 770$ kN.m $\rho = 3,10$ % $c/d = 0,574$	N/A	2-15M @ 240 mm c/c (verticales) $V_r = 535$ kN $P_{max} = 792$ kN (1/3 portée, $a/d = 3,60$) $M_{max} = 710$ kN.m

Dalles épaisses en béton armé Types 2A et 2B			
Portée libre 4000 mm	Longueur totale 5000 mm	Largeur 610 mm	Profondeur 450 mm
	Armature de flexion	Sans armature de cisaillement	Avec armature de cisaillement
Type 2A 2 échantillons	10-25M sur 1 rang $M_r = 660$ kN.m $\rho = 2,06$ % $c/d = 0,381$	$V_r = V_c = 263$ kN $P_{max} = 384$ kN (1/3 portée, $a/d = 3,35$) $M_{max} = 353$ kN.m	N/A
Type 2B 2 échantillons	10-25M sur 1 rang $M_r = 660$ kN.m $\rho = 2,06$ % $c/d = 0,381$	N/A	2-10M @ 260 mm c/c (verticales) $V_r = 391$ kN $P_{max} = 576$ kN (1/3 portée, $a/d = 3,35$) $M_{max} = 524$ kN.m
Dalles épaisses en béton armé Types 3A et 3B			
Portée libre 4000 mm	Longueur totale 5000 mm	Largeur 610 mm	Profondeur 750 mm

	Armature de flexion	Sans armature de cisaillement	Avec armature de cisaillement
Type 3A 2 échantillons	10-25M sur 1 rang $M_r = 1260 \text{ kN.m}$ $\rho = 1,17 \%$ $c/d = 0,217$	$V_r = V_c = 361 \text{ kN}$ $P_{\max} = 708 \text{ kN}$ (1/2 portée, $a/d = 2,87$) $M_{\max} = 729 \text{ kN.m}$	N/A
Type 3B 2 échantillons	10-25M sur 1 rang $M_r = 1260 \text{ kN.m}$ $\rho = 1,17 \%$ $c/d = 0,217$	N/A	2-15M @ 470 mm c/c (verticales) $V_r = 631 \text{ kN}$ $P_{\max} = 1248 \text{ kN}$ (1/2 portée, $a/d = 2,87$) $M_{\max} = 1269 \text{ kN.m}$

Annexe B

Localisation des jauges de déformation

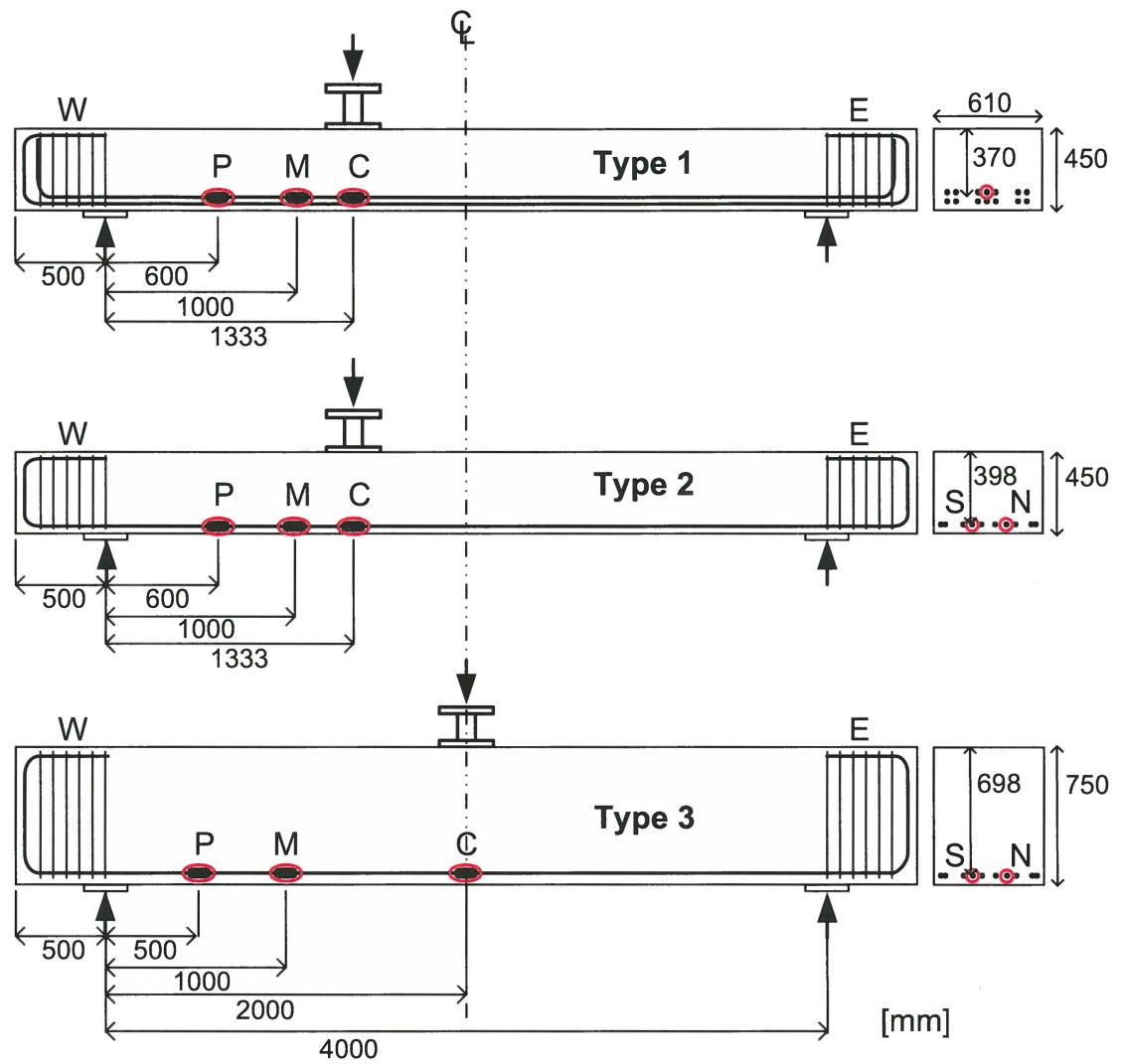


Figure B-1 : Position des jauges de déformation sur les armatures de flexion

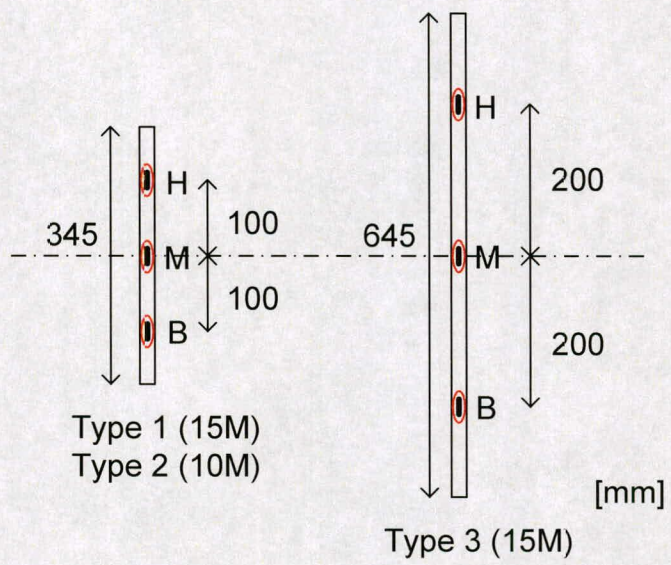
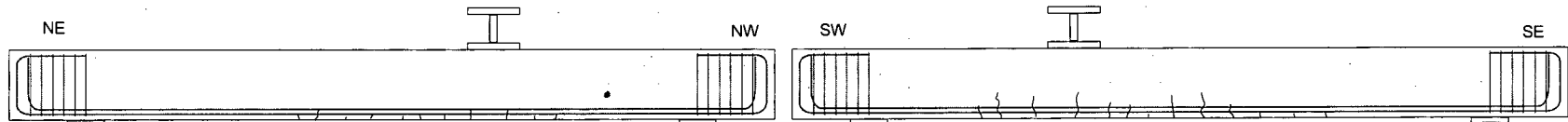


Figure B-2 : Position des jauges de déformation sur les barres de renforcement en

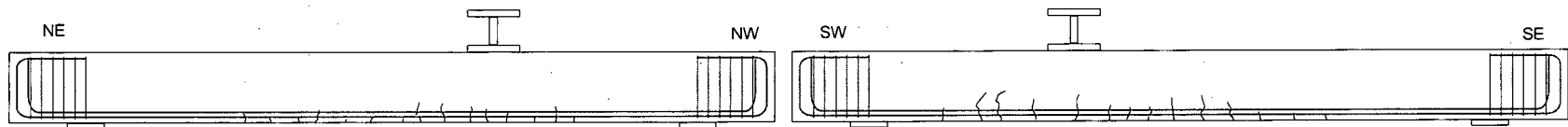
Annexe C

Schéma des fissures

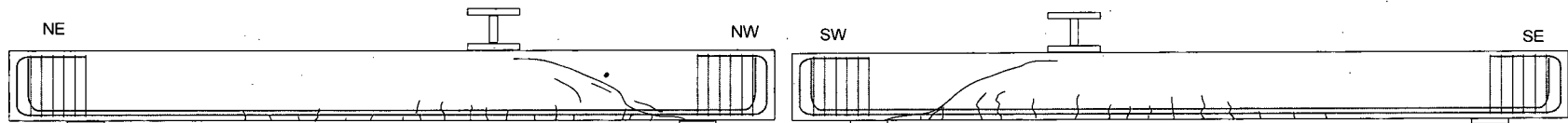
Dalle 1Aa
(charge max 474 kN @ 7,5 mm)
4,4 mm/293 kN.



6,4 mm/400 kN

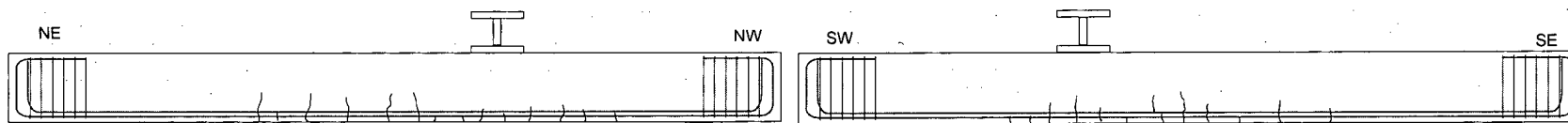


Fin

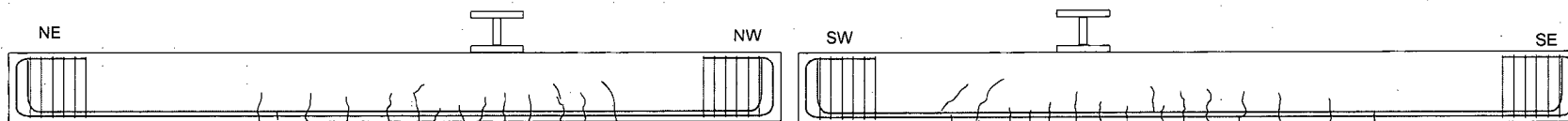


Dalle 1Ab
(charge max 475 kN @ 7,6 mm)

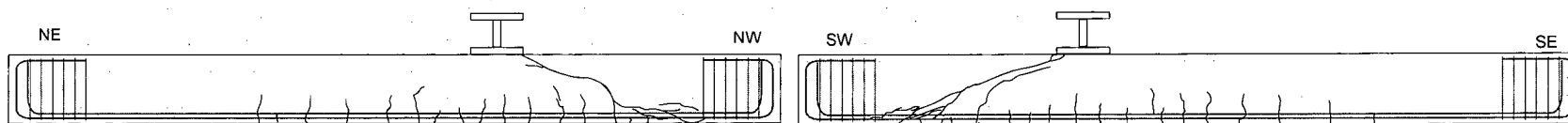
4,4 mm/280 kN



7,1 mm/455 kN

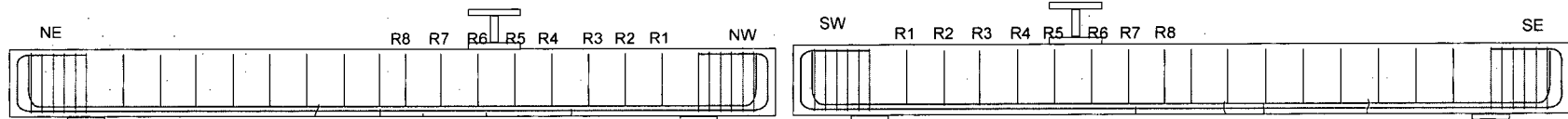


Fin

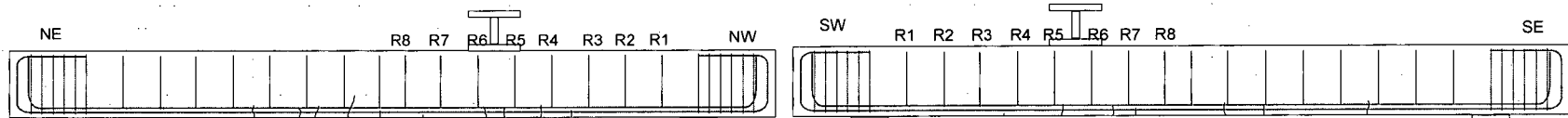


Dalle 1Ba (charge max 694 kN @ 13,6 mm)

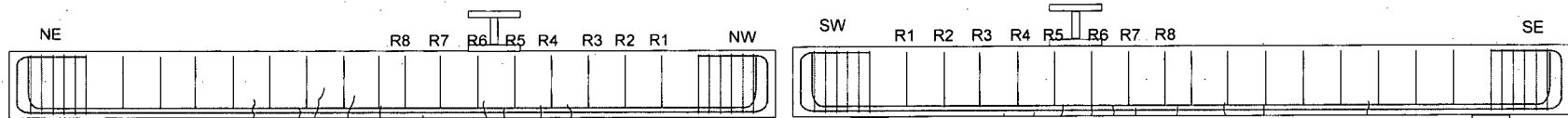
3,4 mm/227 kN



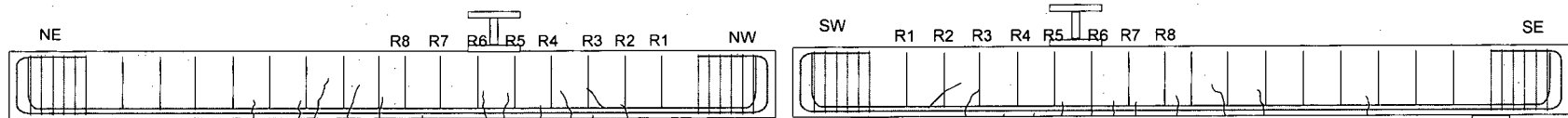
4,3 mm/282 kN



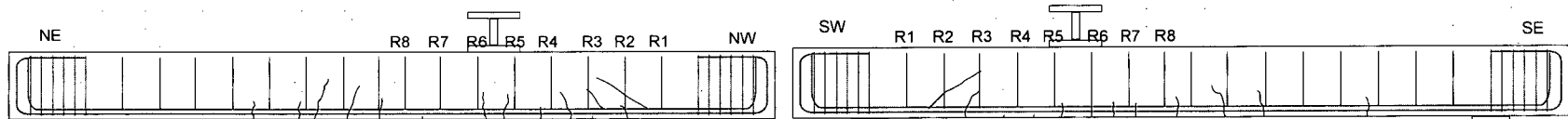
5,2 mm/338 kN



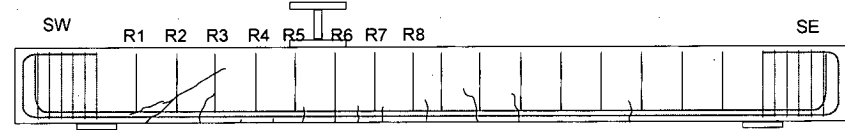
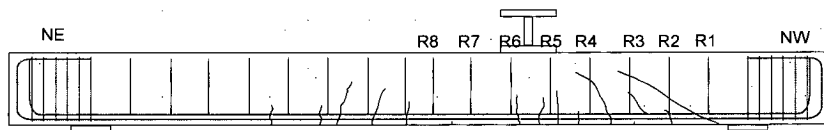
7,1 mm/448 kN



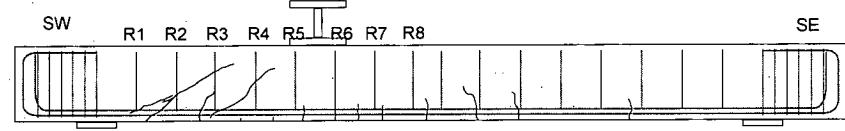
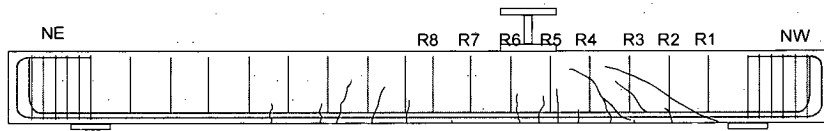
8,2 mm/488 kN



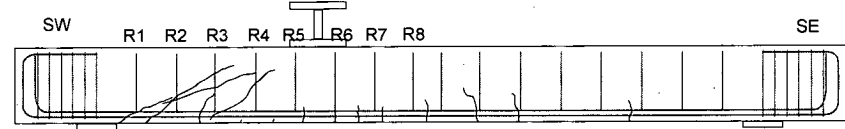
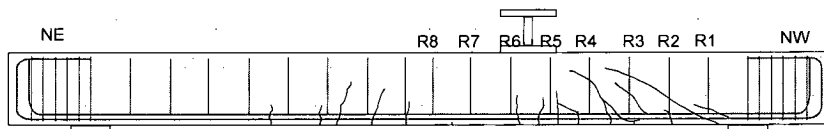
10,4 mm/605 kN



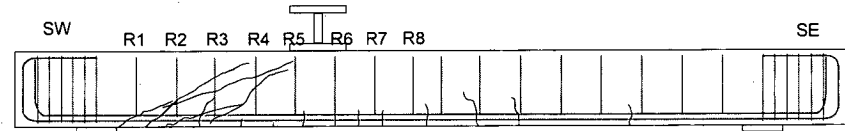
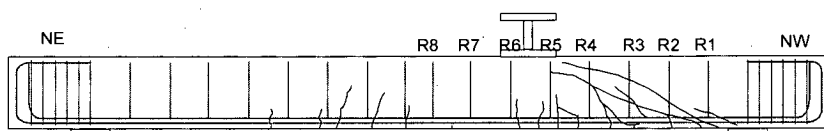
11,0 mm/630 kN



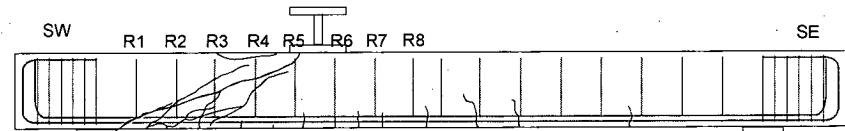
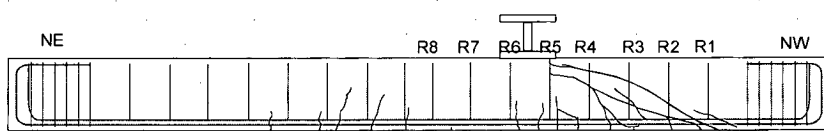
12,1 mm/650 kN



14,2 mm/633 kN

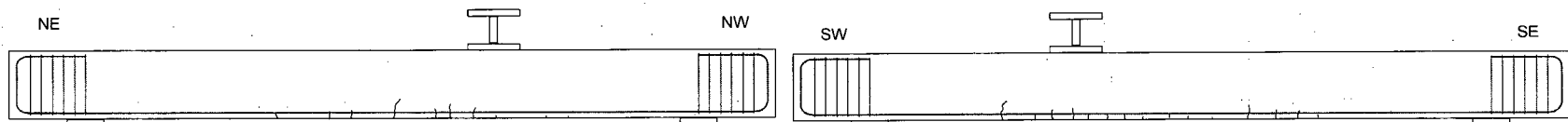


Finale

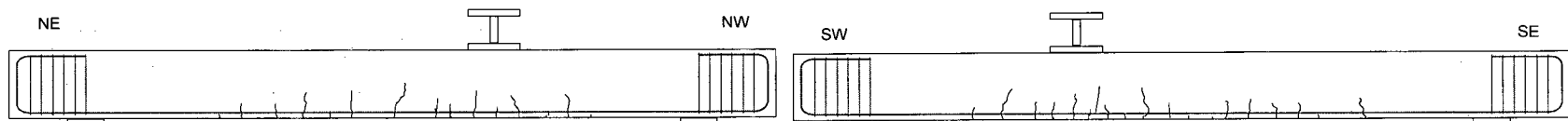


Dalle 2Aa
(charge max 405 kN @ 6,7 mm)

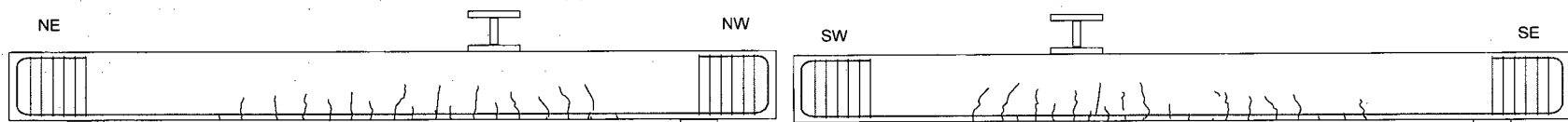
2,5 mm/165 kN



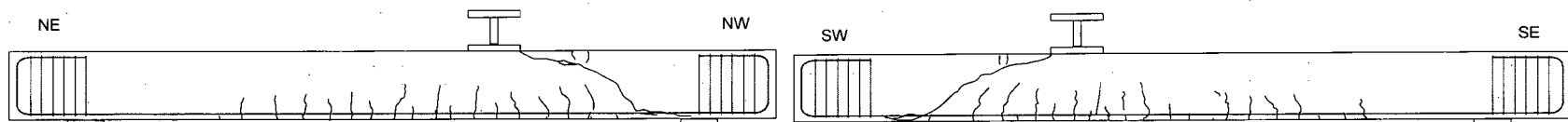
4,3 mm/272 kN



6,3 mm/390 kN

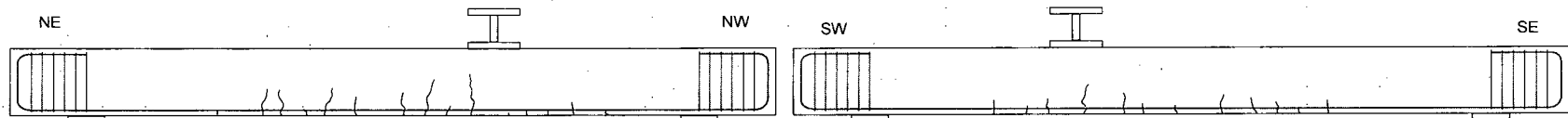


Finale

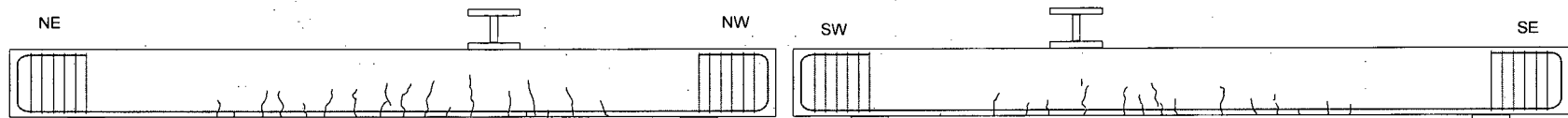


Dalle 2Ab
(charge max 444 kN @ 7,6 mm)

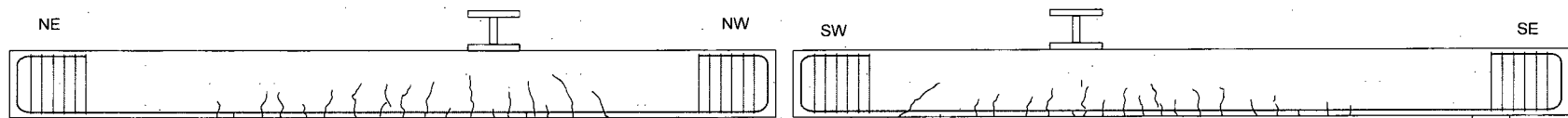
3,5 mm/222 kN



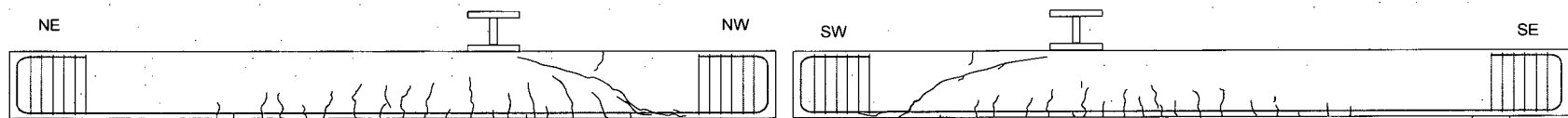
5,3 mm/335 kN



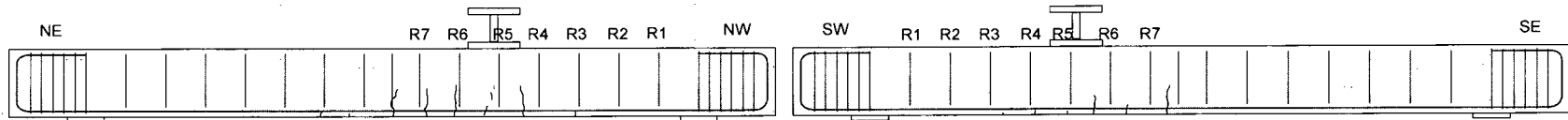
7,2 mm/436 kN



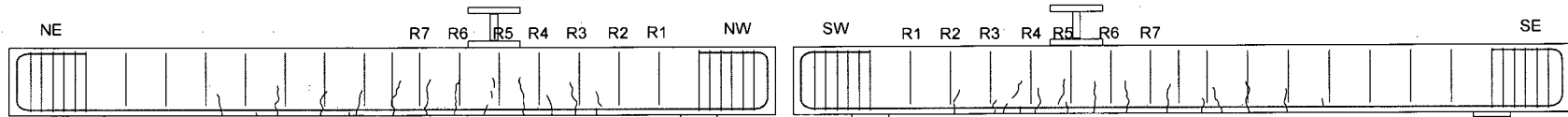
Finale



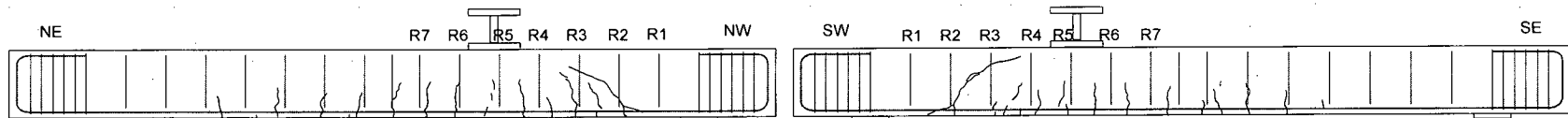
Dalle 2Ba
(charge max 420 kN @ 6,7 mm)
2,4 mm/186 kN



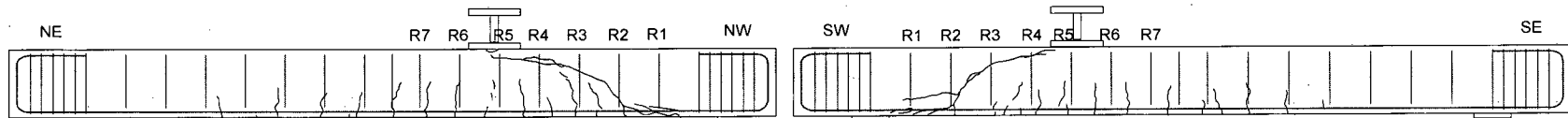
5,1 mm/345 kN



6,7 mm/420 kN

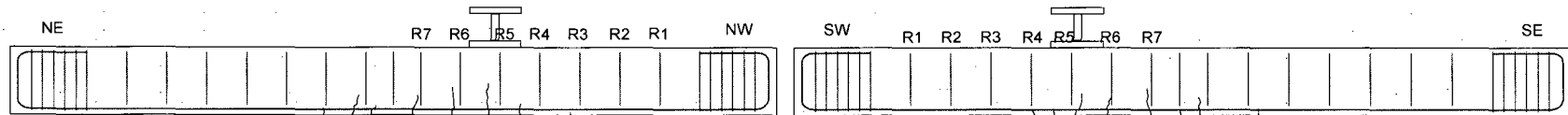


9,7 mm/284 kN

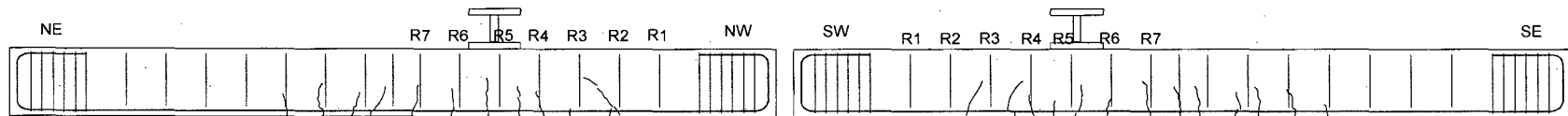


Dalle 2Bb
(charge max 461 kN @ 9,7 mm)

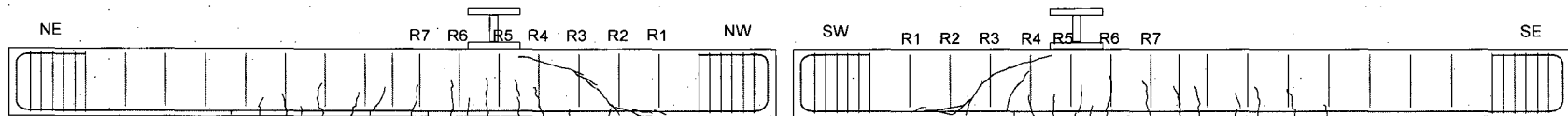
3,2 mm



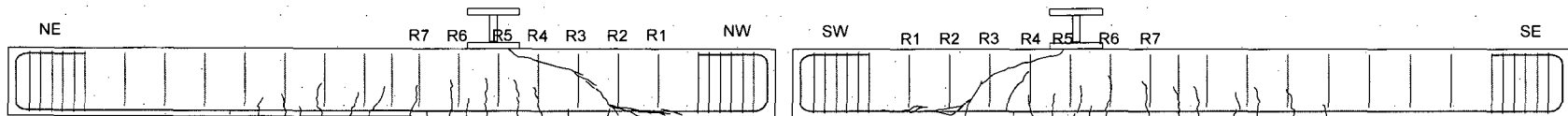
5,9 mm



8,8 mm/441 kN

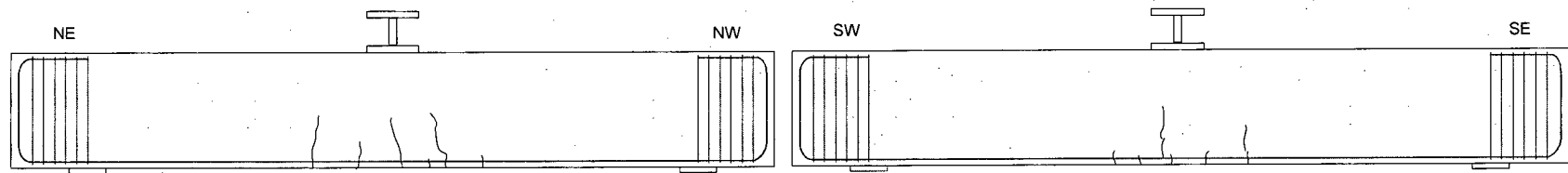


10,9 mm/285 kN

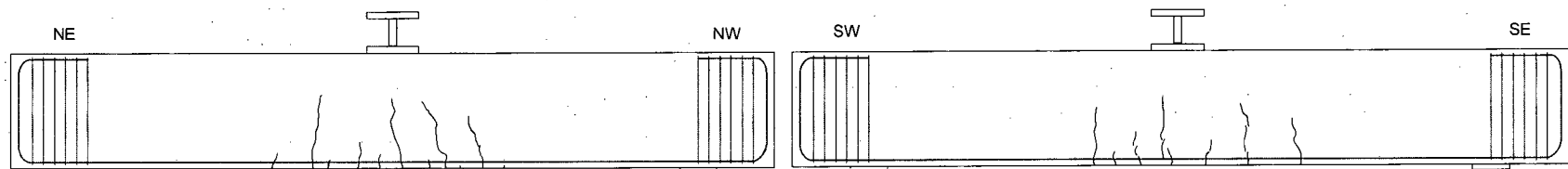


3Aa
(charge max 670 kN @ 5,0 mm)

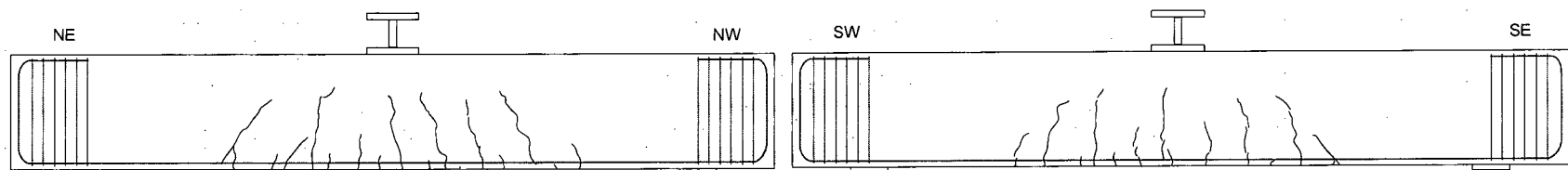
2,0 mm/343 kN



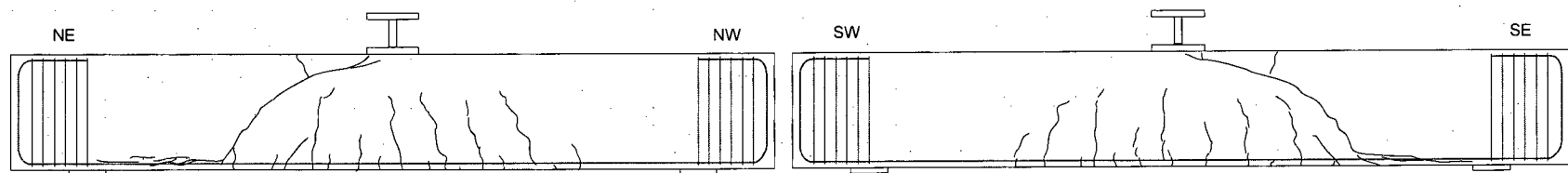
2,8 mm/450 kN



4,7 mm/656 kN

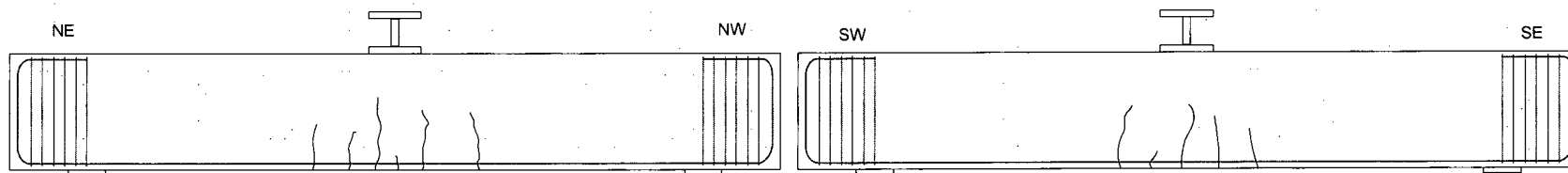


Finale

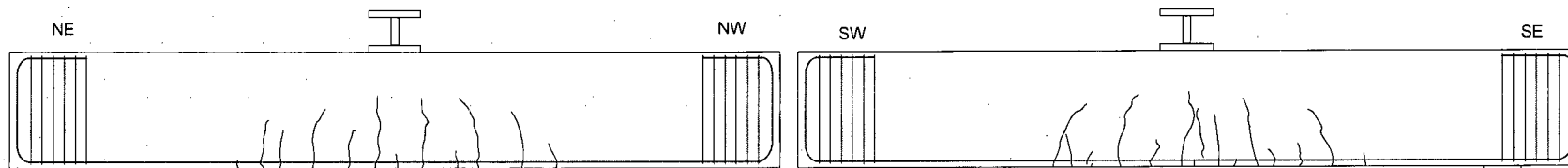


3Ab
(charge max 666 kN @ 4,6 mm)

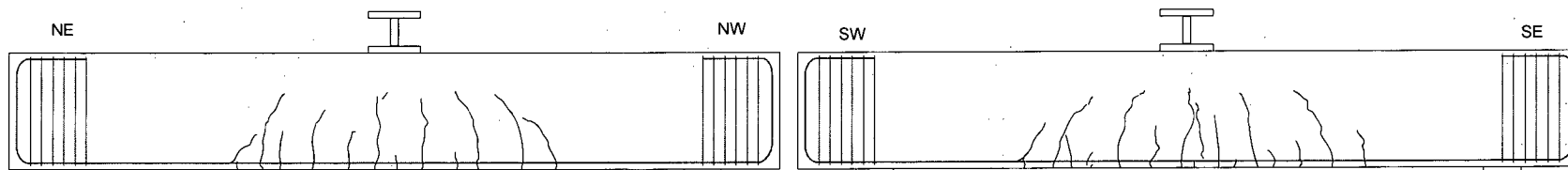
2,3 mm/419 kN



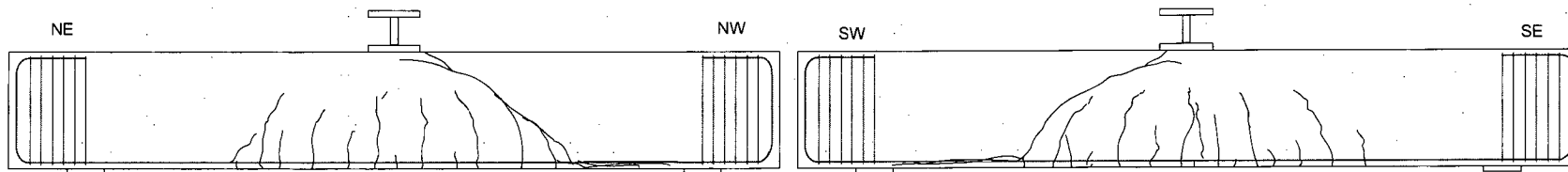
3,2 mm/527 kN



4,1 mm/627 kN

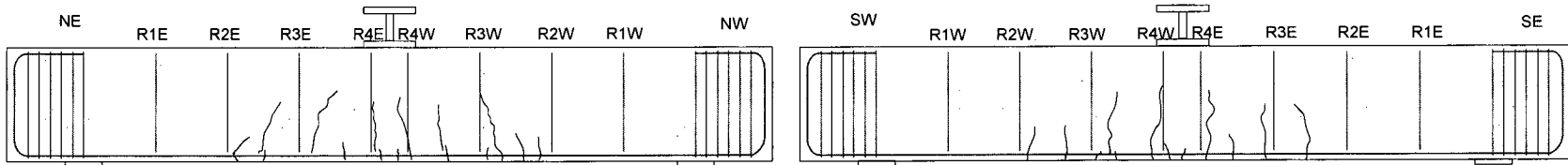


Finale

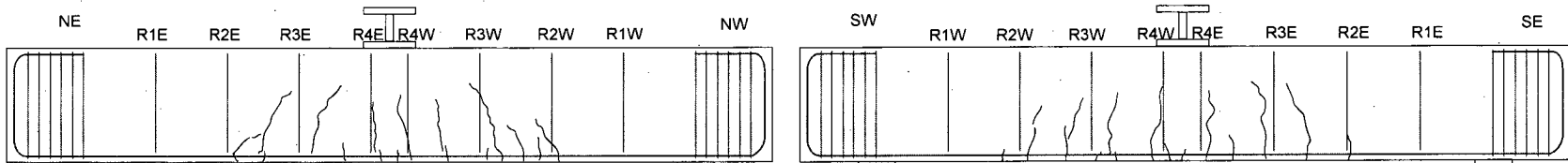


3Ba
(charge max 964 kN@12,25 mm)

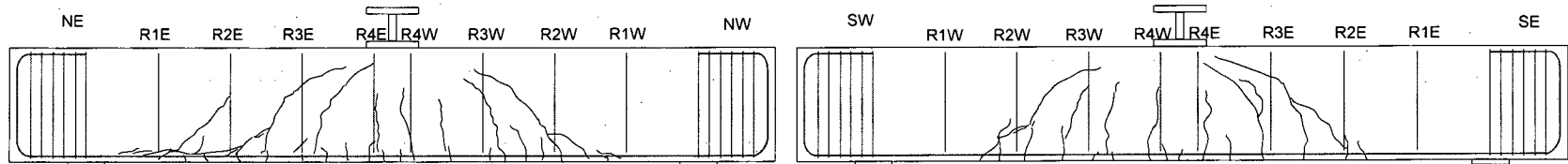
3,3 mm/500 kN



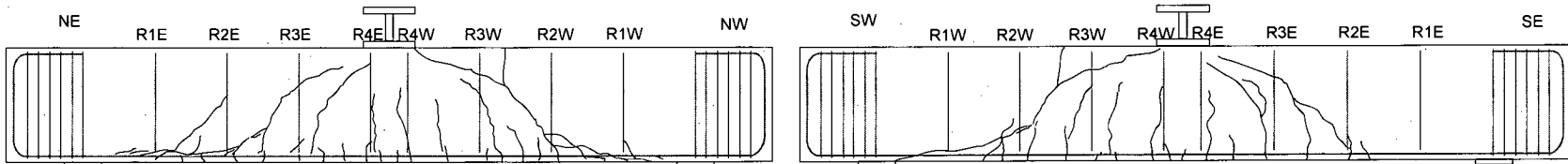
5,0 mm/703 kN



10 mm/871 kN

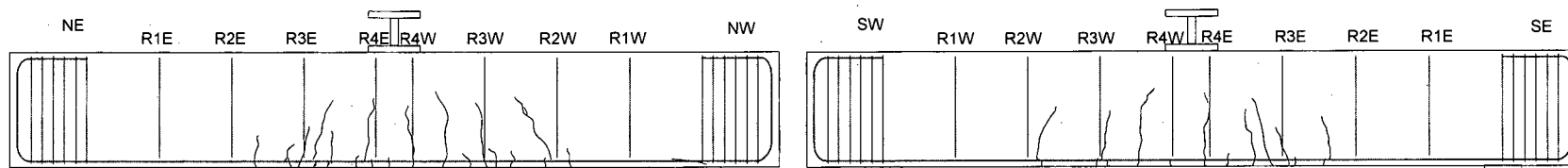


Finale

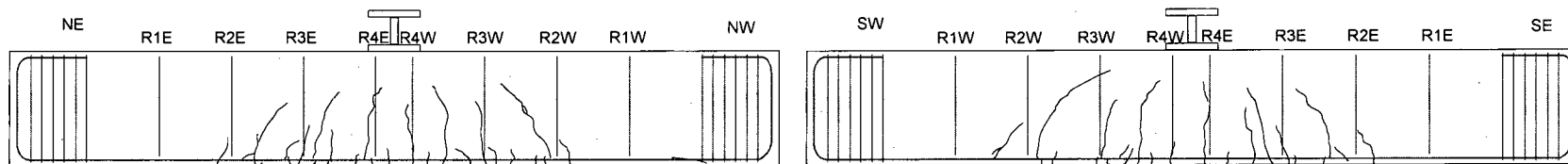


3Bb
(charge max 994 kN@11,4 mm)

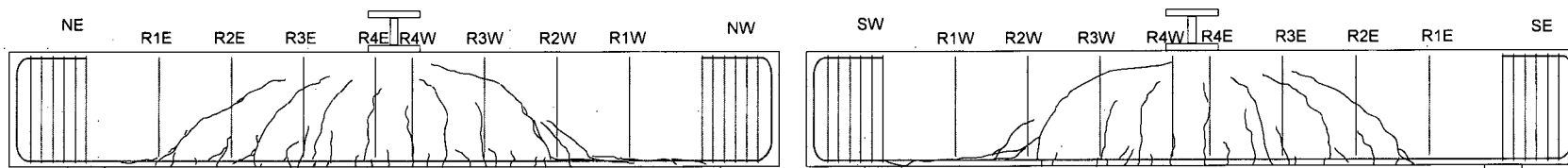
3,3 mm/519 kN



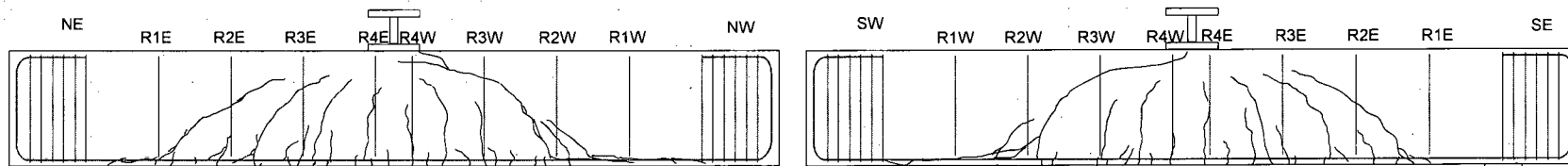
5,0 mm/710 kN



10 mm/932 kN



12,0 mm/240 kN



Annexe D

Calcul de la résistance au cisaillement

Équations de la norme S6-06

8.9.3.3 Résistance pondérée au cisaillement

$$V_r = V_c + V_s \leq 0,25\phi_c f_c' b_v d_v$$

8.9.3.4 Détermination de V_c

$$V_c = 2,5\beta\phi_c f_{cr} b_v d_v = \beta\phi_c \sqrt{f_c'} b_v d_v \quad (\text{béton de densité normale, } f_c' \leq 64 \text{ MPa})$$

8.1.1.8.1 Résistance à la fissuration

$$f_{cr} = 0,4\sqrt{f_c'} \leq 3,2 \text{ MPa} \quad (8.4.1.8.1) (\text{béton densité normale})$$

8.9.3.7 Détermination de β et θ (méthode générale)

$$\beta = \left[\frac{0,4}{(1+1500\varepsilon_x)} \right] \left[\frac{1300}{(1000+s_{ze})} \right]$$

$$s_{ze} = 300 \text{ mm (avec } A_{s,\min}), \text{ sinon: } s_{ze} = \frac{35s_z}{(15+a_g)} = \frac{35d_v}{(15+20)} = d_v$$

$$\theta = (29 + 7000\varepsilon_x)(0,88 + s_{ze}/2500)$$

8.9.3.8 Détermination de ε_x

$$\varepsilon_x = \frac{M_f/d_v + V_f}{2(E_s A_s)}$$

8.9.3.5 Détermination de V_s

$$V_s = \frac{\phi_s f_y A_s d_v \cot \theta}{s}$$

MINISTÈRE DES TRANSPORTS



QTR A 262 101