Light rail civil design and construction standards
T LR CI 12500 ST and T LR CI 12520 ST
Malcolm Peake, Senior Engineer Structures
Introduction/purpose

- Covers aspects of light rail civil infrastructure only
- Supplements Australian Standards and RMS specifications
- Consistency
- Interoperability
- Efficiency
- Whole asset life cycle
- Compliance with standards not sufficient
- AEO professional judgement by competent personnel
- ASA for clarification
Civil infrastructure scope (inclusions)

- bridge structures carrying light rail traffic
- bridge structures over light rail track
- track slabs
- culverts and drainage structures supporting light rail tracks
- retaining walls including reinforced soil walls
- rock bolts and permanent anchors
- earthworks
- drainage
- structural elements of buried utilities
- overhead wiring structures
- acoustic barriers
- cut and cover tunnels
- other tunnels with specialist literature
Civil infrastructure scope (exclusions)

- rail and track
- track clearances
- roads
- pavements
- road barriers
- signage
- traffic signals
- buried structures not loaded by light rail tracks
- vegetation
- other engineering disciplines
Referenced standards of TLR CI 12500 ST

- AS 1657 Fixed platforms, walkways, stairways and ladders – Design, construction and installation
- AS 1726 Geotechnical site investigations
- AS 2159 Piling – Design and installation
- AS 2832 (all parts) Cathodic protection of metals
- AS 3600 Concrete structures
- AS 4100 Steel structures
- AS 4678 Earth retaining structures
- AS 4799 Installation of underground utility services and pipelines within railway boundaries
- AS 5100 Bridge design set
- AS/NZS 1170 (all parts) Structural design actions
- AS/NZS 2566 (all parts) Buried flexible pipelines
- AS/NZS 3725 Design for installation of buried concrete pipes
- AS/NZS 4455 (all parts) Masonry units, pavers, flags and segmental retaining wall units standards series
- Australian Rainfall and Runoff: A Guide to Flood Estimation
- Roads and Maritime Services, Bridge Technical Direction Manual
T LR CI 12500 ST: LR design loading (vertical)

- Bridges & Structures over LR
  ➔ AS 5100 (SM1600 etc.)

- Bridges & Structures carrying LR traffic (vertical) (trailing axles)
  ➔ 125LA (first 9 axles) + 100LA

[300LA x 0.42] [300LA x 0.33]

100kN (axles as necessary)

Repeat number of axle groups as necessary

8 x 125kN (axles) 150kN leading axle
Typical light rail vehicle axle loading

Combination of 3 vehicle manufacturers

*Applicable to a LRV with more than 5 modules*
T LR CI 12500 ST: LR design load effects (vertical loads)
T LR CI 12500 ST: Other LR design loads

**Horizontal Forces** ➤ AS5100:2017 loads: 300LA x 125/300 (as a min)

- Centrifugal
- Braking
- Traction
- Nosing

**Collision Loads** ➤ AS5100:2017 loads: 300LA x 125/300 (as a min)

- Moderate derailments
- Minor collisions
- Specialist literature
- Increase loads depending on specific site factors

( Track components, track alignment, structure offset, pier capacity, occupants, etc.)
T LR CI 12500 ST: Design life

- Bridges: 100 years
- Structural elements: 100 years
- Culverts: 100 years
- Earthworks: 100 years
- Tunnels: 120 years
- Overhead wiring structures: 50 years
- Other components: See standard
T LR CI 12500 ST: Other design requirements

• Bridge ends: Perpendicular to track
• Earthing & Bonding: T LR EL 00001 ST
• Approved Materials: Steel & Concrete
• Drawings: T MU MD 00006 ST
  (standards, loading, materials, life, enviro, specs, maintenance, etc)
• Construction: T LR CI 12520 ST
  (all project requirements & references necessary)
• Maintenance: Whole of life (T MU AM 01003 ST)
T LR CI 12520 ST: Construction standard technical specifications

- RMS bridgework specifications: (B series)
- RMS roadwork specifications: (R series)
- RMS materials specifications:
- T HR CI 12111 SP Earthworks Materials for ballasted track
- Additional specs – Designer to develop if necessary
  (e.g. complex structures, fatigue life enhancement, welding, etc.)
<table>
<thead>
<tr>
<th>AS5100 Design Load</th>
<th>TLR CI 12500 ST Design Load</th>
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<tbody>
<tr>
<td>• National standard</td>
<td>• TfNSW (major urban areas)</td>
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<td>• Many potential operators</td>
<td>• Small number of operators</td>
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<tr>
<td>• First time included in AS5100 - Design Load 150LA (9 axles) (Queuing by Authority)</td>
<td>• Uniformity and conformity amongst operators</td>
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<td>• Derived by comparing LR vehicles in Melbourne and Sydney</td>
<td>• Design load 125LA (9 axles) with 100LA trailing axles</td>
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<td>• Easy integration with other clauses in the standard allowing proportioning for horizontal forces</td>
<td>• Lower design load than AS5100</td>
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<td>• 30-100% growth factor included for 100 year design life</td>
<td>• More aligned to actual LR vehicle</td>
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<td>• Allows 20-80% growth on current LR rolling stock in service in Sydney</td>
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## Light rail design comparison with AS5100 (contd.)

### AS5100 Fatigue

- Number of fatigue cycles ‘guestimate’ and same as HR passenger lines
- Design load conservative – allows for significant increase in fatigue cycles without reducing fatigue life

### T LR CI 12500 ST Fatigue

- Fatigue cycles based on AS5100
- Actual damage for 100 year design life for LR could be higher than AS5100 due to higher stress range
- Fatigue damage should be checked in design for high frequency services
Light rail design comparison with AS5100 (contd.)

AS5100 Derailment Collision Loads

- Derailment load for LR same as for HR
- LR forces (4000kN longitudinal) and 1500kN transverse) allows for head-on collision unlike HR which is glancing impact

T LR Cl 12500 ST Derailment Collision Loads

- Proportionally can reduced collision loads by ratio 125 / 300 = 0.42 min
- Represents moderate derailments / minor collisions
- Does not provide for head-on collision
- Site specific factors and technical literature shall be considered in determining actual design collision load (risk assessment)