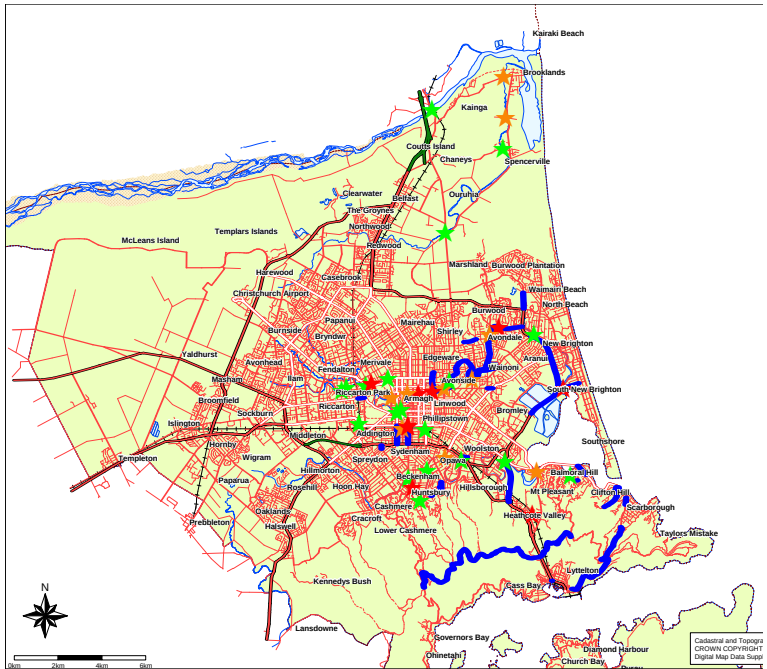
2011年2月22日ニュージーランド地震被害
土木学会・地盤工学会合同報告会（2011年3月11日）

橋梁の被害

高橋良和（京都大学防災研究所）
西田秀明（土木研究所）

橋梁調査位置

- 調査前資料(2/27)では,
  - 9橋が不通
  - 10橋が通行制限



Bridges

Bridge	Status	Notes
Armagh Street (to Hagley Park)	Restricted access	Limited access
Avondale/New Brighton	Closed	
Blenheim Rd	Open	
Bowenvale Ave	Open	
Bridge St	Closed	
Cambridge/Durham St	Open	
Colombo St (Cambridge Tce over Avon River)	Restricted access	Limited access
Colombo St (Ernlea Tce over Heathcote river)	Open	
Colombo St rail overbridge	Closed	
Durham St overbridge	Restricted access	One lane, 3500kg weight limit
Earlham Rd bridge (off Lower Styx)	Restricted access	30km/h speed limit
Ensors Rd (at Heathcote)	Restricted access	North approach cracked
Fendalton Rd (Deans Ave/Harper Ave)	Open	
Ferry Rd/Humphreys Rd (Ferrymead Bridge)	Restricted access	Light vehicles only
Fitzgerald/Avonside/Kilmore	Closed	
Gayhurst Rd/Gloucester St	Restricted access	3500kg weight limit
Harbour Road	Restricted access	30km/h speed limit

橋梁調査位置

- 調査前資料(2/28)では,
  - 9橋が不通
  - 10橋が通行制限
- クライストチャーチ周辺を含む25橋を調査(3/2～5)

Chaney overpasss

Waimakariri brdg

Kaiapoi brdg

Mandeville bootbrdg

Mona Vale footbrdgs

Helmores Lane brdg

Avonside brdg

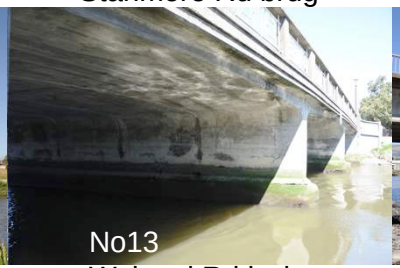
Stanmore Rd brdg

Gayhurst Rd brdg

an arch footbrdg

Avondale Rd brdg

Anzac brdg



Wainoni Rd brdg

South Brighton brdg

Ferrymead brdg

Heathcote River brdg

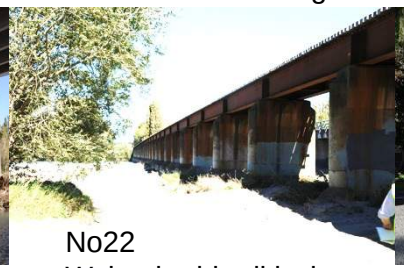
Horotane overbrdg

Port Hills Rd overpass

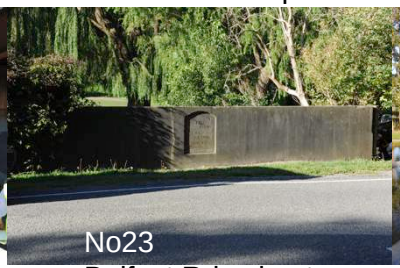
Durham St overbrdg

Moorhouse Ave overbrdg

Old Waimakariri brdg



Waimakariri rail brdg



Belfast Rd culvert

Groynes footbrdg

Main South Line overbrdg

橋梁被害の概要

- 振動による被害
- 地盤変状による被害

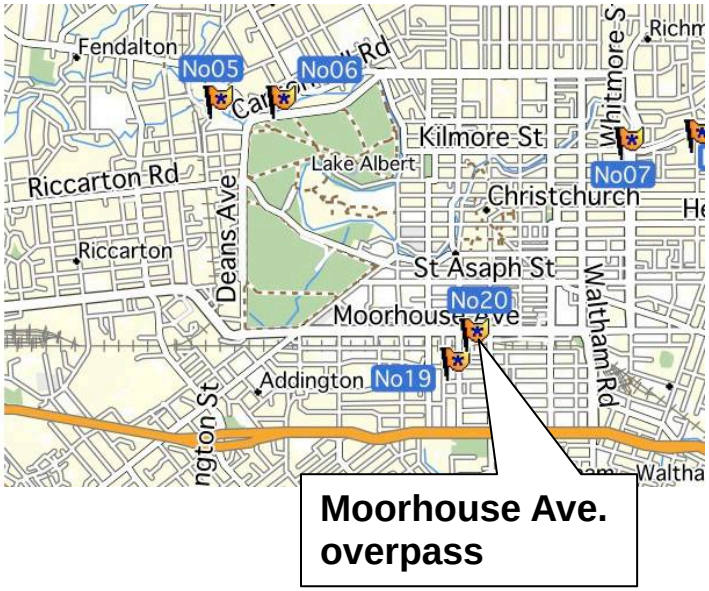
Meeting at OPUS (2011/3/4)

橋梁被害報告

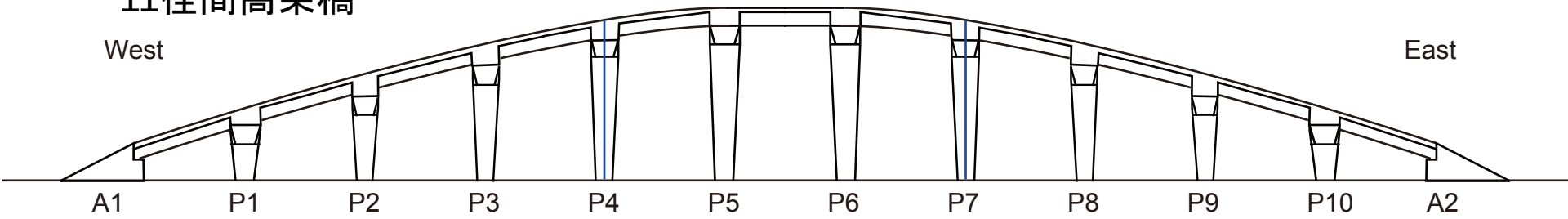

Anzac bridge
South Brighton bridge
Moorhouse Ave. overpass
No11
No12
No13
No14
No15
No16
No17
No18
No19
No20
No10
No09
No08
No07
No06
No05
Burwood
North New Brighton
Avondale
New Brighton
Shirley
Shirley Rd
Mairehau
Cranford St
Papanui
Papanui Rd
Bryndwyr
Strowan Rd
Saint Albans
Merivale
Fendalton
Richmond
Whitmore St
Dallington
Avon River
Wainoni
Aranui
Bexley
Avonside
Woodham Rd
Kilmore St
Lake Albert
Riccarton Rd
Christchurch
Hereford St
Riccarton
Deans Ave
St Asaph St
Linwood
Linwood Ave
Bromley
Poo Ponds
Waltham Rd
Moorhouse Ave
Addington
Barrington St
Milton St
Spreydon
Somerfield
Centaurus Rd
Cashmere Rd
Hoon Hay
Huntsbury
Cashmere
Hillsborough
Woolston
Humphreys Dr
Main Rd
Ferry Rd
Redcliffs
Belleview Tce
Port Hills
Southshore
Sumner
Lakefield Ave
S43 34.597 E172 46.518
0 1 2 3 4 5 6 7 km

代表的橋梁被害

Moorhouse Ave/Colombo St overpass

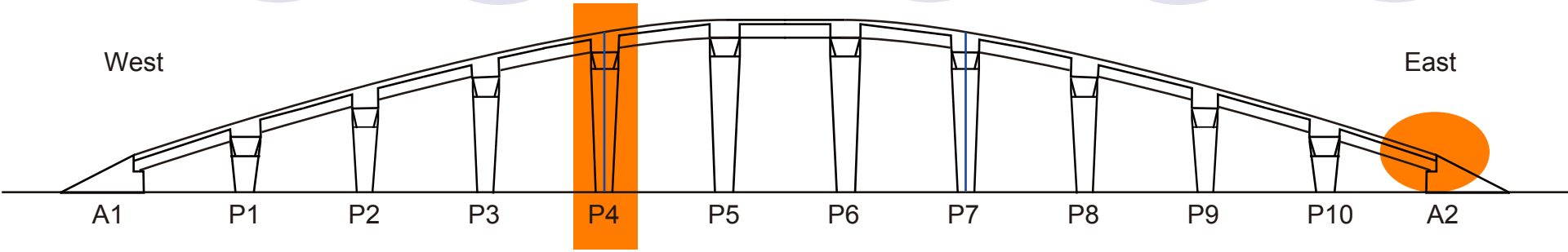


11径間高架橋



代表的橋梁被害

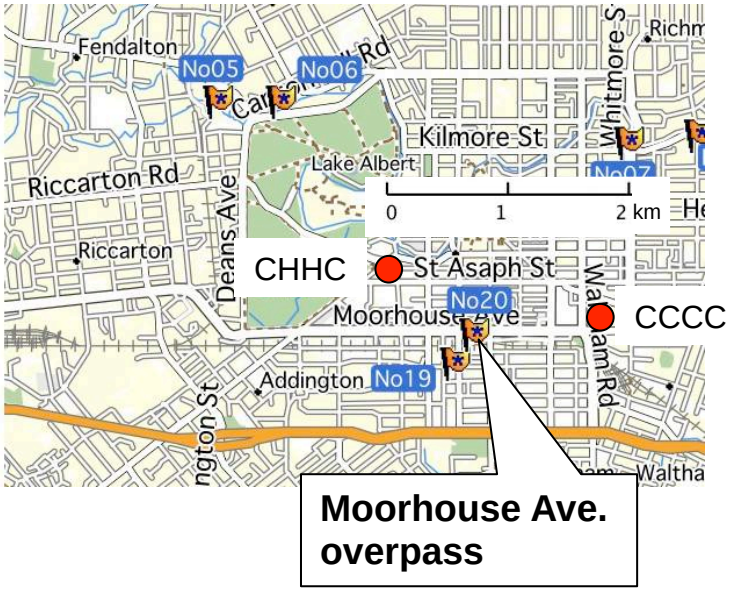
Moorhouse Ave/Colombo St overpass

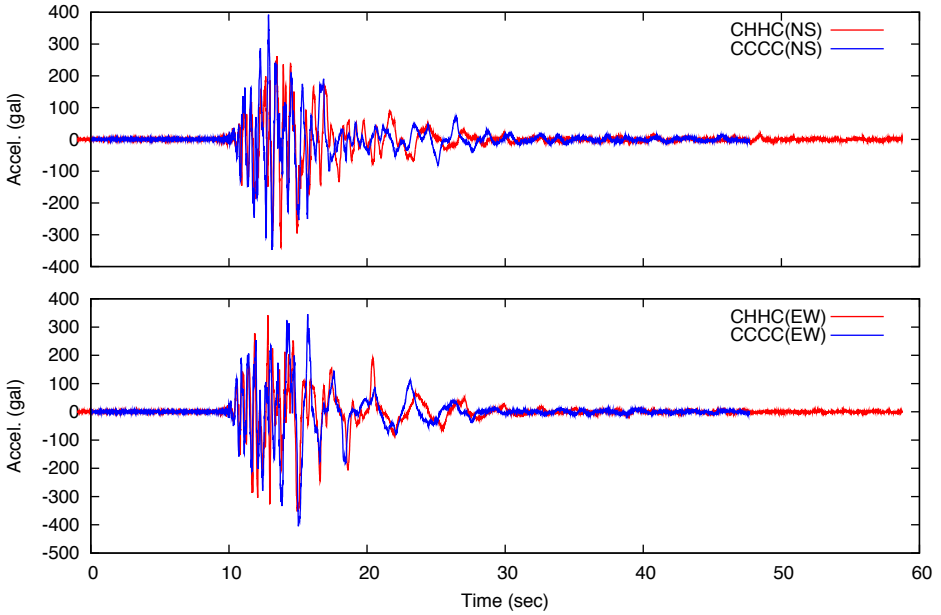


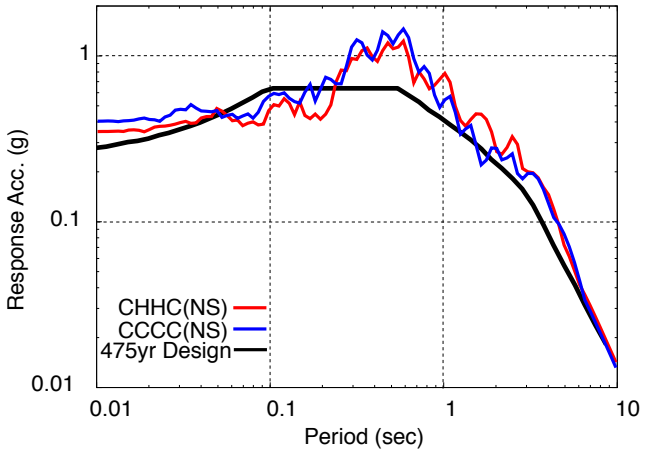
P4橋脚にせん断破壊が発生

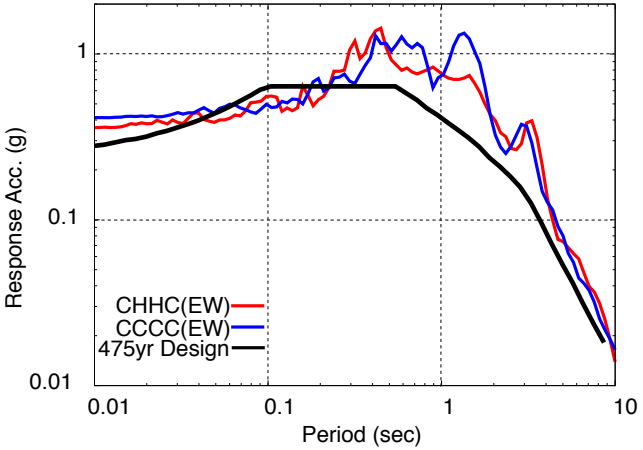
A2橋台で桁衝突

Moorhouse Ave/Colombo St overpass
周辺での地震記録

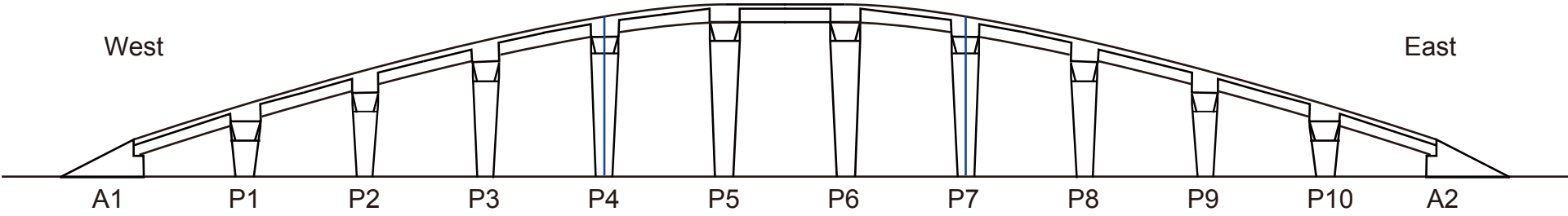


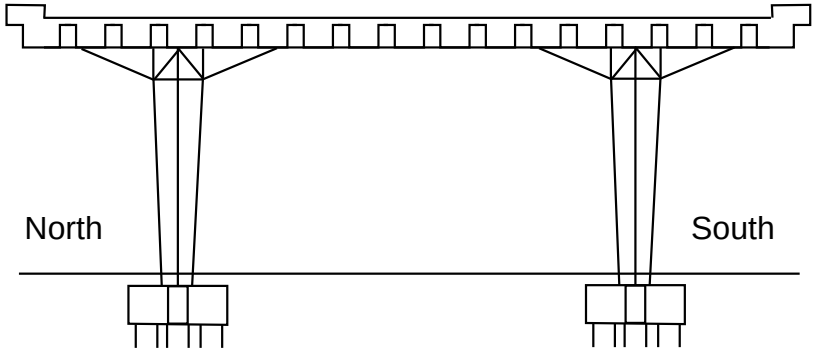






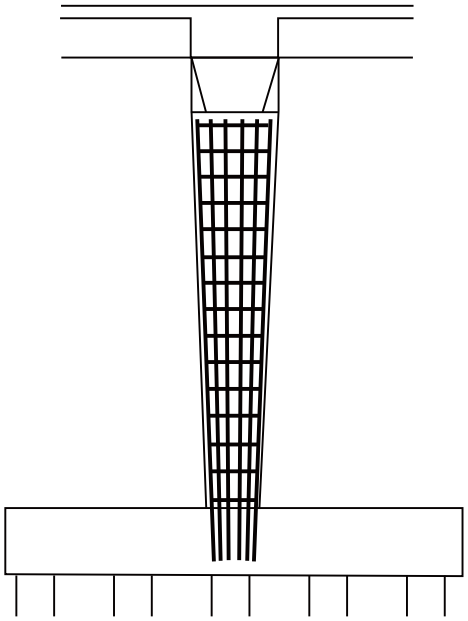
Moorhouse Ave/Colombo St overpass
構造概要



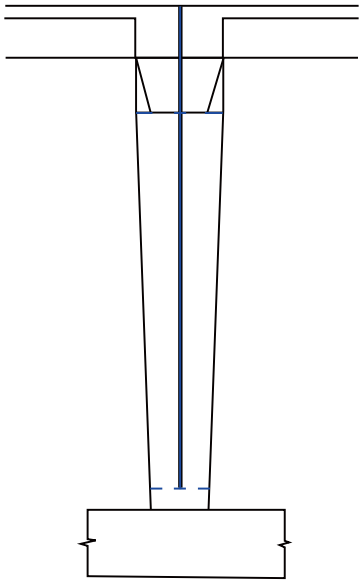


P4, P7以外は，六角形断面の
ラーメン橋脚構造であるのに対し，

P4, P7は2つの橋脚があわさって
一つの橋脚を構成している.

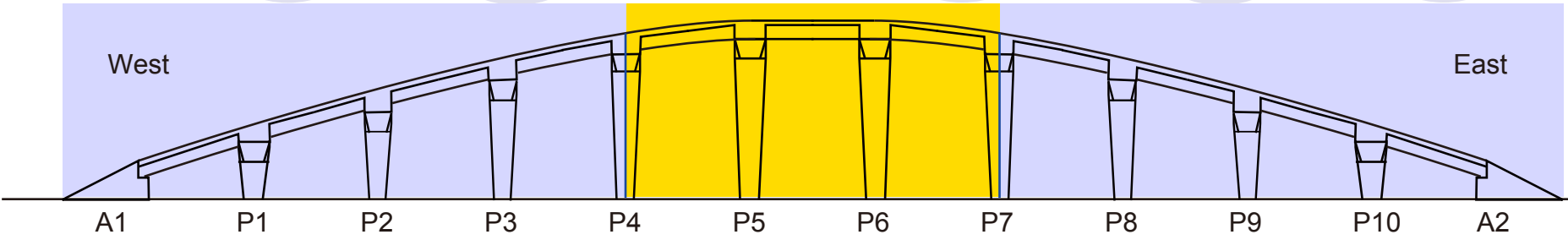


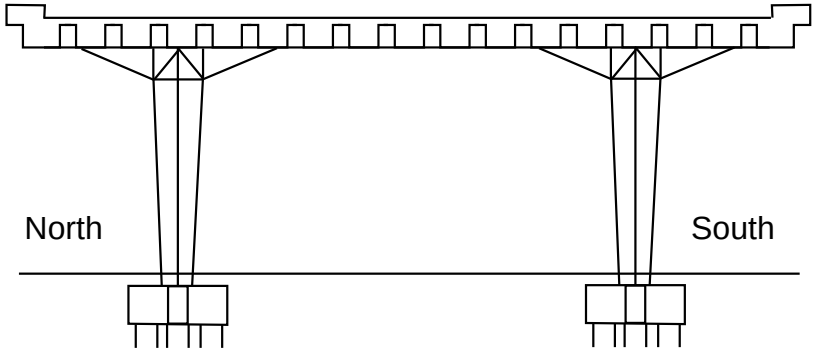
P4, P7以外



P4, P7

Moorhouse Ave/Colombo St overpass
構造概要





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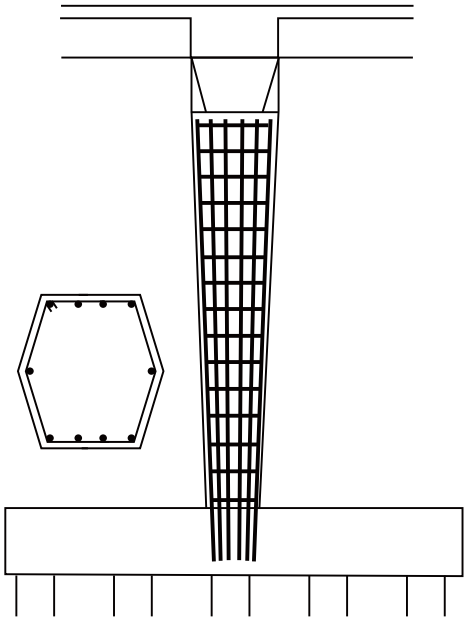
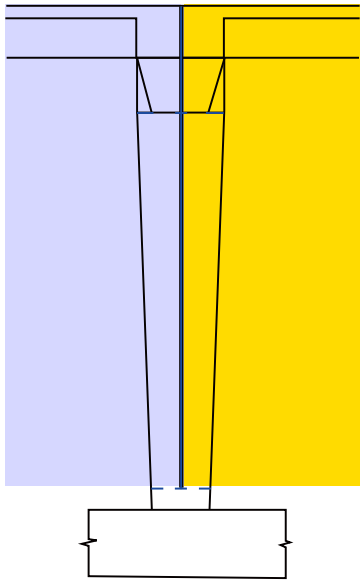
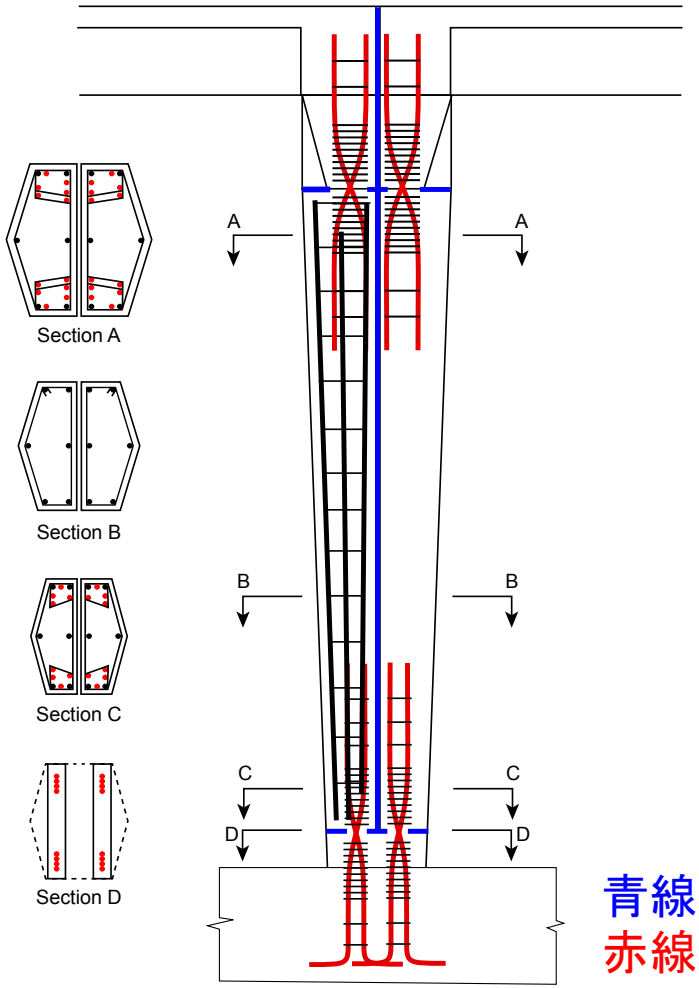


P4, P7以外



P4, P7

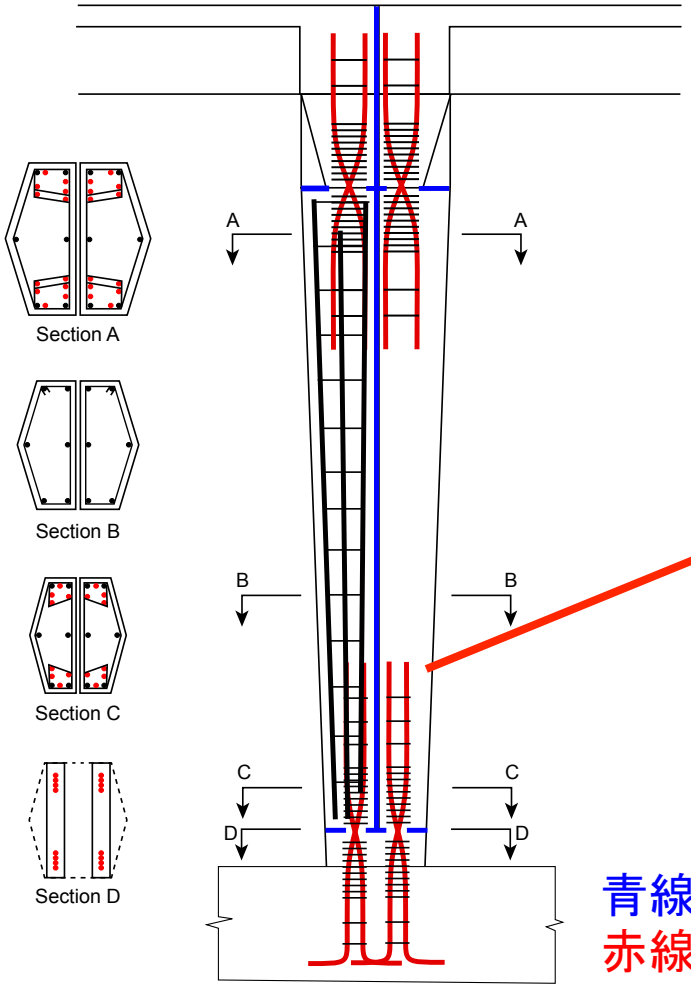
Moorhouse Ave/Colombo St overpass
P4, P7橋脚構造詳細

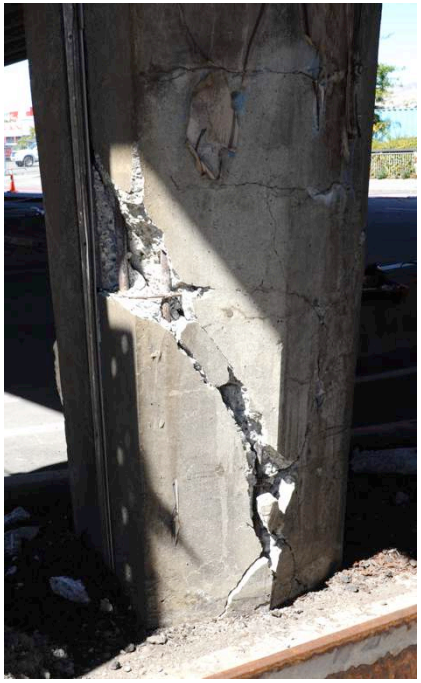


青線：空隙
赤線：補強鉄筋

- P4, P7橋脚は，2本の橋脚が重なり合っていることに加え，上下端にヒンジ構造を有している．
- ヒンジ部を形成するため，補強鉄筋を配置するとともに，断面も小さくしている．

Moorhouse Ave/Colombo St overpass
P4, P7橋脚構造詳細

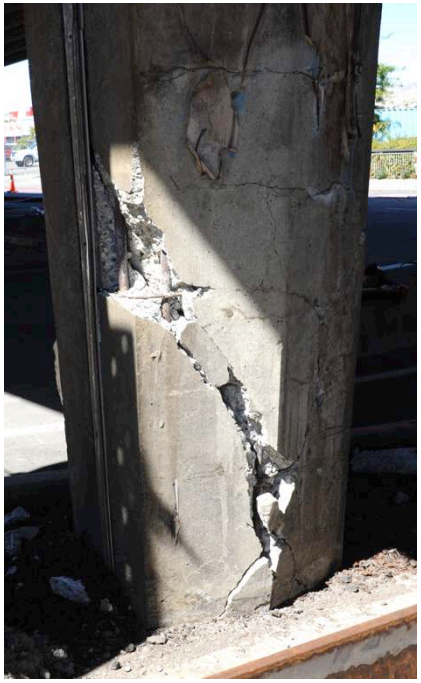


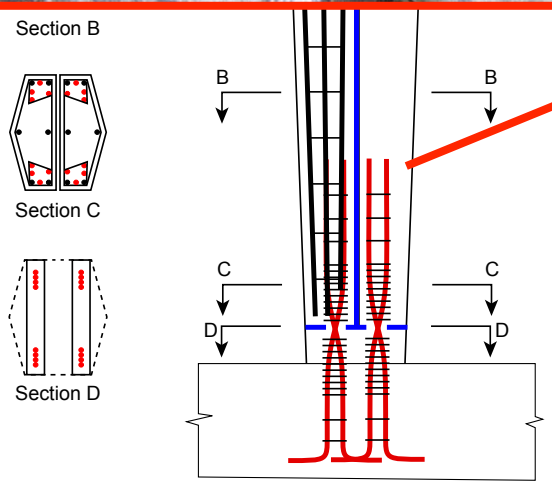


青線：空隙
赤線：補強鉄筋

補強鉄筋の端部が損傷部で確認

St overpass

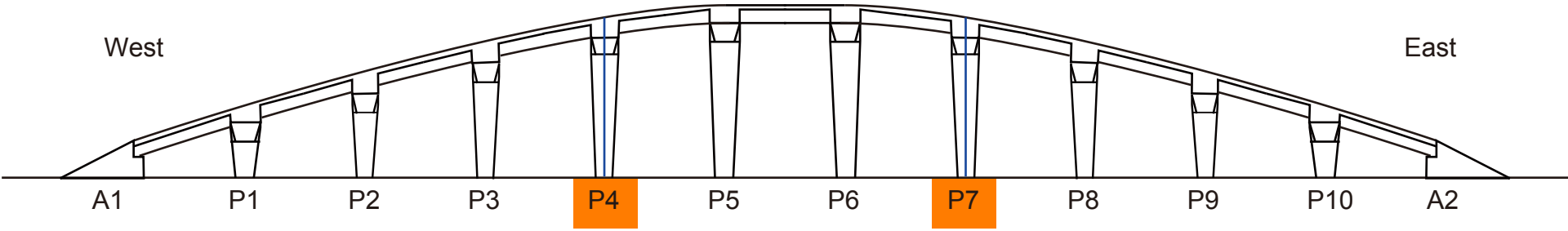




青線：空隙
赤線：補強鉄筋

補強鉄筋の端部が損傷部で確認

Moorhouse Ave/Colombo St overpass
構造概要

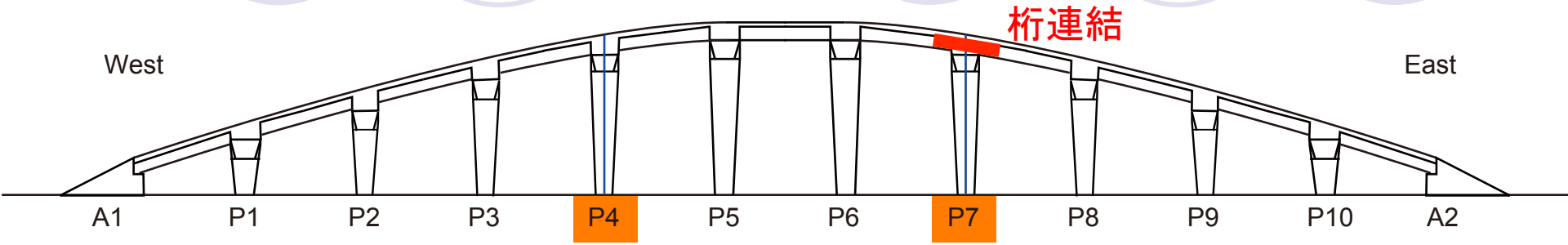


対称な橋梁だが，P4は甚大な損傷であるのに対し，P7はほぼ無損傷．

P4

P7

Moorhouse Ave/Colombo St overpass
構造概要



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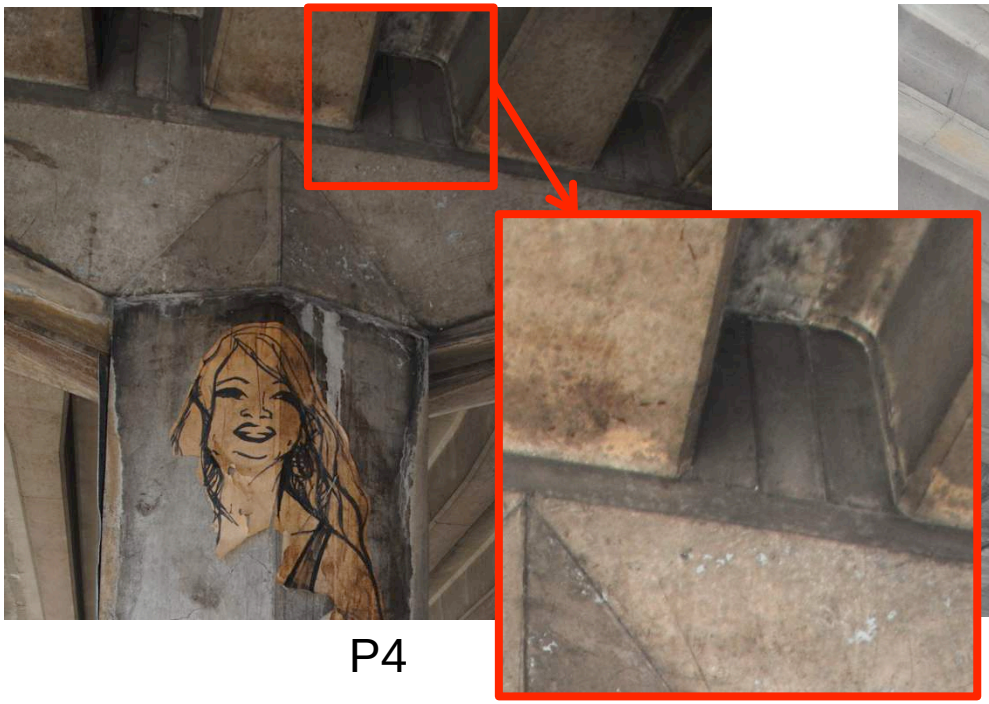
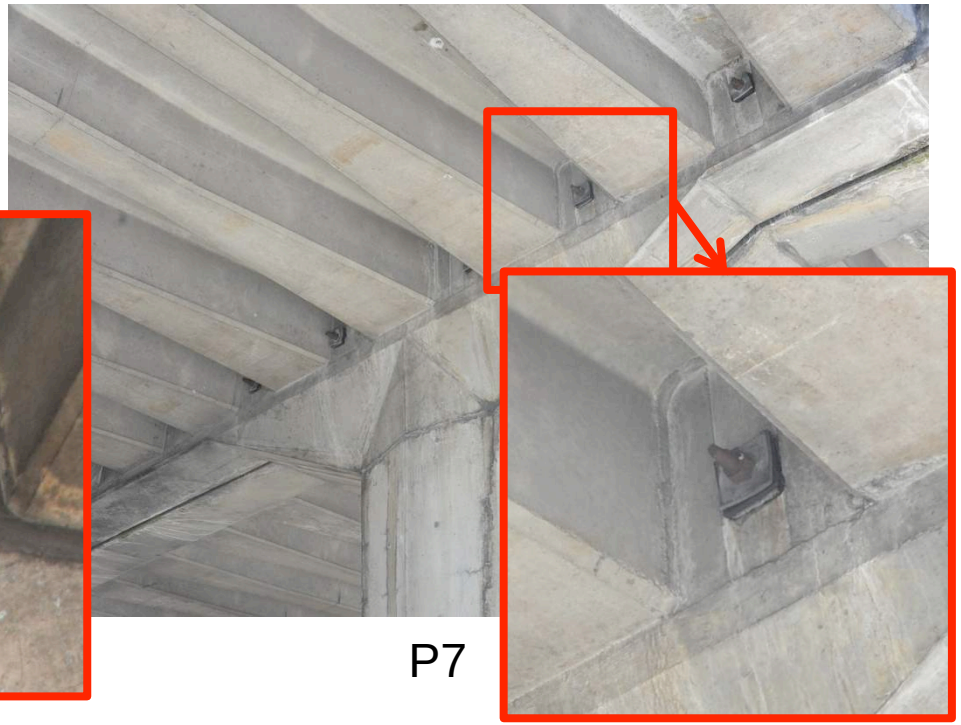


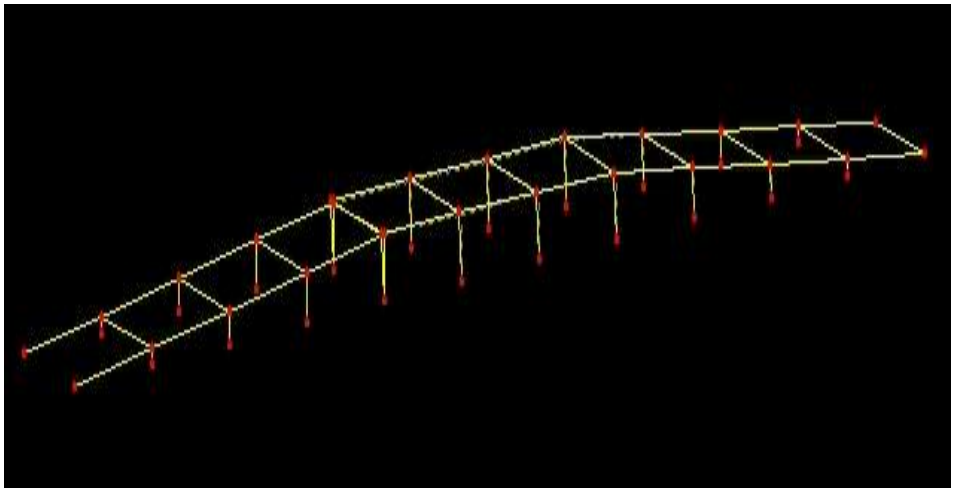
P4



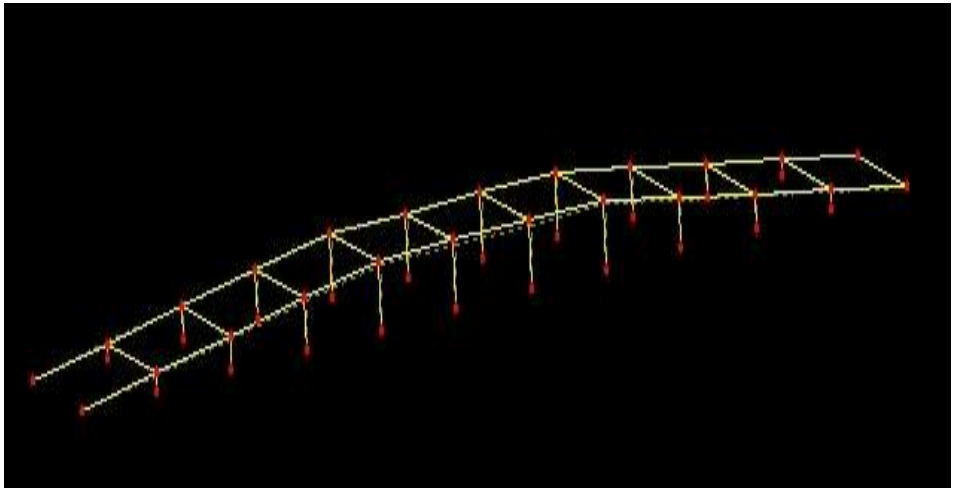
P7

Moorhouse Ave/Colombo St overpass
桁連結有無による振動形態の差異

桁連結無し

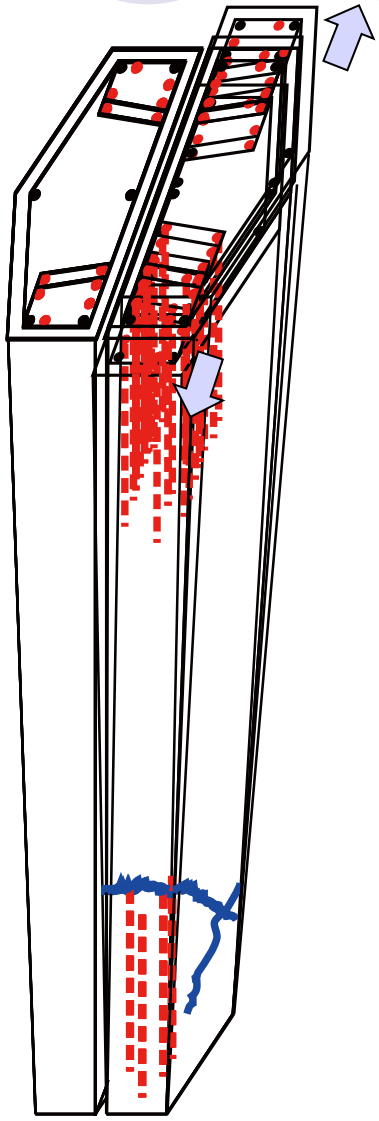


桁連結有り



Moorhouse Ave/Colombo St overpass

損傷メカニズムの推定



P4西側と東側が別々に挙動し，

向北側へ応答し，
段落とし部で曲げ

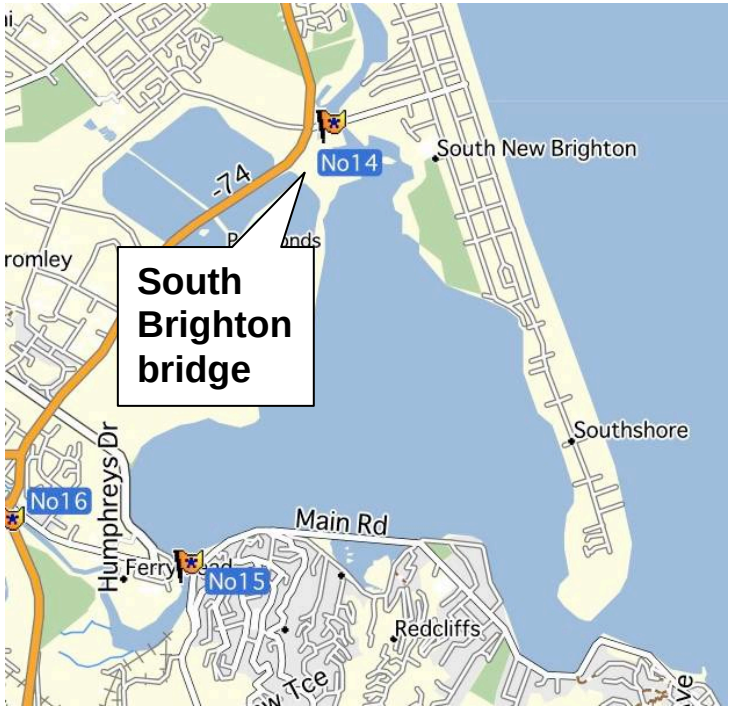
曲げせん断ひび

答し，橋脚北面の
れが発生

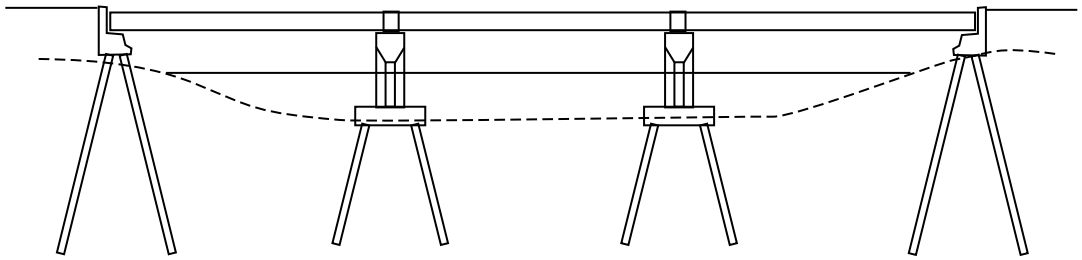
曲げせん断ひび
が交差

代表的橋梁被害

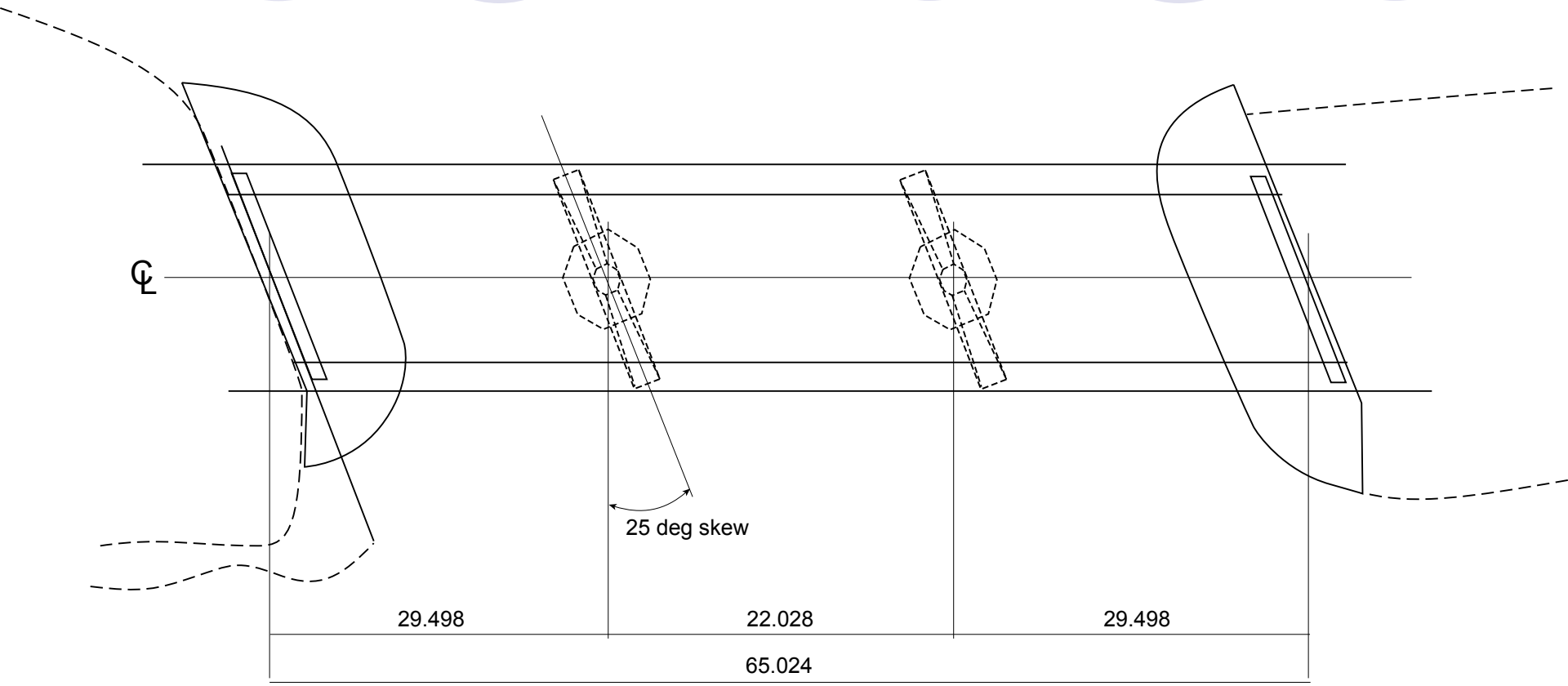
South Brighton Bridge



- 1980年竣工
- 二径間連続橋



South Brighton Bridge
構造概要



South Brighton Bridge
耐震設計経緯

- Bulletin of the New Zealand National Society for Earthquake Engineering, Vol.11, No.2, 1978において，耐震設計検討が報告されている.

SEISMIC DESIGN OF SOUTH BRIGHTON BRIDGE - A DECISION AGAINST MECHANICAL ENERGY DISSIPATORS

M.J.N. Priestley* and M.J. Stockwell**

SUMMARY

The seismic design of a proposed Christchurch bridge is discussed. Initial design was based on supporting the superstructure on elastomeric bearing pads and steel-cantilever dampers. Dynamic analyses showed that the dampers were relatively ineffective, and that the seismic response was dictated by the characteristics of the bearing pads. Final design, based on a conventional ductile approach was found to be more economical without significant increase to seismic risk. It is shown that the decision to opt for a design incorporating mechanical energy dissipators as opposed to a monolithic pier/superstructure design will not necessarily result in a reduction in seismic response.

- 鋼製ダンパーの採用が検討され，動的解析が実施されている.

South Brighton Bridge
耐震設計経緯

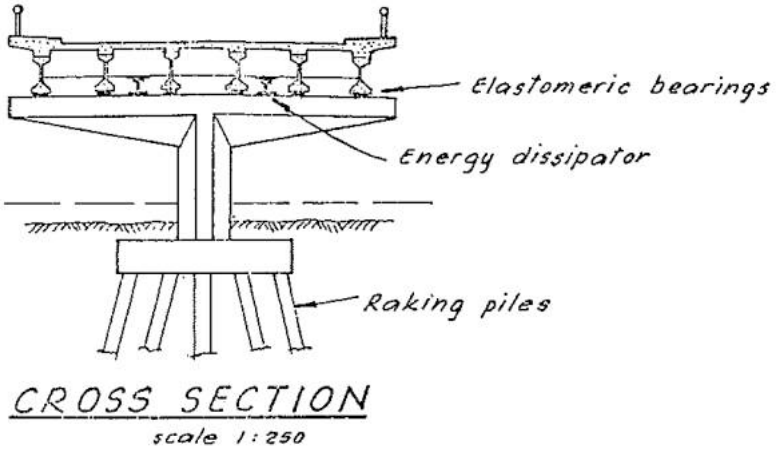


FIGURE 1: BRIDGE DETAILS

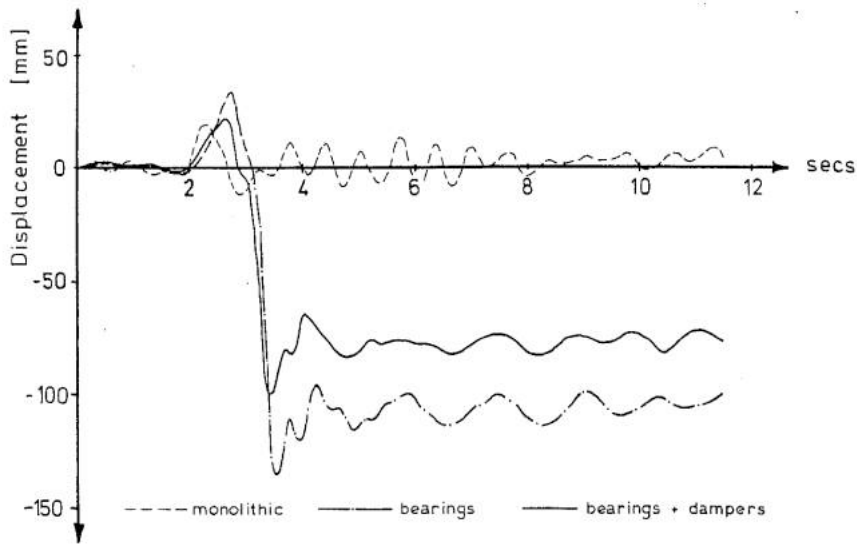
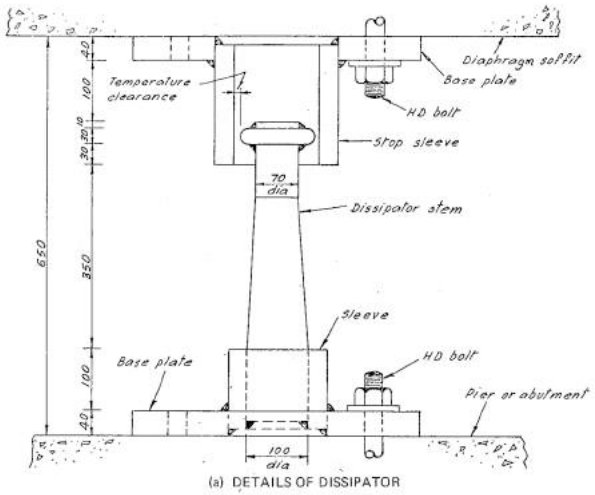


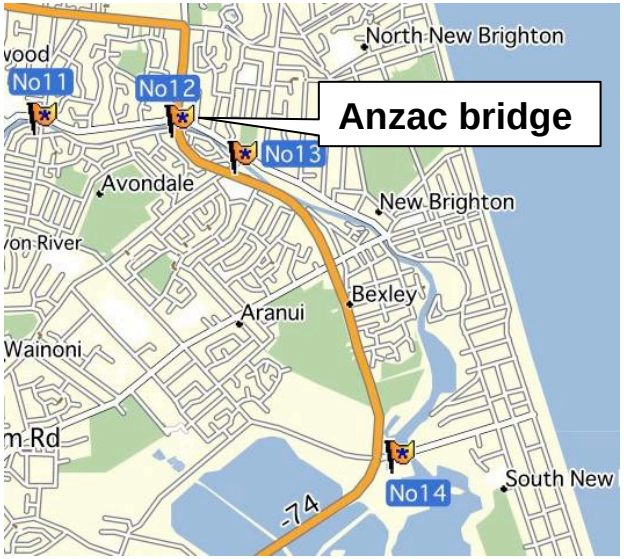
FIGURE 8: PIER DISPLACEMENT (4.73m) BUCHAREST 1977



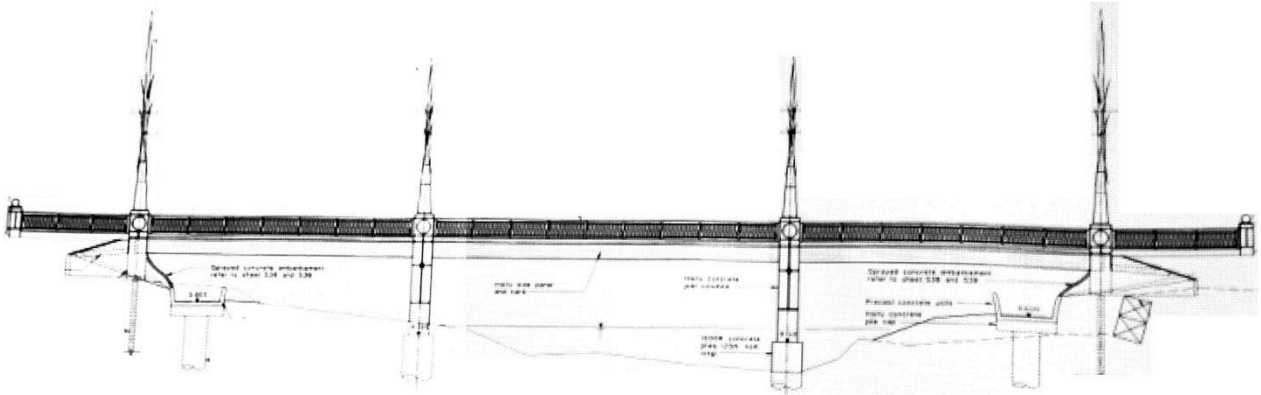
(a) DETAILS OF DISSIPATOR

- 積層ゴム支承＋ダンパーの採用により，El Centro波形に対して効果があったものの，卓越周期の長いBucharest波形では残留変形が大きくなり，結果的に従来型の耐震設計が採用された.

代表的橋梁被害
Anzac Bridge



- 2000年竣工
- 三径間連続橋



Anzac Bridge
周辺での地震記録