13/17737

NEW EQUIPMENT & SYSTEM APPROVAL PROFORMA

Ref: ~~10/30172~~

Note: the prompts given below are only a guide to the information required for approval. Dependent on the type of equipment or system that requires approval delete any section that is not applicable or include additional information if necessary. Mandatory fields are marked with an asterisk (*).

1 **Equipment or System to be approved** *

Reinforced Soil Walls on Underbridges. Use is subject to the following;

1. Galvanised metal strap reinforcement only,
2. To be used on non-electrified tracks,
3. To be used as 'false' abutments where the bridge loads are supported by piles.
4. Only the following proprietary systems are recommended to be used in the design and construction of RSW's.
   a. Reinforced Earth System – System owner is Reinforced Earth Pty Ltd,
   b. VSL Retained Earth System – System owner is VSL Prestressing (Aust) Pty Ltd

2 **Originator** *

Name: Denio Martinelli Company: ARTC

3 **Introduction** *

Reinforced Soil Walls (RSW) have been used as retaining structures and as bridge abutments for over 30 years. These walls are regularly used in road and rail infrastructure projects as they provide an efficient and cost effective design. They have been used on many rail networks within Australia and abroad but currently there are limited uses within the ARTC network.

RSW's generally consist of a select backfill which has been strengthened with reinforcement material and also includes a modular facing system to hold the backfill material in place. The soil and reinforcement combine through friction and produce an integrated mass in which the reinforcements carry the tensile stresses. In this way the combined material acts as a cohesive monolithic body which supports its own weight as well as the external loadings for which it has been designed.

There are numerous types of strengthening material and facing units but this proposal has currently only been assessed on the use of galvanised metal strap reinforcements. Also, the risks associated with electrified tracks (and metal straps) were not known and hence the assessment was restricted to non-electrified tracks.

The Hunter 8 Alliance are currently undertaking the detailed design of the Maitland to Minimbah Third Track project. We are proposing the use of RSW's at two underbridge abutments where due to abutment height and depths to rock an RSW will provide an efficient and cost effective design.

4 **Determination of Need** *

- RSW's offer a cost effective design as retaining structures and bridge abutments on rail embankments and underbridges,
- Alternative design to counterfort concrete abutments or the use of 'dead man' anchors,
- Offer significant cost savings particularly where rock is located at considerable depth's below surface levels,

5 **Significant Change or Not** *(as determined by the Manager Standards)* *

This change in equipment or system is assessed as SIGNIFICANT

6 **Review Panel** *

- Graeme Templer – Executive Manager Maintenance
- Peter Prasad – National Bridge and Structures Engineer
- Denio Martinelli – Project Manager, Hunter Valley
- Tim Neville – Senior Geotechnical Engineer

7 **Safety**

The design of RSW's are to be carried out in accordance with AS4678 Earth Retaining Structures and AS5100 Bridge Design. Designs are also to be carried out in accordance with ARTC Standard BDS 06.

In addition to the above standards the Roads and Traffic Authority of NSW have developed a specification for design of these walls. The specification is known as 'RTA QA Specification R57 – Design of Reinforced Soil Walls'.

Attached is the outcome of a Risk Assessment carried out on the use of RSW's in the rail network.

Reinforced earth walls have been in Australia for over 30 years and we are not aware of any significant failures. A

number of minor failures have occurred in the past which would cause no risk to loss of life or closure of the rail line. The repairs of these issues could also be undertaken without closure of the rail line. Significant failures of RSW's have occurred in France in the 1980's where RSW's were designed and constructed with stainless steel reinforcement straps which had corroded. A significant RSW failure also occurred in South Africa (1980) where a cathodic protection system had been installed. It has since been identified that stainless steel reinforcing straps and CP systems are not suitable for the application in RSWs and there use has been banned from inclusion in designs since the early 1980's.

To ensure there are no unknown issues with corrosion of reinforcement straps it is recommended that monitoring straps be included in the design and construction of RSW's. These straps can be removed at nominated times to confirm that the effects of corrosion are in line with the design. If corrosion is found to be in excess of the estimated rate of corrosion there will be sufficient time to undertake further monitoring and any remedial works before there are any effects on the wall integrity.

The RSW systems included in part 1 of this document are all pre-approved systems nominated in the RTA (Roads and Traffic Authority of NSW) QA Specification R57 – Design of Reinforced Earth Walls. These systems are in use on many projects and there have not been any significant incidents.

8 **Performance and Suitability**

The following information has been provided to verify the performance and suitability of RSW's.

- RECO Australia Brochure, October 2007.
- Reinforced Earth – Structures for Railway Applications.
- Reinforced Earth – Bridge Abutments

(i) **Use in other rail networks**

RSW's have been used on railways in Australia and abroad and details of locations have been included in attachment A.

The attached list included uses in the USA, Spain, South Africa, France, Brazil Germany and Japan.

(ii) **Use in the ARTC network**

Reinforced soil walls have been used as abutments on the rail underbridge over Clare Road in Crystal Brook, South Australia. The abutment supports the full bridge loads (true abutment) and was constructed in the early 1980's. RSW's have also been included in the Wodonga bypass project.

A RSW has also been used as an embankment retaining structure in the recently commissioned Minimbah Bank Third Track project in the Hunter Valley. The same project also includes RSW's as bridge abutments on the two new road overbridges at Golden Highway and Range Road.

(iii) **Issues arising from usage of the equipment/system**

The risk assessment attached includes a list of issues raised but overall it was determined that Reinforced Soil Walls are suitable for use in the rail network.

(iv) **Changes required to infrastructure or systems for use of the equipment**

Nil changes to existing infrastructure. The RSW system is proposed for new works.

9 **Reliability**

The pre-approved systems nominated in section 1 can all be designed for a 100year design life and the system owner provides certification that all components supplied meet the system specification.

10 **Maintainability**

Inspections of RSW structures is to be carried out in accordance with ARTC Standard BES 01 and also following significant storm events. Relevant ARTC maintenance staff are to receive appropriate training in the inspection of Reinforced Soil Walls.

11 **Approval** *

Approval is sought for the use of Reinforced Soil Retaining Walls and bridge abutments on rail underbridges.

12 **Conditions of Approval** *

Approval for RE Wall use on underbridges is currently subject to the following conditions;

1. Use of galvanised metal strap reinforcing system,
2. Use in area on Non-electrified tracks,
3. In 'False Abutments' where the bridge loads are supported by an abutment on piles.
4. Inclusion of six (6) additional test straps per abutment or 1 per 5 linear metres of retaining walls which are removed at set timeframes to confirm corrosion rates are in line with design assumptions.

5. Only the proprietary systems nominated in Section 1 to be designed and installed.

Maintenance staff be appropriately trained in the inspection of RE Walls.

13	Does the Originator accept the additional Conditions of Approval as set by the Review Panel	Yes	☑	No	☐	N/A	☐

14 Sign off — ARTC office use only

Review Panel		
Graeme Templer	Graeme Templer	Date: 28-06-10
Peter Prasad		Date: 28-06-10
Denio Martinelli		Date: 28/06/2010
Tim Neville		Date: 28/06/2010
Robert Taylor	28/06/10	

Manager Standards 29/10/2010

Risk & Safety Committee 12/07/2010

15 Sign off on minor editorial amendments that clarify walls covered as well as abutments — ARTC office use only

Review Panel		
Graeme Templer		Date: 16/1/12
Peter Prasad		Date: 28/09/11
Denio Martinelli		Date: 29/09/11
Tim Neville		Date: 11/10/2011
~~Robert Taylor~~	No longer with ARTC	Date:
John Furness		Date: 16/01/2012

Updated 16/04/2013 - Additional condition of approval (No. 6): "Specific site approval must be obtained from the National Bridges & Structures Engineer to ensure the integrity of the wall will not be affected by any major floods".

Review Panel sign off on update:

Peter Prasad:	On file	Date: 16/04/2013
Denio Martinelli:	On file	Date: 9/05/2013
Tim Neville:	On file	Date: 22/04/2013
John Furness:	On file	Date: 17/04/2013

ATTACHMENT A

Uses of Reinforced Earth Walls in Australia and Overseas.

Table-1
Reinforced Earth Walls Supporting Heavy Railroad

Construction Date	Project Name	Owner	Location
1973	Newcastle Street Extension	Georgia DOT	Brunswick, Georgia, U.S.A.
1975	Owensboro Riverport	Owensboro Riverport	Owensboro, Kentucky, U.S.A.
1975	Port Bou Railway Station*	Spanish Railways	Port Bou, Spain
1978	Tavistock Mines	Tavinstock Colliery	South Africa
1980	Clinchfield Railroad	Clinchfield Railroad	North Carolina, U.S.A.
1981	Clare Road Overcrossing*	Australian National	South Australia
1982	Torrens River Overcrossing*	Australian National	Adelaide, Australia
1983	Joseph McNeil Generating	Burlington Elect. Dept.	Burlington, Vermont, U.S.A.
1984	Conrail UG Bridge 183	Conrail	Cleveland, Ohio, U.S.A.
1984	Granville to Westmead Rail	State Rail Authority	Sydney, Australia
1984	CSX Rail	MARTA	Atlanta, Georgia, U.S.A.
1985	Fepasa-Capivari	Capivari	Capivari, Brazil
1985	Hebung Der Emschertalbahn	Bergbau Ag Lippe	Gelsenkirchen, Germany
1985	Mona Vale Rail Bridge	State Rail Authority	Sydney, Australia
1986	Gare De Strasbourg-Nendorf	French National Railways	Strasbourg, France

* Reinforced Earth Railroad Bridge Abutments - Spans up to 138ft.

Table 1 (Continued)
Reinforced Earth Walls Supporting Heavy Railroad

Construction Date	Project Name	Owner	Location
1987	Route 580, Caltrans	Southern Pacific RR	Richmond, California, U.S.A.
1987	Wolfensberger Road	Rio Grand/Santa Fe RR	Castle Rock, Colorado, U.S.A.
1993	SFRR Yard	Sante Fe Railroad	Fort Worth, Texas, U.S.A.
1994	Brittian Howard	Caltrain	San Francisco, California,
1994	San Bernardino Flyover	Metrolink	San Bernardino, California,
1994	SFRR/Tennison Connection	Santa Fe Railroad	Dallas, Texas, U.S.A.
1995	Capital Ave. Bridge	Burlington Northern	Grand Island, Nebraska, U.S.A.
1995	Route 3/3A Improvements	Mass Bay Transit	Kingston, Massachusetts,
1996	New Dock Street	Port of Los Angeles	Los Angeles, California, U.S.A.
1996	South Street	Union Pacific Railroad	Long Beach, California, U.S.A.
1999	Big Brown Rail Spur	TU Electric Co.	Fairfield, Texas, U.S.A.
1999	Ralston/Harbor/Holly Streets	Caltrain	San Francisco, California,
2000	Redondo Junction	Alameda Corridor	Los Angeles, California, U.S.A.

Table-2
Reinforced Earth Walls Supporting High Speed Trains

Year	Project Name	Owner	Location	Dist. from CL of track
1983	Namaze	Japan National Railways	Takarazuka-Shi, Japan	4.5 m
1986	Shinkansen Shin Onomichi	Japan National Railways	Onomichi-Shi, Japan	
1987	Madrid-Sevilla, Section 1*	TAV - Renfe	Majarabique, Spain	
1987	Shinkansen Mikawa - Anjyo	Japan National Railways	Anjyo City, Japan	9.0 m
1987	Shinkansen Ohmihachiman	Japan National Railways	Kyoto, Japan	5.2 m
1988	Tsugaru-Kaikyou Line	Japan National Railways	Tsugara, Japan	5.0 m
1989	The Folkestone Terminal	Eurostar, UK-France Intercon'l	Folkstone, Great Britain	6.0 m
1992	Madrid-Sevilla, Section 2*	TAV - Renfe	Majarabique, Spain	
1992	Madrid-Sevilla, Miraflores Rd.*	TAV - Renfe	Majarabique, Spain	

* Reinforced Earth Railroad Bridge Abutments

Table-3
Reinforced Earth Walls Supporting Light Railroad

Year	Project Name	Owner	Location	Dist. from CL of track
1975	Puente Sobre Rio Nora*	Spanish Railways	Lugones, Spain	
1976	Odawara	Japan National Railways	Odawara-Shi, Japan	4.5 m
1977	Cergy Pontoise	National French Railways	Cergy Pontoise, France	
1978	Lutwyche Road	Queensland Railways	Brisban (Queensland),	
1979	Niigata Depot	Japan Railway Construction	Niigata - Shi, Japan	
1980	Echangeur de Fontaine	S.T.I.C.	Charleroi, Belgium	
1980	Fujigawa Nakama Yokotori	Gifo Construction Bureau	Fuji City, Japan	
1980	Ritto Maintenance Base	Osaka Construction Bureau	Ritto-Cho, Japan	
1981	Gelden Huis Siding	South Africa Transport Service	Germiston, South Africa	
1982	Ossory Road	Irish Railways	Dublin, Ireland	3.2 m
1982	Tolka Bridge	Irish Railways	Dublin, Ireland	
1983	Dade County Transit	DCT Administration	Dade County, Florida,	
1983	Fairview	Irish Railways	Dublin, Ireland	3.2 m
1983	METRO Vienna Station	Washington METRO	Washington, D.C., U.S.A.	
1983	N.E. LRT Bow River Bridge	City of Calgary	Calgary (Alberta), Canada	

*Reinforced Earth Railroad Bridge Abutments

Table-3 (Continued)
Reinforced Earth Walls Supporting Light Railroad

Year	Project Name	Owner	Location	Dist. from CL of track
1983	Namaze	Japan National Railways	Takarazuka-Shi, Japan	4.5 m
1984	Gare De Conflans Fin D'oise	French National Railways	Conflans Ste Honorine,	
1984	MARTA Chamblee Station	MARTA	Atlanta, Georgia, U.S.A.	
1985	Grandview Guideway	British Columbia Transit	Vancouver (B.C.), Canada	
1985	Princes Highway	State Rail Authority	Unanderra, Austriala	
1986	Linea FF-SS Udine-Tarvisio	Asfalti Sintex SpA	Gemona del Friuli, Italy	4.0 m
1986	Metro de Caracas	Metro de Caracas	Venezuela	
1986	North West LRT	City of Calgary	Calgary (Alberta), Canada	2.3 m
1986	Shinkansen Shin Onomichi	Japan National Railways	Onomichi-Shi, Japan	
1987	Madrid-Sevilla, Section 1*	TAV - Renfe	Majarabique, Spain	
1987	Shinkansen Mikawa - Anjyo	Japan National Railways	Anjyo City, Japan	9.0 m
1987	Shinkansen Ohmihachiman	Japan National Railways	Kyoto, Japan	5.2 m
1988	Columbia River	Tri Met	Portland, Oregon, U.S.A.	3.6 m
1988	Sacramento Transit	Sacramento Regional Transit	Sacramento, California,	3.6 m
1988	Tsugaru-Kaikyou Line	Japan National Railways	Tsugara, Japan	5.0 m

*Reinforced Earth Railroad Bridge Abutments

Table 3 (Continued)
Reinforced Earth Walls Supporting Light Railroad

Year	Project Name	Owner	Location	Dist. from CL of track
1989	The Folkestone Terminal	Eurostar, UK-France Intercon'l	Folkstone, Great Britain	6.0 m
1989	Route 87	Guadalupe Corridor Light Rail	San Jose, California, U.S.A.	
1990	MARTA Avondale Station	MARTA	Atlanta, Georgia, U.S.A.	
1990	METRO E9A over CSX	Washington METRO	College Park, Maryland,	
1992	Madrid-Sevilla, Section 2*	TAV – Renfe	Majarabique, Spain	
1992	Madrid-Sevilla, Miraflores Rd.*	TAV – Renfe	Majarabique, Spain	
1992	Metro Green Line	Metrolink	Los Angeles, California,	2.7 m
1994	MAC-RTD	RTD	Denver, Colorado, U.S.A.	
1994	Sunset Highway	Tri Met	Portland, Oregon, U.S.A.	2.7 m
1995	Banfield LRT	Tri Met	Portland, Oregon, U.S.A.	4.8 m
1995	DART SOC-2	DART	Dallas, Texas, U.S.A.	
1996	Cleveland RTA - 32F	Cleveland RTA	Cleveland, Ohio, U.S.A.	
1996	DART NC-2	DART	Dallas, Texas, U.S.A.	
1996	DART NC-1D	DART	Dallas, Texas, U.S.A.	
1999	Portland Airport LRT	TriMet	Portland, Oregon, U.S.A.	2.1 m
1999	RTD Line Segment 2	RTD	Denver, Colorado, U.S.A.	2.0 m

* Reinforced Earth Railroad Bridge Abutments

Table 3 (Continued)
Reinforced Earth Walls Supporting Light Railroad

Year	Project Name	Owner	Location	Dist. from CL of track
1999	RTD Line Segment 4	RTD	Denver, Colorado, U.S.A.	2.0 m
2000	DART G-2	DART	Dallas, Texas, U. S. A.	
2000	DART NC-4	DART	Dallas, Texas, U.S. A.	
2001	DART G-3	DART	Dallas, Texas, U.S. A.	
2001	DART NC-3	DART	Dallas, Texas, U.S.A.	
2001	METRO Yard	Washington METRO	Washington, D.C., U.S.A.	
2001	Airport Max Extension	TRI MET	Portland, Oregon, U.S.A.	
2001	Hiawatha LRT Airport to Metrodome	City of Minneapolis	Minneapolis, Minnesota, U.S.A	

* Reinforced Earth Railroad Bridge Abutments
Note: Over 200 Reinforced Earth structures supporting light rail lines have been completed in Japan.

Application	No.	Project Name	Area	Height	Facing	Finish	Product	Function	Design Loading	Date	State	Owner	Engineer	Contractor
REINFORCED EARTH ABUTMENT WALLS SUPPORTING RAIL BRIDGE														
RAIL	232	Clare Road Rail Underbridge	332	6	Concrete	PLAIN	TClass	True Abut	Vert Bridge (250kN/m LL, 300kN/m DL), 50 kPa Surcharge	04/81	SA	ANR	ANR	MATULICK
RAIL	321	Torrens River Rail Underbridge	896	8.5	Concrete	PLAIN	TClass	True Abut	Vert Bridge (300kN/m LL, 400kN/m DL), 50 kPa Surcharge	10/82	SA	ANR	ANR	
RAIL	731	Glenelg Street Bridge	113	4.1	Concrete	PLAIN	TClass	Piled Abut	60kpa Surcharge	01/85	QLD	QR	QR	JOHN HULL
RAIL	2305	Glenfield to Ingleburn Rail Loop	403	5	Concrete	PLAIN	TClass	True Abut	Vert Bridge (225kN/m LL, 150kN/m DL), 42 kPa Surcharge	04/94	NSW	NRC	TIERNEY PARTNERS	JOHN HOLLAND CONSTR
RAIL / Road	3048	Kemrick Junction	3362	9	Concrete	Plain	TClass	True Abut	Austroads 92, 200-A-12	02/99	WA	MRWA	Connell Wagner	Consolidated Constructions
Rail	4099	Revesby Turnback	2357	6.5	Concrete	Plain	TClass	Piled Abut	AS 5100- 300 LA	07/10	NSW	Rail Services Australia	Rail Infrastructure	Various
REINFORCED EARTH RETAINING WALLS DIRECTLY SUPPORTING RAIL FORMATION														
RAIL	59	Lutwyche Road Brisbane	942	6.75	Concrete	PLAIN	TClass	Ret. Walls	60 kPa Surcharge at Formation Level	06/78	QLD	QR	QR	HORNIBROOK
RAIL	151	Granville-Parramatta Rail Quadruplication	2578	7.1	Concrete	Exp Agg	TClass	Ret. Walls	60 kPa Surcharge at Formation Level	01/81	NSW	SRA	SRA	SRA
RAIL	176	Mona Vale Road Rail Bridge Replacement	1764	11.23	Concrete	RIBBED	TClass	Ret. Walls	50 kPa Surcharge at Formation Level	02/84	NSW	SRA	CAMERON MCN	SRA
RAIL	231	Parramatta-Westmead Railway Quadruplication	2146	8	Concrete	Exp Agg	TClass	Ret. Walls	60 kPa Surcharge at Formation Level	08/83	NSW	SRA	MAUNSELL &P	SRA
RAIL	252	Wynnum Road, Manly, Rail Bridge	807	8.23	Concrete	RIBBED	TClass	Ret. Walls	60 kPa Surcharge at Formation Level	07/81	QLD	QR	QR	ARMSTRONG
RAIL	501	Granville-Westmead Quad - Dive Ext	939	10	Concrete	PLAIN	TClass	Ret. Walls	60 kPa Surcharge at Formation Level	05/85	NSW	SRA	SRA	SRA
RAIL	778	Link Road Underbridge - Botany	779	4	Concrete	PLAIN	TCLass	Ret. Walls	60 kPa Surcharge at Formation Level	08/85	NSW	SRA	Maunsell & P	SRA
RAIL	989	George St Beenleigh	530	5	Concrete	PLAIN	TClass	Ret. Walls	60 kPa Surcharge at Formation Level	11/86	QLD	QR	QR	THEISS WATKINS
RAIL	1832	QR Goods Yard	475	5	Concrete	PLAIN	TClass	Ret. Walls	50 kPa Surcharge at Formation Level	02/80	QLD	QR	QR	EDWARDS
RAIL	2272	One Nation Rail	299	7	Concrete	Plain	TClass	Ret. Walls	Metric Cooper M270, 66 Kpa Surcharge at Formation Level	02/94	VIC	NATIONAL RAIL	Connell Wagner Pty	COOKS CONSTRUCTION
RAIL	2349	Flemington Rail	800	4.486	Concrete	Plain	TClass	Ret. Walls	73 kPa Surcharge at Formation Level	05/94	NSW	NRC	SHP ENG	BARCLAY MOWLEM
RAIL	2480	Cowan Rail	423	5	Concrete	PLAIN	TClass	Ret. Walls	Metric Cooper M270, 66 Kpa Surcharge at Formation Level	06/94	NSW	NATIONAL RAIL	R MAGRO & ASSOCIATE	LEIGHTONS
RAIL	4181	Chatswood Railway	480	5.146	Concrete	Smooth	TClass	Ret. Walls	82 kPa at Formation Level	03/10	NSW	RSA	Cardno MBK (NSW) Pt	John Holland
RAIL	4551	Endeavour Rd Riverview (Supply)	535	8	Concrete	Smooth	TPlus	Ret. Walls	QR 300-A12	05/10	QLD	Queensland Rail	Queensland Rail	Moggill Constructio