

October 2004 Edition

Code of Practice for Railway Protection



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PREFACE

The last edition of the Code of Practice for Railway Protection (herein referred to as the Code) was issued in August 2000 under the Rapid Transit Systems (Development and Building Works in Railway Corridor and Railway Protection Zone) Regulations.

The Rapid Transit Systems Regulations empower the Authority to issue codes of practice setting out standards, procedures, conditions and other requirements for carrying out any development or building works within the railway corridor and railway protection zone.

As part of the Authority's continual efforts to be more business friendly, the Authority embarked on the review of the Code in April 2003 and invited qualified persons to provide feedback on the Code.

We like to express our appreciation to all those who have given us valuable contributions and support in the review of the Code. We welcome any suggestion or feedback from all users on this latest version of Code for improvement of future editions.

Development & Building Control Department

Land Transport Authority
Singapore

PART I INTRODUCTION

SECTION 1 GENERAL

1.1 SCOPE

1.1.1

This Code covers the submission procedures and requirements for obtaining the approval for development and building proposals, the permit to commence engineering works and the clearance for the release of certificate of statutory completion for works in the railway corridor and the railway protection zone. Technical requirements for compliance at the design and construction stages of development are also stipulated.

1.2 USEFUL REFERENCES

1.2.1

Handbook on development and building works in railway protection zone

1.2.1.1

To illustrate the interpretation of the technical requirements in this Code, the Authority has published a document entitled 'Handbook on Development and Building Works in the Railway Protection Zone'.

1.2.1.2

This handbook is written in an easy to read manner and it contains supplementary materials such as photographs, diagrams, explanatory notes, case examples, etc. to guide the users through the technical requirements of the Code.

1.2.2

Guidelines on restricted activities

1.2.2.1

Under the Rapid Transit Systems (Railway Protection, Restricted Activities) Regulations, any person intending to carry out restricted activities in the railway protection zone shall obtain prior permission from the Authority before commencement of work on site.

1.2.2.2

Restricted activities are activities which when carried out in the vicinity of the railway would expose the railway to danger. They could cause injuries and fatalities to passengers or results in damage to the railway thus disrupting passenger service if no proper design and method of construction or safety measures are provided.

1.2.2.3

The types of restricted activities stipulated in the schedule of the Regulations are as follows :

- (a) The movement or operation of any crane, whether fixed or mobile, hoist, ladder, drilling or piling equipment, excavator or any other mechanical equipment or vehicle;
- (b) The installation of boreholes, wells, sheetpiles, pile foundations, ground anchors and horizontal tie-backs;
- (c) The storing or placing, or causing or allowing the storage or placement of, any goods, material or thing or any solid, liquid or gaseous matter or substance;
- (d) The digging or excavation of trenches or pits, the carrying out of earthworks and backfilling, or the shifting or pushing of earth or soil from one area to another, whether or not such activities are carried out manually or by mechanical means;

- (e) The dredging of sea beds or river beds and the anchoring of vessels with displacement (laden) weight of more than 20 tonnes;
- (f) The erection of sheds, shelters, tents, scaffolding, maintenance towers, ladders, hoardings and other similar temporary structures for the purpose of trade fairs, fun fairs, exhibitions, entertainment, night markets, religious functions or ceremonies;
- (g) The planting of trees with full-grown height extending above the parapet or wing wall of the railway;
- (h) The use of explosive material for the purpose of blasting, demolition or removal of rocks; and
- (i) The construction of an underground passageway designed for use as a street or railway; to serve as a conduit for utilities; to provide access for people, vehicles or equipment to an underground work site.

1.2.2.4

To offer guidance to any person proposing to carry out restricted activities in the railway protection and safety zones, the Authority has published a document entitled 'Guide to Carrying out Restricted Activities within Railway Protection and Safety Zones'. The submission requirements for obtaining the Authority's permission to carry out any restricted activities and the suggested safety considerations are given in this publication.

1.2.2.5

For any development works which would involve restricted activities such as the use of crane, etc. within the first reserve, an application for the exemption of the provisions under the Rapid Transit Systems (Railway Protection, Restricted Activities) Regulations shall be made by the qualified person in writing. Application for such exemption shall be made using Form LTA DBC RAIL-EXEMPT.

1.3 CONSULTATION

1.3.1

The appointed qualified person may consult the Authority on any requirements relating to railway protection before making any formal application for approval.

1.3.2

Any preliminary consultation with the Authority or submission of plans shall not be taken as approval or disapproval of the proposed development or to be construed as having the agreement of the Authority.

1.3.3

All correspondence including applications for approval and requests for consultation meeting or information should be addressed to :

Manager
Development & Building Control Department
Land Transport Authority
251, North Bridge Road
Singapore 179102

1.4 REFERENCE PLANS

1.4.1

Plans delineating the Railway Corridor and Railway Protection & Safety Zones are available for inspection by the public free of charge at the following address :

Development & Building Control Department
Land Transport Authority
251, North Bridge Road
Singapore 179102

1.4.2

The information on the plans is indicative only. Details and exact location of the rapid transit system structures must be verified at site.

1.4.3

The information on the plans are provided 'as is' and 'as available'. Whilst every effort is made to ensure that the information is correct, the Authority does not warrant their adequacy and completeness and expressly disclaims liability for any error or omission.

1.4.4

The above plans may be modified, deleted or replaced from time to time and at any time in the absolute discretion of the Authority.

1.4.5

The Authority shall in no event be liable for any damages, losses or expenses including without limitation direct, indirect, special or consequential damage or economic loss arising from any reliance on the information on the drawings.

1.5 APPLICATION FORMS

1.5.1

All application forms can be downloaded from the Corenet or obtained from the Authority's web site.

1.6 DEFINITIONS

For the purpose of this Code, the following definitions shall apply :

“above ground structure”

shall include viaduct, bridge, abutment and any rapid transit systems station which adjoins the railway viaduct;

“alternative solution”

means a solution which complies with the performance requirements other than by reason of complying with the deemed-to-satisfy provisions;

“amendment plan”

has the same meaning as in the Rapid Transit Systems (Development and Building Works in Railway Corridor and Railway Protection Zone) Regulations;

“assessment method”

means a method used for determining or establishing that a development solution complies with the performance requirements;

“at grade structure”

shall include any rapid transit systems station where the platform level is at ground level, on embankment or in cutting and any section of the railway with tracks at ground level, on embankment or in cutting;

“Authority”

means the Land Transport Authority of Singapore established under the Land Transport Authority of Singapore Act 1995;

“building works”

has the same meaning as in the Building Control Act (Cap 29);

“deemed-to-satisfy provisions”

means the provisions contained in Part II Section 9 of this Code which are deemed to comply with the performance requirements;

“solution”

means a solution which complies with the performance requirements and is :

- a) an alternative solution; or
- b) a solution which complies with the deemed-to-satisfy provisions; or
- c) a combination of (a) and (b)

“development”

has the same meaning as in the Planning Act (Cap 232);

“expert judgement”

means the judgement of an expert (or group of experts) who has the relevant qualifications, substantial knowledge and experience in a particular subject/ field to determine whether a development solution complies with the performance requirements. The appointed expert shall be approved by the Authority.

“land surveyor”

means a person registered under the Land Surveyors Act;

“objectives”

mean a statement contained in this Code that forms the aim of the Authority in safeguarding the railway;

“performance requirement”

means a requirement which states the level of performance which a development solution must meet;

“professional engineer”

means a person registered under the Professional Engineers Act;

“qualified person”

means a person as defined in the Building Control Act (Cap 29);

“railway area”

has the same meaning as in the Rapid Transit Systems Act (Cap 263A);

“railway corridor”

has the same meaning as in the Rapid Transit Systems (Development and Building Works in Railway Corridor and Railway Protection Zone) Regulations;

“railway protection zone”

has the same meaning as in the Rapid Transit Systems (Railway Protection, Restricted Activities) Regulations;

“railway safety zone”

has the same meaning as in the Rapid Transit Systems (Railway Protection, Restricted Activities) Regulations;

“rapid transit systems”

has the same meaning as in the Rapid Transit Systems Act (Cap 263A);

“restricted activities”

has the same meaning as in the Rapid Transit Systems (Railway Protection, Restricted Activities) Regulations;

“sub-aqueous structure”

shall include any rapid transit systems structure beneath river or sea;

“the Regulations”

means the Rapid Transit Systems (Development and Building Works in Railway Corridor and Railway Protection Zone) Regulations 2000 as amended from time to time.

“transition structure”

shall include any rapid transit systems structure that occurs between underground structure and above ground or at grade structure;

“underground structure”

shall include inter-alia any rapid transit systems underground station, bored tunnel, cut and cover tunnel, interchange shaft, pedestrian passage, cross passageway between tunnels and emergency escape shafts;

“verification method”

means a test, inspection, calculation or other method that determines whether a development solution complies with the relevant performance requirements.

SECTION 2 STRUCTURE OF CODE

2.1 Code Structure

2.1.1

This Code is divided into four main parts as follows :

- (a) Part I - Introduction
- (b) Part II - Proposals in Railway Protection Zone
- (c) Part III - Proposals in Railway Corridor
- (d) Part IV - Appendices

2.1.2

Unless otherwise stated, references to a Regulation number (example, Regulation 4) in this Code are references to the regulations numbered in the Rapid Transit Systems (Development and Building Works in Railway Corridor and Railway Protection Zone) Regulations 2000 as amended from time to time.

2.2 SUBMISSION REQUIREMENTS

2.2.1

The submission procedures and requirements for obtaining approval for development and building proposals, permit to commence engineering works, etc. in the railway protection zone and railway corridor are stipulated in Part II Section 1 to Section 6 and Part III Section 1 to Section 3 respectively.

2.3 TECHNICAL REQUIREMENTS

2.3.1

The technical requirements for the various types of engineering works in the railway protection zone and railway corridor are stipulated in Part II Section 7 to Section 9 and Part III Section 4 respectively.

2.4 APPENDICES

2.4.1

The following items are presented in the appendices of this Code :

- (a) Appendix A - Submission process for development and building works in the railway protection zone.
- (b) Appendix B - Preparation of contingency plan and emergency procedure.
- (c) Appendix C - Application for access to track and station premises.
- (d) Appendix D - Drawings indicating the definitions of reserve lines for the various types of rapid transit system structures; the typical trainway cross-sectional details for tunnel and viaduct; the typical debonding details for load bearing piles and the interpretation of track criteria.

PART II PROPOSALS IN RAILWAY PROTECTION ZONE

SECTION 1 DEVELOPMENT PROPOSAL

1.1 GENERAL

1.1.1

This section stipulates the procedures and requirements for obtaining approval for a development proposal in the railway protection zone.

1.1.2

Plan for development proposal in the railway protection zone shall be submitted to the Authority for approval in accordance with Regulation 4.

1.2 PRELIMINARY ENGINEERING ASSESSMENT

1.2.1

The submission process for any development proposal in the railway protection zone is as shown in Appendix A.

1.2.2

A Professional Engineer (Civil) should be engaged at this stage to carry out a preliminary engineering assessment of the effects of the development proposal on the rapid transit systems. The appointed Professional Engineer (Civil) is encouraged to initiate a consultation meeting with the Authority to discuss his proposal before submitting a formal application.

1.2.3

A copy of the engineering evaluation report, accompanied by plans for engineering works, endorsed by the appointed Professional Engineer (Civil) shall be submitted together with the application for the approval of development proposal. For development located close to the rapid transit system structures, the Authority requires the qualified person to submit certified survey plans to assist in the processing of engineering evaluation report.

1.3 APPLICATION FOR APPROVAL OF DEVELOPMENT PROPOSAL

1.3.1

An application for the approval of development proposal shall be accompanied by the following items:

- (a) Plan for development works;
- (b) Engineering evaluation report accompanied by plan for engineering works; and
- (c) Certified survey plans (only applicable for critical development involving tunnelling, piled foundation, basement construction, etc. within the first reserve of underground rapid transit system structures).

1.4 INFORMATION TO BE INDICATED ON PLAN

1.4.1

Plan for development works shall be prepared in accordance with the requirements of the Regulations.

1.4.2

The qualified person shall sign on every sheet of the plans. This requirement shall also apply to plans submitted electronically.

1.4.3

The first sheet of the plan shall bear the standard declarations as given below :

I, _____, NRIC no./ Passport no.,
_____, being the qualified person
appointed under Regulation 4(3) of the Rapid Transit
Systems (Development and Building Works in Railway
Corridor and Railway Protection Zone) Regulations,
hereby certify that the development or building works in
the railway protection zone as shown on these plans
have been designed in accordance with the Code of
Practice for Railway Protection and other conditions
imposed by the Land Transport Authority.

1.4.4

The plan shall be drawn to a scale of 1:100 or 1:200 or 1:250 generally, except for the site plan which is to be presented in a scale of 1:500.

1.4.5

Site and layout plans shall show the following items :

- (a) Scale of plans;
- (b) Location and clearances of the proposed development works in relation to the rapid transit system structures;
- (c) First, second and third reserve lines of the rapid transit system structures, where applicable; and
- (d) Basement outline, if any.

1.4.6

Sections and elevations shall show the following items :

- (a) Scale of the plans;
- (b) Platform levels of the proposed development works;
- (c) Minimum clearance between proposed development works and the nearest rapid transit system structures; and
- (d) First, second and third reserve lines of the rapid transit system structures, where applicable.

1.4.7

Certified survey plans shall :

- (a) Be prepared and submitted using Form LTA DBC RAIL-SURVEY;
- (b) Be endorsed by a registered land surveyor after conducting a physical geometric survey of the relevant sections of the rapid transit system structures (refer to Part IV Appendix C on the procedure for applying access to track and station premises);
- (c) Indicate the scale, existing contours, alignments, chain-ages, co-ordinates, levels and reserve lines of the rapid transit system structures; and
- (d) Indicate the boundary lines, lot numbers and the existing structures.

1.5 APPROVAL OF DEVELOPMENT PROPOSAL

1.5.1

The Authority will approve the development proposal in writing if the following requirements are complied with :

- (a) Qualified person has complied with the requirements of Clause 1.2 to Clause 1.4 of this section and that all items submitted are found to be in order; and
- (b) Qualified person has demonstrated and confirmed that it is feasible for the development proposal to fully meet the technical requirements of Part II Section 7 to Section 9.

SECTION 2 BUILDING PROPOSAL

2.1 General

2.1.1

This section stipulates the procedures and requirements for obtaining approval for a building proposal in the railway protection zone.

2.1.2

Plan for building works in the railway protection zone shall be submitted to the Authority for approval in accordance with Regulation 4.

2.2 APPLICATION FOR APPROVAL OF BUILDING PROPOSAL

2.2.1

An application for the approval of building proposal shall be accompanied by the following items :

- (a) Plan for building works;
- (b) Drainage Department's clearance letter on the proposed flood threshold levels for all entrances and openings in the development if it is connected or integrated with the rapid transit systems; and
- (c) Engineering evaluation report accompanied by plan for engineering works.

2.3 INFORMATION TO BE INDICATED ON PLAN

2.3.1

Plan for building works shall be prepared in accordance with the requirements of the Regulations.

2.3.2

The first sheet of the plan shall bear the standard declarations as given in Clause 1.4.3 of Part II Section 1.

2.3.3

The qualified person shall sign on every sheet of the plans. This requirement shall also apply to plans submitted electronically.

2.3.4

The plan shall be drawn to a scale of 1:100 or 1:200 or 1:250 generally, except for the site plan which is to be presented in a scale of 1:500.

2.3.5

Site and layout plans shall show the following items :

- (a) Scale of plans;
- (b) Building and boundary lines of building;
- (c) Location and clearances of the proposed building works in relation to the rapid transit system structures;
- (d) First, second and third reserve lines of the rapid transit system structures, where applicable;
- (e) Existing ground level and proposed platform levels;
- (f) Basement outline, if any;
- (g) Discharge outlet from pump sump in basement, if any; and
- (h) Main roads and special landmarks.

2.3.6

Sections and elevations shall show the following items :

- (a) Scale of the plans;
- (b) Building and boundary lines of building;
- (c) Horizontal and vertical clear distances between rapid transit system structures and the proposed development;
- (d) First, second and third reserve lines of rapid transit system structures, where applicable;
- (e) Depth of basement, if any;
- (f) Details of proposed drainage system including discharge outlet, if any;
- (g) Proposed platform level if the development is connected or integrated with the rapid transit systems; and
- (h) Affected drain lines and lightning protection system of the rapid transit systems.

2.4 APPROVAL OF BUILDING PROPOSAL

2.4.1

The Authority will approve the building proposal in writing if the following requirements are complied with :

- (a) Qualified person has complied with the requirements of Clause 2.2 to Clause 2.3 of this section and that all items submitted are found to be in order; and
- (b) Qualified person has demonstrated and confirmed that it is feasible for the building works to fully meet the technical requirements of Part II Section 7 to Section 9.

SECTION 3 ENGINEERING WORKS

3.1 GENERAL

3.1.1

This section stipulates the procedures and requirements for obtaining a permit to commence engineering works in the railway protection zone.

3.1.2

Engineering works refer to any kinds of construction works that may endanger or is likely to affect the structural integrity of the rapid transit system structures and the safety of its operation.

3.1.3

In accordance with Regulation 6, an application for a permit to commence any works for which the plans have been approved under Regulation 4 or 5 shall be made.

3.1.4

No engineering work shall commence on site without the permission of the Authority in writing.

3.2 APPLICATION FOR PERMIT

3.2.1

An application for permit to commence a specific phase of engineering works shall be submitted by the qualified person appointed under Regulation 9 for supervision and accompanied by the following items :

- (a) Plan for engineering works;
- (b) Engineering evaluation report;
- (c) Instrumentation proposal and initial instrumentation readings;
- (d) Method statement of work;
- (e) Emergency procedure;
- (f) Pre-condition survey report;
- (g) Certified survey plan (if not submitted at Development Proposal stage);
- (h) Form LTA DBC RAIL-PERMIT (to be submitted once only unless there is any change in the developer/ owner, qualified person appointed for supervision or builder); and
- (i) Relevant documents indicating planning approval from the competent authority.

3.2.2

The requirements for the above items are given in Clause 3.3 to Clause 3.10 of this section for compliance.

3.3 PLAN FOR ENGINEERING WORKS

3.3.1

Plan for engineering works shall be prepared in accordance with the requirements of the Regulations and endorsed by a qualified person.

3.3.2

Layout plans and cross sectional details shall indicate the following items :

- (a) Scale of the plans;
- (b) Building and boundary lines of building;
- (c) Vertical and horizontal distances of the engineering works (site preparation, substructures and building construction works, etc.) in relation to the existing rapid transit system structures; and
- (d) First, second and third reserve lines of the rapid transit system structures and the line of influence, where applicable.

3.4 ENGINEERING EVALUATION REPORT

3.4.1

Engineering evaluation report shall be prepared and endorsed by a qualified person.

3.4.2

The above report shall address the following items :

- (a) Predicted movements at various stages of construction and at completion of the development works of the existing rapid transit system structures due to the proposed engineering works. The evaluation shall include the following items :
 - (i) Detailed examination of the ground conditions at site;
 - (ii) Calculations for the derivations of the predicted movements; and
 - (iii) Appropriate sensitivity analysis to check that the assessment would not be affected by any variation in input parameters and conditions that may occur during all stages of the construction work.
- (b) Assessment of the likely effects of movement on the existing rapid transit systems. The effects on structural integrity, track beds, structural gauge clearances, drainage of the existing rapid transit systems, etc. shall be considered.
- (c) Proposal for any special measures or advance works needed to minimise the susceptibility of the existing rapid transit systems to damage and to ensure the continuation of safe train-operating conditions.
- (d) Proposal for rectification works to the existing rapid transit system structures. These may include specifications for remedial grouting or structural repair, requirements to adjust the track during or subsequent to construction, the need to re-align the affected drains, etc.
- (e) The report shall clearly demonstrate that the performance provisions in Part II Section 8 are fully met after all works have been completed.

3.4.3

Notwithstanding the above, the Authority reserves the right to specify any other requirements on the engineering evaluation report which are deemed necessary for the safeguarding of the rapid transit systems.

3.5 INSTRUMENTATION PROPOSAL

3.5.1

Instrumentation proposal shall be prepared and endorsed by a qualified person.

3.5.2

The proposal shall include the following items :

- (a) Comprehensive monitoring system to monitor the behaviour of the existing rapid transit systems and the ground adjacent to it;
- (b) Layout plans and relevant cross-sections indicating the locations of proposed instruments relative to the rapid transit system structures;
- (c) Details of the instruments or equipment, including the types, function of instruments, depth of installation, etc.;
- (d) Frequency of monitoring;
- (e) Valid calibration certificates for the instruments proposed, where applicable; and
- (f) Schedule for instrument installation works within the premises of rapid transit system structures indicating the number and frequency of access required.

3.5.3

In preparing the above proposal, the qualified person shall comply with the requirements stipulated in Part II Section 4.

3.5.4

For any installation of instruments in the trainway, the requirements in Part II Section 6 shall also be complied with.

3.5.5

A copy of the initial readings endorsed by the qualified person shall be submitted to the Authority for the release of permit to commence work.

3.6 METHOD STATEMENT OF WORK

3.6.1

Method statement for carrying out any engineering works shall be prepared and endorsed by a qualified person.

3.6.2

The proposal shall be accompanied by the following items :

- (a) Layout plan showing the location of the engineering works relative to the rapid transit system structures;
- (b) Write-up and/or plans indicating step-by-step sequence of carrying out each phase of works or activities; and
- (c) Hazard analysis identifying all possible risks that may be posed to the rapid transit system and a description of the safety and precautionary measures to mitigate these risks.

3.7 CONTINGENCY PLAN/ EMERGENCY PROCEDURE

3.7.1

A contingency plan and emergency procedure prepared using the guidelines given in Part IV Appendix B shall be endorsed and submitted by a qualified person.

3.8 PRE-CONDITION SURVEY REPORT

3.8.1

A condition survey report (including photographic record of the rapid transit system structures) shall be prepared and endorsed by an independent person who has the appropriate qualifications, for example, professional engineer or building surveyor.

3.8.2

Condition surveys to be undertaken shall include physical surveys of rapid transit system structures to be carried out by a registered land surveyor. The procedure to apply for access to the rapid transit systems tracks and station premises is given in Part IV Appendix C.

3.9 CERTIFIED SURVEY PLAN

3.9.1

Certified survey plan shall meet the requirements of Clause 1.4.7 of Part II Section 1.

3.10 UNDERTAKING FOR SUPERVISION

3.10.1

Qualified person appointed under Regulation 9 for supervision shall provide an undertaking to supervise development and building works in the railway protection zone using Form LTA DBC RAIL-PERMIT.

3.10.2

The above form shall be resubmitted whenever there is a change in the owner/ developer or qualified person appointed for supervision.

3.11 COMMENCEMENT OF WORK

3.11.1

The Authority will issue the permission in writing to commence works upon approving the relevant engineering work plans if the following requirements are complied with :

- (a) Qualified person has complied with the requirements of Clause 3.2 to Clause 3.10 of this section and that all items submitted are found to be in order; and
- (b) Qualified person has fully demonstrated that the proposal satisfies the technical requirements of Part II Section 7 to Section 9.

3.11.2

Written clearance from the Development & Building Control Department of the Authority shall be obtained before the commencement of construction works including soil investigation and foundation works on site.

3.12 DEPARTURE OR DEVIATION FROM APPROVED PLAN

3.12.1

In accordance with Regulation 5, amendment plan shall be submitted to the Authority for approval if any building works depart or deviate from the approved plan.

3.12.2

An application for approval of amendment plans shall be accompanied by one set of the following documents prepared, signed and submitted by the qualified person :

- (a) A copy of the amendment plans showing the amended proposal; and
- (b) Engineering evaluation report accompanied by plans for engineering works, if applicable.

3.12.3

No person shall carry out any building works in departure or deviation from the approved plan unless the amendment plan has been approved.

SECTION 4 INSTRUMENTATION PROPOSAL

4.1 General

4.1.1

This section stipulates the minimum monitoring requirements for development and building works in railway protection zone.

4.1.2

The Authority reserves the right to impose any additional requirements deemed necessary to safeguard the rapid transit systems.

4.2 GROUND MONITORING

4.2.1

The ground shall be monitored for changes in ground conditions and movements which may result from the proposed works.

4.2.2

Typical ground instruments such as water standpipes, inclinometers, piezometers, borehole extensometers and settlement markers shall be provided where applicable.

4.2.3

The type of ground instrument to be provided shall be appropriate for the ground conditions.

4.2.4

Adequate monitoring instruments shall be provided. The spacing of instruments shall be such that adverse changes in the ground conditions can be captured. The frequency of monitoring must tie-in with the criticality of the stage of works. Instrumentation proposal shall be submitted to the Authority for approval.

4.3 RAPID TRANSIT SYSTEM STRUCTURES & TRACKS MONITORING

4.3.1

Rapid transit system structures and tracks shall be monitored if the development and building works have implications on the integrity of the rapid transit system and its operation.

4.3.2

Typical monitoring instruments such as precision surveying theodolite, tiltmeter, vibration sensor, crack meter, electrolevel, tape extensometer can be used.

4.3.3

Where the cumulative movement of the underground or at-grade rapid transit system structure is expected to exceed 5 mm, an automatic remote control monitoring of the structures shall be provided. At least four monitoring cycles of results shall be provided for the entire monitoring zone within a period of 24 hours.

4.3.4

The automatic tunnel monitoring systems shall also have the facility to be switched to continuous mode for reading points within any localised areas of interest along the rapid transit system tunnels.

4.3.5

The software used in processing of data shall be in accordance with the procedure recommended by the manufacturer. The software must be proven to be reliable and the Authority reserves the right to reject any proposed software that is deemed not acceptable.

4.3.6

All remote control systems shall be equipped with automatic data acquisition and processing units, viewing screen and printer for hard copy printout of the monitoring results.

4.3.7

Where automatic monitoring is provided, manual survey shall be provided to countercheck all the monitoring points and control points. This shall be carried out at least once a month.

4.3.8

The rapid transit system tunnels shall be monitored for movements along its length spaced not more than 3m intervals within the predicted zone of influence. At least four points around each tunnel ring at these intervals shall be monitored. Monitoring shall extend at least 20m beyond the zone of influence. This monitoring and that for more massive part of rapid transit system stations and related structures shall not be more than 5m apart.

4.3.9

The at-grade rapid transit system structures are supported on ballast and sub-ballast. Where the proposed works have implications on these structures, there shall be additional monitoring to check that there is no differential settlement between the sub-ballast and the sub-soil below it as this may cause derailment of train.

4.3.10

Manual survey shall be carried out using 1sec theodolite and distance accuracy of 1mm+/- 2ppm or better. The results shall be certified by registered surveyor for submission to the Authority. The monitoring instrument and set up must take into consideration the effects of train operation and changes in ambient conditions such as vibration, changes in air pressure and temperature.

4.4 CALIBRATION

4.4.1

Instruments used shall have calibration done once every 6 months. Certificates for calibration shall be submitted to the Authority for record.

4.5 INSTALLATION

4.5.1

The type of anchor and bolt used shall be HKD-SKR or equivalent. The material shall be made of stainless steel. The anchor shall be 30 mm long and 10 mm in diameter. The bolt shall be 8 mm in diameter. Before drilling into the rapid transit system structures, checks shall be made to identify the depth and location of the embedded reinforcements. The proposed drilling locations shall be away from the existing reinforcements.

4.5.2

Upon completion of monitoring, all fixtures installed (except the bolt anchors at the tunnel sides) must be removed and the rapid transit system structures shall be made good to the acceptance of the Authority. Approval shall be obtained from the Authority for any other left-in fixtures.

4.6 ACCURACY OF READINGS

4.6.1

The readings shall attain the level of accuracy when instruments are installed properly and maintained in good working condition as specified by the manufacturer. Damaged

instruments shall be immediately replaced to the acceptance of the Authority and readings correlated with the previous.

4.6.2

The readings taken by automatic tunnel monitoring system must be consistent and stable. The deviation from the mean readings which is taken as actual reading must be less than +/-1 mm for 90% confidence level.

4.6.3

Control and reference points shall be located outside the zone of influence of the proposed works and such that they do not impact on the accuracy of monitoring results. At least two numbers of control points on opposite ends of site shall be provided. In addition, control points must be located on very stable structures which would not be affected by the adjacent development.

4.7 INITIAL READINGS AND TERMINATION OF MONITORING

4.7.1

Readings must be stabilised before commencement of work.

4.7.2

Readings which are the most representative of the initial condition shall be taken as the initial readings.

4.7.3

For automatic monitoring of the rapid transit system structures for movements, the initial set of readings must include test results to demonstrate the monitoring system meets the required accuracy as stated in Clause 4.6.2.

4.7.4

Before termination of monitoring, the sub-structural works must be completed, the ground conditions and the monitoring readings shall both shown to have stabilised and thereafter no further change is expected in the long term. If the construction of superstructure is expected to affect adversely on the ground conditions and the rapid transit system structures, monitoring shall be continued until their completion and stable readings obtained.

SECTION 5 SUPERVISION OF WORKS

5.1 General

5.1.1

In accordance with Regulation 9, the developer shall appoint and notify the Authority of the qualified person supervising the development and building works.

5.2 DUTIES OF QUALIFIED PERSON

5.2.1

In addition to the duties stipulated in Regulation 9 and Regulation 10, the qualified person shall also carry out the duties stipulated in this section.

5.3 MONITORING OF RAPID TRANSIT SYSTEMS

5.3.1

The qualified person shall continuously monitor the effects of construction works on the rapid transit system structures, tracks and the ground. He shall analyse the monitoring results, predict the likely trends and notify the Authority of any deviation from the predicted results and trends. He shall also make proposal to change the method of working or to implement an emergency plan as a result of monitoring.

5.3.2

Once the monitoring readings are taken, they shall be submitted to the Authority timely. A report of the review and the monitoring results endorsed by a qualified person shall be submitted to the Authority within a week from the date of monitoring.

5.3.3

During the progress of the works, if it becomes apparent from the monitoring results that the ground movement and/or the structural movement are likely to exceed the limits, the Authority may revoke the permit. The developer shall take additional measures to control movements to within the acceptable limits, all at the cost and expense of the developer before the work is allowed to resume.

5.3.4

The monitoring shall continue until all works that may affect the movement of the rapid transit system structures have been completed and the monitoring results show that the rapid transit system structures and the surrounding ground have stabilised and no further movement or change would be anticipated.

5.4 PROTECTION OF RAPID TRANSIT SYSTEMS

5.4.1

Preventive measures shall be taken during construction stage to prevent any damage to the existing rapid transit systems such as their structures, mechanical and electrical works (including signalling), architectural finishes, external works and lightning protection and drainage systems of above ground structures.

5.5 COMPLETION OF WORK

5.5.1

Condition surveys of the rapid transit systems shall be carried out upon completion of the proposed works or at intermediate stages as directed by the Authority. Defects found shall be highlighted and compared with the findings of precondition survey.

5.5.2

A proposal on making good of all defects arising from the development found in the rapid transit systems (including that of its facilities and tracks) prepared and endorsed by the qualified person shall be submitted to the Authority for prior approval.

5.5.3

Making good of defects arising from the development and building works shall be completed to the satisfaction of the Authority. The developer shall bear all direct or indirect costs arising from the rectification works. A report on the remedial work done shall be submitted upon completion of all remedial work.

5.5.4

Defects and damages rectified shall be highlighted with photograph and compared with those found after the completion of work indicated in the final condition survey report.

5.6 CLEARANCE FOR RELEASE OF CERTIFICATE OF STATUTORY COMPLETION

5.6.1

The qualified person shall make an application to the Authority to issue clearance for the release of the certificate of statutory completion.

5.6.2

An application for clearance of certificate of statutory completion shall be accompanied by the following items :

- (a) As-built foundation, structural and building plans/ details endorsed by the relevant qualified persons;
- (b) As-built mechanical and electrical plans/ details endorsed by a qualified person (applicable for development with integration/ interface with the rapid transit systems);
- (c) Form LTA DBC RAIL-CSC-BW;
- (d) Form LTA DBC RAIL-CSC-PW (if applicable);
- (e) Form LTA DBC RAIL-CSC-SW (if applicable);
- (f) Form LTA DBC RAIL-CSC-M&E (if applicable);
- (g) Final condition survey report.

5.6.3

The Authority will issue clearance for the release of the certificate of statutory completion in writing if the following requirements are complied with :

- (a) Qualified person has complied with Clause 5.6.2 of this section and that all items submitted are found to be in order; and
- (b) The development and building works are completed in accordance with the approved plans; and any damage to the rapid transit systems or defects of new rapid transit system structures are rectified to the satisfaction of the Authority.

SECTION 6 INSTALLATION OF INSTRUMENTS IN TRAINWAY

6.1 General

6.1.1

This section stipulates the requirements for obtaining approval for the installation of instrument that may infringe into the structure gauge of the operating rapid transit system tunnel or trainway.

6.1.2

All instruments to be installed in the trainway shall be submitted to the Authority for approval before track access can be granted for the installation works.

6.2 APPLICATION FOR INSTRUMENT INSTALLATION

6.2.1

An application for the approval of instrument installation in trainway shall be accompanied by three sets of the following items :

- (a) Instrumentation layout plan;
- (b) Tunnel or trainway cross-sectional plans;
- (c) Plans and calculations on fixing details;
- (d) Document stating the name and particulars of the appointed registered surveyor and his assignee, if any, responsible for checking structure gauge clearance of instruments installed on site; and
- (e) Document stating the name and particulars of the appointed professional engineer (civil) and his assignee, if any, responsible for checking fixing details of instruments installed on site.

6.2.2

One set of virus free soft copy of item (a) and item (b) shall also be submitted.

6.3 INFORMATION TO BE INDICATED ON PLANS & CALCULATIONS

6.3.1

Instrumentation layout plan shall show the following items :

- (a) Registered surveyor's endorsement on every plan;
- (b) Scale of drawing;
- (c) Rapid transit system tunnel or trainway alignment with respect to the development site; and
- (d) Chainages of all instrument locations.

6.3.2

Tunnel or trainway cross-sectional plans (refer to sample drawing nos. LTA/DBC/CPRP/005-007) shall show the following items :

- (a) Registered surveyor's endorsement on every plan for structure gauge clearance;
- (b) Professional engineer (civil)'s endorsement on every plan for fixing details;
- (c) Scale of drawing;
- (d) Chainage of tunnel or trainway cross-sections;
- (e) Direction of tunnel or trainway cross-section, i.e., orientation facing towards a particular station or towards increasing chainage;
- (f) Horizontal & vertical offsets of outmost object protrusion towards the track, with reference from the inner side of the lower rail;
- (g) Cant of track in the direction of cross-section;
- (h) Horizontal throw;
- (i) Structure gauge profile without throw or with throw (if applicable);
- (j) All instruments including brackets are indicated to be outside the structure gauge; and
- (k) Clearance from the outermost object protrusion towards the structure gauge.

6.3.3

Fixing details and calculations shall show the following items :

- (a) Professional engineer (civil)'s endorsement on the first and last sheets of calculations;
- (b) 3-dimensional details of instruments, brackets (including mounting holes & any extendable parts), hold down bolts, fixing details of cables, etc.;

- (c) Specifications of all instruments, cables (conforming to the railway operator's requirements), etc.; and
- (d) Design calculations on all fixing including hold down bolts, anchorage, etc.

6.4 APPROVAL FOR INSTRUMENT INSTALLATION

6.4.1

The Authority will stamp 'Approved for Installation' on every sheet of the proposal plans for the installation of instrument in the trainway if all the requirements listed in Clause 6.2 and Clause 6.3 are complied with.

6.4.2

The Authority's officer will not allow any installation in the trainway that do not meet the details shown on the approved drawings. Modification or alteration of any details which may be required due to site constraints shall be submitted to the Authority for approval first before actual installation.

6.5 SUPERVISION OF INSTALLATION

6.5.1

The registered surveyor and professional engineer (civil) whose names appear on the approved plans shall be fully responsible for the supervision of instrument installation as shown on the approved plans.

6.5.2

In the event the registered surveyor or the professional engineer (civil) cannot be in attendance on site, subject to the approval of the Authority, they shall appoint an experience assignee(s) to act and suitably discharge their responsibilities as required. Notwith-standing such assignment, the registered surveyor and professional engineer (civil) shall be deemed fully responsible for all action taken by the assignee with or without their consents or sanctions.

6.5.3

Upon completion of the installation works, the registered surveyor and the professional engineer (civil) or their assignee(s) shall sign on the certificate of supervision Form LTA DBC RAIL-INSTR and submit it to the Authority's officer prior to leaving the tunnel or trainway.

SECTION 7 FRAMEWORK FOR DEVELOPING SOLUTIONS FOR DEVELOPMENT AND BUILDING WORKS

7.1 General

The framework for developing solutions for development and building works within the railway protection zone comprises of the following components that are structured as shown in Diagram 7.1 :

- (a) The objectives;
- (b) The performance requirements;
- (c) The solutions; and
- (d) The assessment methods.

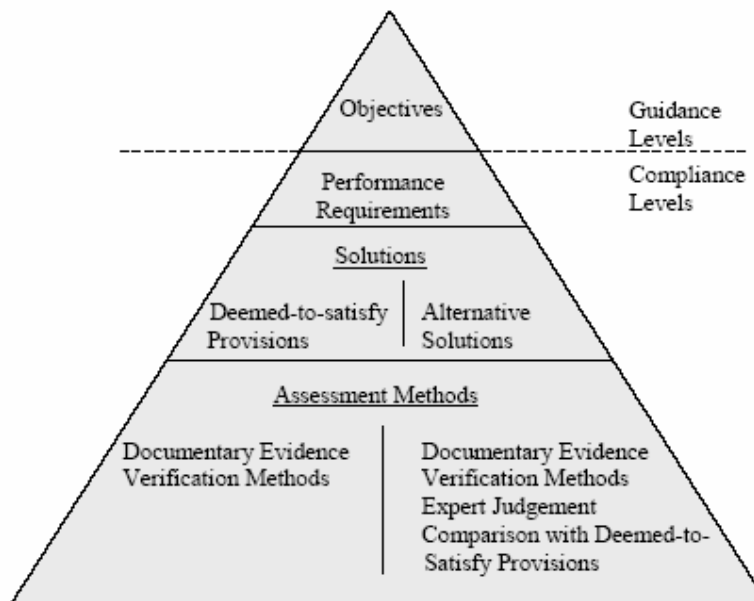


Diagram 7.1 Framework for Developing Solutions for Development and Building Works

7.2 MEETING THE PERFORMANCE REQUIREMENTS

Compliance with the performance requirements can be achieved by :

- (a) complying with the deemed-to-satisfy provisions contained in Part II Section 9; or
- (b) formulating an alternative solution which :
 - (i) complies with the performance requirements contained in Part II Section 8; or
 - (ii) is shown to be at least equivalent to the deemed-to-satisfy provisions; or
- (c) a combination of (a) and (b)

7.3 ASSESSMENT METHODS

The following assessment methods, or any combination of them, shall be used to determine a solution which complies with the performance requirements :

- (a) **Documentary evidence**
Evidence to support that the form of construction or design meets the performance requirement or the deemed-to-satisfy provisions.
- (b) **Verification methods**
The verification methods shall include any method deemed relevant or appropriate by the appointed qualified person. For an alternative solution, such verification shall be carried out by an expert(s). The verification methods shall also include a detailed assessment of the risks or hazards which the rapid transit systems will be subjected to, and the effective measures to mitigate these risks.
- (c) **Expert judgement**
The expert (group or individual) shall make his judgement based on independent factual information and experience. He shall be responsible for all evaluation and necessary information used to arrive at this judgement.
The basis of his judgement shall be clearly stated and must be demonstrated to be applicable and relevant to the local environmental and ground conditions.
- (d) **Comparison with the deemed-to-satisfy provisions.**

SECTION 8 PERFORMANCE PROVISIONS

8.1 General

This section stipulates the objectives and performance requirements for safeguarding the rapid transit systems in the following aspects :

- (a) Structural safety
- (b) Operational safety
- (c) Fire safety
- (d) Flood protection
- (e) Inspection and maintenance

8.2 STRUCTURAL SAFETY

8.2.1 OBJECTIVE

The objective is to safeguard the structural integrity of the rapid transit systems against damage arising from any development or building works.

8.2.2 PERFORMANCE REQUIREMENTS

The design and construction of any development or building works must make adequate provisions to check and ensure that the rapid transit system structures are capable of sustaining at an acceptable level of safety and serviceability under :

- (a) the most adverse combination of loads;
- (b) the most adverse movements; and
- (c) other actions other

to which the rapid transit system structures may reasonably be subjected to.

8.3 OPERATIONAL SAFETY

8.3.1 OBJECTIVE

The objective is to ensure the safe operation of the rapid transit systems is not being affected by any development or building works.

8.3.2 PERFORMANCE REQUIREMENTS

The design and construction of any development or building works must make adequate provisions to check and ensure that :

- (a) the rapid transit system structures and tracks are not subjected to deformation and changes that will not allow trains to operate at the maximum design speed;
- (b) the impact on the rapid transit system structures and tracks is not such that the safety and comfort of passengers are compromised;
- (c) there is no obstruction to the free flow of public moving in and out of the rapid transit system station; and
- (d) the performance of the mechanical and electrical services are maintained.

8.4 FIRE SAFETY

8.4.1 OBJECTIVE

The objective is to ensure that the fire safety measures and fire protection works for the rapid transit systems are adequately provided for and are acceptable arising from integration of any development or building works.

8.4.2 PERFORMANCE REQUIREMENTS

The design and construction of any development or building works must be carried out in such a manner that :

- (a) there is provision of adequate protection for the rapid transit systems against the spread of fire from any development or building works;
- (b) there is provision of adequate egress capacity for the rapid transit systems from the most remote point in the rapid transit systems to the point of safety;
- (c) there is no re-circulation of smoke into the rapid transit systems in the event of station fire or fire from any development or building works; and
- (d) provision of fire fighting measures in the rapid transit systems is not compromised.

8.5 FLOOD PROTECTION

8.5.1 OBJECTIVE

The objective is to protect the safety of people in the rapid transit systems against the ingress of water due to flooding or other means.

8.5.2 PERFORMANCE REQUIREMENTS

The design and construction of any development or building works with underground connections to the rapid transit systems must make adequate provisions to :

- (a) prevent the ingress of water into rapid transit systems due to flooding or other means including run off from the surface; and
- (b) avoid the likelihood of water discharged or redirected into the rapid transit systems.

8.6 INSPECTION AND MAINTENANCE

8.6.1 OBJECTIVE

The objective is to ensure that there are adequate provisions of access and facilities for inspection and maintenance of the rapid transit system structures including the viaduct columns, beams and bearings in the development.

8.6.2 PERFORMANCE REQUIREMENTS

The design and construction of any development or building works must be carried out in such a manner as to ensure that :

- (a) there is provision of adequate facilities for the inspection and maintenance of the rapid transit system structures including the viaduct columns, beams and bearings; and
- (b) the existing lightning protection and drainage systems of the rapid transit systems are not adversely affected or compromised.

SECTION 9 DEEMED-TO-SATISFY PROVISIONS

9.1 General

Development and building works in the railway protection zone shall meet the technical requirements contained in this section. Proposals that comply with the deemed-to-satisfy provisions of this section will be deemed to have satisfied the objectives and performance requirements stipulated in this code.

9.1.1 ALLOWABLE IMPOSED LOADS

The design and construction of development and building works in the railway protection zone shall satisfy the allowable limits for imposed loads on the rapid transit system structures as given in Table 9.1(a).

9.1.2 ALLOWABLE MOVEMENT LIMITS ON STRUCTURES

- (a) The design and construction of development and building works in the railway protection zone shall satisfy the movement limits on the rapid transit system structures as given in Table 9.1(b) to Table 9.1(d), unless otherwise advised by the Authority at development proposal stage.
- (b) Alternative solution shall be adopted if the allowable limits given in Table 9.1(b) to Table 9.1(d) have already been exceeded during the construction of a past development.
- (c) Allowable movement limits for the above ground rapid transit system structures, such as the viaduct, are dependent on the allowable capacity of the bearings and the structural system of the rapid transit system structures.
The developer shall appoint a qualified person to carry out an inspection of all bearings that are within the influence zone of the proposed development and assess the capacity of these bearings to tolerate further movements. The inspection report prepared and endorsed by the qualified person shall be submitted to the Authority. Other constraints such as tie beams, cross beams, bearings, etc. that form an integral part of the rapid transit system structures must also be checked before adopting the allowable values in Table 9.1(d)

9.1.3 ALLOWABLE TRACK DISTORTIONS

- (a) The design and construction of development and building works in the railway protection zone shall satisfy the track limits as given in Table 9.1(e), unless otherwise advised by the Authority at development proposal stage.
- (b) The interpretation of track twist, vertical dip or peak and change in horizontal versine is given in Drawing no. LTA/DBC/CPRP/008. The limits given in Table 9.1(e) refer to the allowable deformations to the track in comparison with present conditions.

9.1.4 VIBRATION LIMIT

The peak particle velocities at any rapid transit system structures resulting from demolition works, driving or withdrawal of piles or any other construction activities which can induce vibration shall not exceed 15 mm/sec.

9.1.5 MONITORING OF RAPID TRANSIT SYSTEMS

Rapid transit systems and the adjacent ground shall be closely monitored during the construction stage of the development and building works. Reference shall be made to the requirements provided in Part II Section 4. The track shall be monitored against the allowable track distortions if the track is expected to be affected by the development and building works. All monitoring results shall be analysed and compared with the alert and work suspension levels specified by a qualified person.

Table 9.1(a) Allowable Imposed Loads On Rapid Transit System Structures

RAPID TRANSIT SYSTEM LINES*	TYPES OF RAPID TRANSIT SYSTEM STRUCTURES		IMPOSED LOAD (KN/m ²)#		
			COVER UNDER ROADWAY (m)		NOT UNDER## ROADWAY
			<= 1.5	> 1.5	
East West Line (except Expo Station to Changi Airport Station) and North South Line	Underground & Sub-aqueous	Bored Tunnel	(a) HA loading or 45 units of HB loading dispersed in accordance with BS5400 Part 2 and HB vehicle placed within the central 5m of the carriageway and no HA loading in combination with the HB vehicle.	15	15
		Cut & Cover Tunnel & Station			
	At Grade	Embankment	-	-	40 (outside 1 st reserve)
		Cutting	-	-	15 (outside 1 st reserve)
Expo Station to Changi Airport Station	Underground & Transition	Bored Tunnel	As for [(a) + 7.5] or 22.5, whichever is greater	22.5	22.5
		Cut & Cover Tunnel & Station			
North East Line	Underground & Sub-aqueous	Bored Tunnel	As for [(a) + 7.5] or 22.5, whichever is greater	22.5	22.5
		Cut & Cover Tunnel & Station			
Circle Line	Underground & Sub-aqueous	Bored Tunnel	As for [(a) + 7.5] or 25, whichever is greater	25	75
		Cut & Cover Tunnel & Station			25

Notes:

* Refer to diagram 9.1 on MRT/LRT System Map

Load that the rapid transit system structures, except for sub-aqueous structures, are designed for.

For structures influenced by load imposed from an existing building, the self weight of the existing building with appropriate allowance for live load in accordance with BS 6399 was applied as imposed load at the foundation level of the building. Where the effect of this load is less than the surcharge given in 'Not Under Roadway', the values for imposed load were adopted.

Table 9.1(b) Allowable Limits for Movement of Underground, Transition and Sub-aqueous Rapid Transit System Structures

RAPID TRANSIT SYSTEM LINES*	TYPES OF RAPID TRANSIT SYSTEM STRUCTURES	MOVEMENT (mm)	
		TOTAL MOVEMENT IN ANY DIRECTION	DIFFERENTIAL MOVEMENT IN ANY PLANE
East West Line (except Expo station to Changi Airport station) and North South Line	Bored Tunnel	15	15 or 1:1000 (whichever is lesser)
	Cut & Cover Tunnel and Station		
Expo station to Changi Airport station	Bored Tunnel	15	15 or 1:1000 (whichever is lesser)
	Cut & Cover Tunnel and Station		
North-East Line	Bored Tunnel	15**	15 or 1:1000** (whichever is lesser)
	Cut & Cover Tunnel and Station		
Circle Line	Bored Tunnel	15	15 or 1:1000 (whichever is lesser)
	Cut & Cover Tunnel and Station		

Notes:

* Refer to diagram 9.1 on MRT/LRT System Map.

** Value is not applicable to 36 tunnel rings located along Race Course Road, between North Bound Chainage 32733 to 32823 and South Bound Chainage 32711 to 32803 and as identified in drawing no. LTA/DBC/RP/NEL/016. These 36 rings have limited capacity to tolerate distortion and that an alternative evaluation shall be adopted to determine the tolerable distortion.

Table 9.1(c) Allowable Limits for Movement of At Grade Rapid Transit System Structures

RAPID TRANSIT SYSTEM LINES*	TYPES OF RAPID TRANSIT SYSTEM STRUCTURES	MOVEMENT (mm)	
		TOTAL MOVEMENT IN ANY DIRECTION	DIFFERENTIAL MOVEMENT IN ANY PLANE
East West Line (except Expo station to Changi Airport station) and North South Line	Embankment	15	15 or 1:1000 (whichever is lesser)
	Cutting		
Bukit Panjang LRT	Cutting	10	10

Notes:

* Refer to diagram 9.1 on MRT/LRT System Map

Table 9.1(d) Allowable Limits for Movement of Above Ground Rapid Transit System Structures

RAPID TRANSIT SYSTEM LINES*	TYPES OF RAPID TRANSIT SYSTEM STRUCTURES	MOVEMENT (mm)**	
		TOTAL SETTLEMENT	DIFFERENTIAL SETTLEMENT
East West Line (except Expo station to Changi Airport station) and North South Line	Viaduct	15	15 or 1:1000 (whichever is lesser)
	Station		5
Expo station to Changi Airport station	Viaduct	15	15 or 1:1000 (whichever is lesser)
	Station		5
Bukit Panjang LRT	Viaduct	10	10 or 1:500 (whichever is lesser)
	Station		
Sengkang & Punggol LRT	Viaduct	15	15 or 1:500 (whichever is lesser)
	Station		

Notes:

*.. Refer to diagram 9.1 on MRT/LRT System Map

** Subject to tolerance of viaduct bearings against further movements including settlement

Table 9.1(e) Allowable Limits for Track Distortions

RAPID TRANSIT SYSTEM LINES*	TRACK		
	TWIST/ CHANGE IN CANT	VERTICAL DIP OR PEAK	CHANGE IN HORIZONTAL VERSINE
East West Line North South Line North East Line Circle Line	1.5 mm (measured over 2.5m) or 1:1666	5 mm (measured over 5m chord)	6 mm (measured over 16m chord)
Bukit Panjang LRT Sengkang & Punggol LRT	Not Applicable	Not Applicable	Not Applicable

Notes:

*.. Refer to diagram 9.1 on MRT/LRT System Map

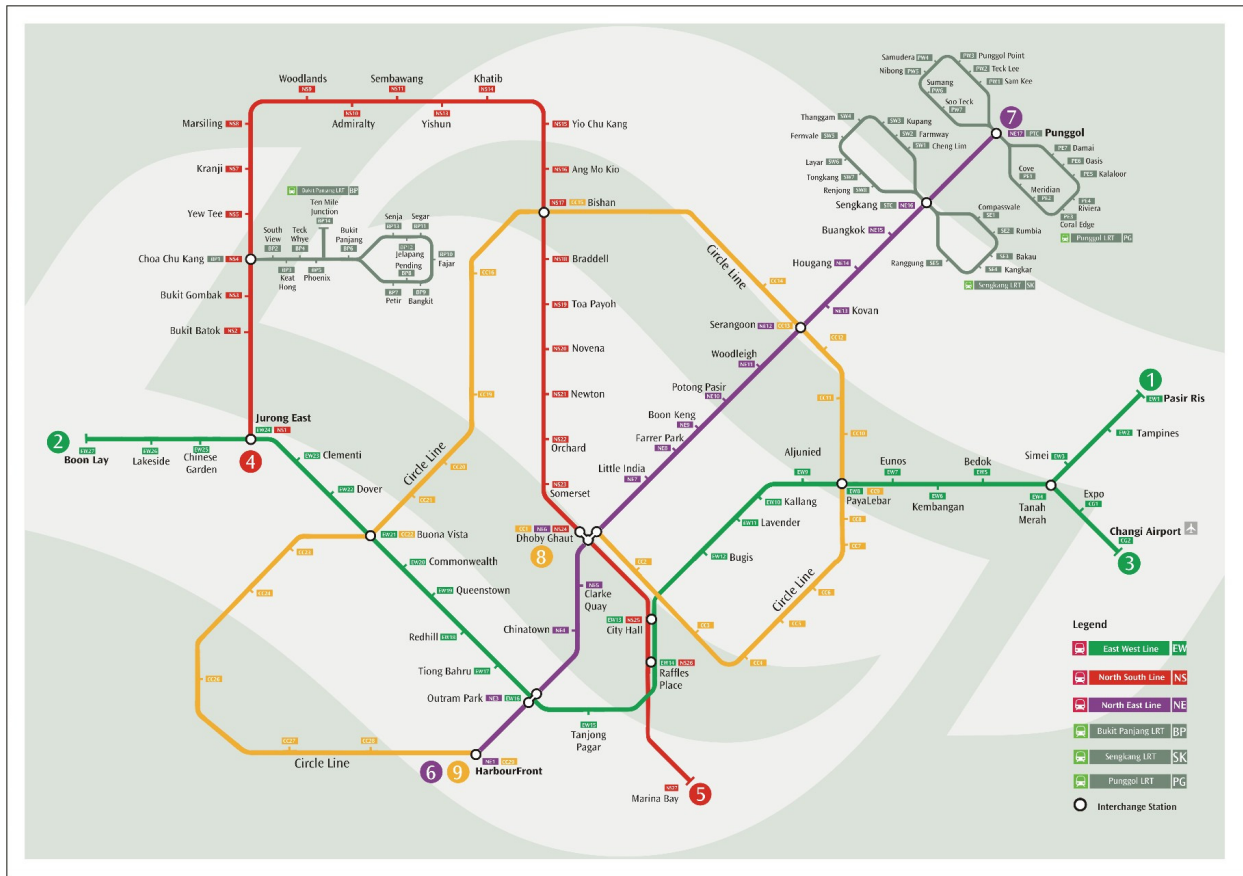


Diagram 9.1 MRT/LRT System Map

9.2 Site Preparation Works

Site preparation in the railway protection zone shall satisfy the conditions of Clause 9.1 to Clause 9.1.5 of this section.

9.2.1 MOBILIZATION WORKS

Mobilization works in the railway protection zone shall be read in conjunction to requirements in Part I Section 1.3 and satisfy the following conditions :

- (a) The first, second and third reserve lines of the rapid transit system structures, where applicable, must be pegged and demarcated clearly on site by a registered land surveyor based on the approved certified survey plan. Details of first reserve line should follow the typical cross section given in the Handbook on Development and Building Works in Railway Protection Zone.
- (b) Temporary buildings such as site office, worker's quarter or similar shall be located outside the first reserve.
- (c) Access under the railway must have height restriction gantries on both sides of the viaduct beam erected.

9.2.2 DEMOLITION WORKS

Demolition of buildings is generally acceptable in all reserves. However, special care shall be taken during demolition works to prevent any physical damage to the rapid transit system structures. No blasting shall be carried out during any demolition work in the railway protection zone.

If development and building works interface with the rapid transit system structures, special precaution and method of demolition shall be considered. Where a design interface report is

available for the affected rapid transit system structures, the conditions stated in the report shall be complied with.

9.3 Substructure Works

Substructure works in the railway protection zone shall satisfy the conditions of Clause 9.1 to Clause 9.1.5 of this section.

9.3.1 FOOTINGS AND RAFTS

Footings and rafts are allowed in the railway protection zone. The design and layout of the footing and rafts shall allow for the maintenance of the viaduct structure including bearing replacement.

9.3.2 PILING AND DRILLING WORKS

Piling works including the construction of foundation piles, temporary or permanent earth retaining walls and any other drilling works in the railway protection zone shall satisfy the conditions of Table 9.3.2 of this section.

9.3.3 DEBONDING OF LOAD BEARING PILES

- (a) Load bearing piles shall be designed so that they are debonded within the zone of influence of the underground, transition or sub-aqueous structures. They shall develop their load capacities either in shear or end bearing from soil located below the zone of influence of the underground, transition (see Drawing nos. LTA/DBC/ CPRP/001-002) or sub-aqueous structures.
- (b) Details of the proposal including the thickness of all casings, gap between inner and outer permanent casings, type and thickness of debonding membrane, etc. shall be clearly shown.
- (c) The installation sequence and procedure including the measures to prevent concrete flowing into the gap between the inner and outer permanent casings during concreting shall also be included.
- (d) For piles with single permanent casing, temporary casing shall be provided to prevent the debonding membrane on the permanent casing from being damaged during installation.
- (e) All temporary casing shall be installed to the debonding level to prevent the ground from moving into the borehole.
- (f) Where piles within the first reserve of the rapid transit system structures are permitted, permanent left-in outer casing shall be provided to ensure ground stability. The depth of outer casing must be equal to the length of the debonding depth.
- (g) Details for a single and double casing debonding system as illustrated in Drawing nos. *LTA/DBC/CPRP/008-009* shall be adopted.

Table 9.3.2 Piling Works

		First Reserve	Outside First Reserve	
			Second Reserve	Third Reserve
Underground, Transition or Sub-aqueous	Clearance	Not allowed*	Allowed if piles are kept at least 6m clear on plan from the exterior edge of rapid transit system structures.	Allowed.
	Debonding	Not applicable.	Load bearing piles within the zone of influence of rapid transit system structures shall be debonded according to the requirements of Clause 9.3.3.	Not Required.
	Method of Installation	Not applicable.	(a) Piles shall generally be constructed by augering or reverse circulation drilling techniques. (b) Stability of the ground shall be ensured by the use of casings and/or drilling mud as appropriate. (c) Use of percussively driven concrete piles, steel H-piles, sheetpiles or tanalised timber piles is not acceptable. (d) Use of rock chopping chisels is prohibited. (e) Use of vibratory method of installing and extracting sheetpiles, H-piles or casings is prohibited.	Rock chiselling and percussive piling techniques is acceptable.
At grade	Clearance	Not allowed.	Allowed.	Allowed.
	Method of Installation	Not applicable.	(a) Use of percussively driven concrete piles, steel H-piles, sheetpiles or tanalised timber piles is not acceptable. (b) Use of drilling fluid in the drilling of piles shall be carefully controlled to prevent an increase in the piezometric head in the railway protection zone.	
Above ground	Clearance	Not allowed.	Allowed if piles are kept at least 3m clear on plan of the toe of the existing raker pile supporting the rapid transit system structures.	

*** The following may be considered on case-by-case basis:**

- (a) Piling, retaining walls and boreholes which are located less than 6m but more than 3m horizontally from the extreme edge of rapid transit system structures; and
- (b) Limited bakau piling terminating at least 3m above the crown of the rapid transit system tunnels or underground structures.
- (c) For diaphragm wall excavation within or near to first reserve, the panel size shall not exceed 3m in width.

9.3.4 GROUND ANCHORS OR TIE BACKS

The use of ground anchors or tie backs in the railway protection zone shall satisfy the conditions of Table 9.3.4 below.

9.3.5 DREDGING WORKS

Dredging of seabed or riverbed in the railway protection zone shall satisfy the conditions of Table 9.3.5 below.

Table 9.3.4 Ground Anchors or Tie Backs

	First Reserve	Outside First Reserve	
		Second Reserve	Third Reserve
Underground, Transition or Sub-aqueous	Not allowed.	Not allowed.	Allowed.
At grade	Not allowed.	Not allowed.	Allowed.
Above ground	Not allowed.	Allowed if ground anchors or tie-backs are kept at least 3m clear on plan of the toe of the existing raker pile supporting the rapid transit system structure.	

Table 9.3.5 Allowable dredging level

Location	Allowable Dredging Level Reduced Level (m)
Between Raffles Place station to City Hall station (Singapore River)	96.2
Between Clarke Quay station to Dhoby Ghaut station (Singapore River)	96.0
Between Nicoll Highway station to Boulevard station (Kallang Basin River)	94.0

Note:

Vertical control datum shall be based on Land Survey Department (Singapore Land Authority) precise level datum (100m below mean sea level).

9.3.6 BASEMENT AND TUNNEL CONSTRUCTION

- (a) Where basements are more than 1m below the existing ground water table, they shall be made watertight. The base slab shall be designed for full hydrostatic pressures and pressure relief in the form of weep-holes or drainage blankets is not allowed.
- (b) Where tunnel construction works are permitted, the temporary or permanent linings shall be made watertight to prevent any seepage of water into the proposed tunnels under both temporary and permanent conditions.

9.3.7 EXCAVATION WORKS

- (a) Excavation works in the railway protection zone shall satisfy the conditions of Table 9.3.7 of this section.
- (b) The design of temporary works for the excavation shall be in accordance with acceptable codes of practice. Besides other safety considerations, the design shall take into account the following aspects :

- (i) Effects due to hydrostatic pressure from the soil
 - (ii) Effects due to both drained and undrained conditions of the soil
 - (iii) Effects of surcharge loads, including incidental loads, adjacent slope
 - (iv) Wall embedment and overall wall stability
 - (v) Provisions of restraints in structural members' connections, ties and bracings
 - (vi) Adequate embedment for piles and temporary retaining walls
 - (vii) Provision of preloading on struts
 - (viii) Varying load conditions on the wall during stages of the construction
- (c) The design of temporary works for excavation shall also include the following specific control :
- (i) Cater for a surcharge load of at least 10kN per square metre and other incidental loadings
 - (ii) Adopt full water table height when considering water pressure acting on the wall
 - (iii) For design soil strength, use factors of safety of at least 1.2 and 1.5 for effective stress and total stress respectively
 - (iv) Not to use Terzaghi's and Peck Pressure Envelope to compute bending moment on the wall
 - (v) Not to use net pressure method in stability analysis for the wall
 - (vi) Cater for a minimum depth of 0.5m for unplanned excavation
 - (vii) Check for one-strut failure according to BS8002

Table 9.3.7 Excavation Works

	First Reserve	Outside First Reserve
Underground / Transition	Not allowed*	<p>Allowed subject to :</p> <p>(a) Piezometric Pressure in Compressible Soil The piezometric pressure in compressible soils within the first and second reserves shall not be reduced by more than 10kPa. Where the rapid transit system structures are supported on piles or other foundations extending below the compressible layer, this clause may be waived. The definition of compressible soils shall make reference to LTA Design Criteria for Road & Rail Transit Systems.</p> <p>(b) Cut-off Wall No trench, excavation, caisson, pile or well deeper than 1m below the existing ground water level shall be allowed unless suitable measures such as installation of cut-off wall, excavation under stabilising fluid or mud, etc. are taken to control the reduction of piezometric pressure.</p> <p>(c) The stability of the rapid transit system structures adjacent to/below the excavation shall be checked against the effect of buoyancy, uplifting, etc.</p> <p>(d) The design of temporary works for the excavation shall ensure adequate factor of safety against basal heave, hydraulic uplift of the base, toe-stability of retaining walls, material failure, strut failure, etc.</p>
At grade	Not allowed.	Same as above
Above ground	Not allowed.	Allowed subject to item (c) above if lowering of the ground water table is expected due to the excavations.

*** The following may be considered on case-by-case basis:**

- (a) Excavation over underground rapid transit system tunnels that is greater than 2m depth but stops above 3m vertically of the rapid transit system tunnel may be considered on a case-by-case basis.
- (b) Excavation under the aboveground rapid transit system structures that is less than 2m and not affecting the existing pilecap of the rapid transit system may be considered on a case-by-case basis.

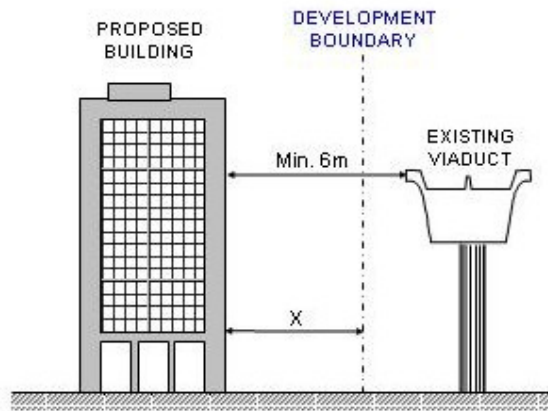
9.4 BUILDING WORKS IN ALL RESERVES

9.4.1 Building adjacent to above ground structure

9.4.1.1

The layout and design of any building adjacent to the above- ground structures shall comply with the conditions below :

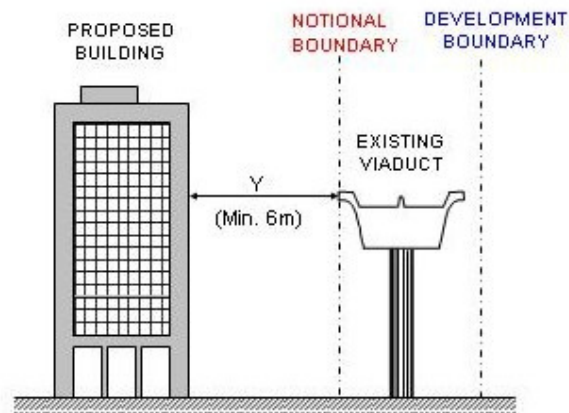
- (a) The building shall be at least 6m clear or the separation distance calculated for unprotected opening in accordance with the Code of Practice for Fire Precautions in Buildings (Fire Code), whichever is greater, of the outermost edge of the rapid transit system structures as shown in Diagram 9.4.1.1(a) to Diagram 9.4.1.1(e)
- (b) The building shall be orientated preferably with the end walls facing the rapid transit system structures. The building facade facing the rapid transit system structures shall be designed such that incidence of “Killer Litter” that will affect the safety of railway will not occur. Adequate screening of windows or openings shall be provided where necessary.



Distance between the proposed building and the outermost edge of rapid transit system viaduct shall be at least 6m.

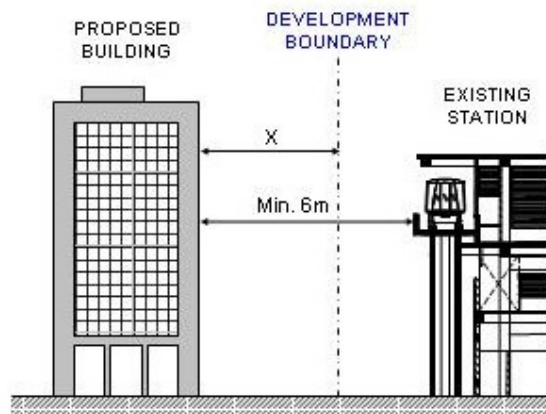
Distance between the proposed building and the development boundary, X, must also comply with the distance stipulated in the Fire Code.

Diagram 9.4.1.1(a) Separation Distance - Viaduct outside development boundary



Distance between the proposed building and the outermost edge of rapid transit system viaduct, Y, must comply with the distance stipulated in the Fire Code, or must be at least 6m whichever is greater.

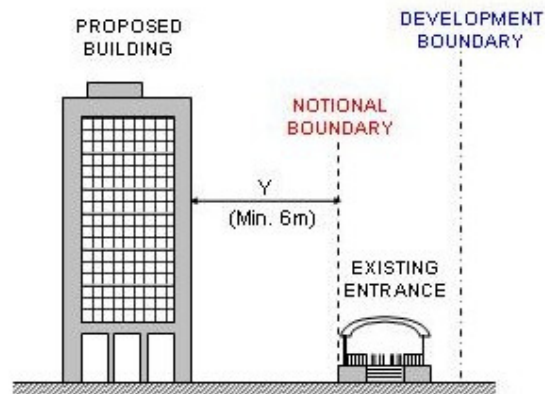
Diagram 9.4.1.1(b) Separation Distance - Viaduct within development boundary



Distance between the proposed building and the outermost edge of rapid transit system station shall be at least 6m.

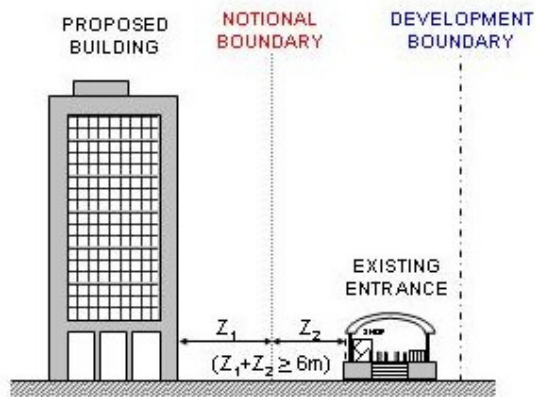
Distance between the proposed building and the development boundary, X, must comply with the distance stipulated in the Fire Code.

Diagram 9.4.1.1(c) Separation Distance - Station outside development boundary



Distance between the proposed building and the outermost edge of rapid transit system entrance, Y must comply with the distance stipulated in the Fire Code, or must be at least 6m whichever is greater.

Diagram 9.4.1.1(d) Separation Distance – Station entrance (without habitable room) within development boundary



Distance between the proposed building and outermost edge of rapid transit system station entrance shall be at least 6m.

Distance between the proposed building and the notional boundary, Z_1 must comply with the distance stipulated in the Fire Code.

Distance between the station entrance and the notional boundary, Z_2 must also comply with the distance stipulated in the Fire Code.

Diagram 9.4.1.1(e) Separation Distance - Station entrance (with habitable rooms) within development boundary

9.4.2 Building under rapid transit system viaduct

9.4.2.1

The space beneath the viaduct can be used for commercial, institutional and other purposes as given in the examples below :

- (a) Commercial – Kiosk, convenience/ retail store, shopping complex, office, bank, restaurant, pub, beer garden, café, entertainment, cinema, karaoke lounge, video arcade, commercial school, etc.
- (b) Institutional – Police station, community club, home for the aged, library, museum, childcare centre, family activities centre, tuition centre, etc.
- (c) Others – Parks, children playground, etc.

9.4.2.2

The layout and design of any building under and within 6m from outermost edge of the rapid transit system viaduct shall comply with the conditions below :

9.4.2.2.1 Fire safety requirements

- (a) The development shall not affect the fire fighting facilities for the rapid transit system viaduct.
- (b) The rapid transit system columns enclosed within the building shall be provided with a 25mm thick plaster all round the development as shown in Diagram 9.4.2.2.
- (c) Fire-rated wall/roof shall be provided within 6m of the rapid transit system viaduct to protect the viaduct against fire from the development as shown in Diagram 9.4.2.2. The fire-rated wall/roof provided shall be constructed to the same specification as that of a specimen exposed to test by fire in accordance with the method and procedure under BS 476: Part 20 to 23 and satisfied the requirements of that test for the three performance criteria of stability, integrity and insulation for not less than 2 hours. There shall be no opening on the fire-rated roof. For windows and other openings on the fire-rated walls, 2-hour fire-rated dampers/doors/shutters shall be provided. If sprinkler protection is provided, the fire resistance rating can be reduced to at least 1 hour.
- (d) Sprinkler Protection

- (i) For building with fire-rated compartment(s) smaller than or equal to 150m², automatic fire sprinkler system need not be provided.
- (ii) For building with compartment larger than 150m² and below 4000m², automatic fire sprinkler system shall be provided. The automatic fire sprinkler system shall be designed in compliance with SS CP 52 Code of Practice for Automatic Sprinkler System with the following exceptions :
 - The system to be designed by hydraulic calculation.
 - Pump sized according to the flow and pressure required from hydraulic calculation.
 - The minimum stored water supply requirement is the maximum calculated demand for a period of 30 minutes.
 - Fire Service breaching inlet is not required.
- (e) An automatic fire alarm system shall be provided in compliance with SS CP 10 Code of Practice for the Installation and Servicing of Electrical Fire Alarm Systems. For buildings protected by automatic fire sprinkler system, sprinkler flow switch can be allowed to activate the fire alarm system. The automatic fire alarm system shall be connected to a fire station through an approved alarm monitoring station.
- (f) There shall not be any use of liquefied petroleum gas or any storage of flammable liquids or highly combustible substances.
- (g) Where low-pressure PUB manufactured gas supply is provided, the gas supply systems shall comply with the requirements of SS CP 51 Code of Practice for Manufactured Gas Pipe Installation. The safety cut-off valve of the gas monitoring system shall also be interlocked with the fire alarm system to cut off the gas supply in the event of fire emergency. Approved extinguishing systems shall be fitted for all the cooking facilities.
- (h) The building owner shall engage a qualified person to carry out annual testing of the automatic fire protection and detection systems, fire safety measures, gas monitoring system, etc. provided and to certify them to be in good working condition, and shall submit a copy of the certification to the Authority.

9.4.2.2.2 Maintenance requirements

- (a) Building roof shall be at least 0.75m clear below the viaduct beam soffit level as shown in Diagram 9.4.2.2.
- (b) There shall be no placement of equipment such as air-con condenser above the level of the building roof.
- (c) There shall be proper access provided to allow for the inspection and maintenance of the rapid transit system structures.
- (d) Building roof below the viaduct shall be designed for bearing replacement such that the jacking load could be transferred to the ground. The ground floor slab must likewise be designed for the imposed loading.
- (e) Building shall not transfer any loading on to the rapid transit system viaduct structures.

9.4.2.2.3 Other requirements

- (a) Viaduct drainage system, if affected, shall be suitably diverted. Building drainage system shall not be discharged into the viaduct drainage system.
- (b) Viaduct lightning protection system, if affected, shall be suitably diverted, reinstated and tested.

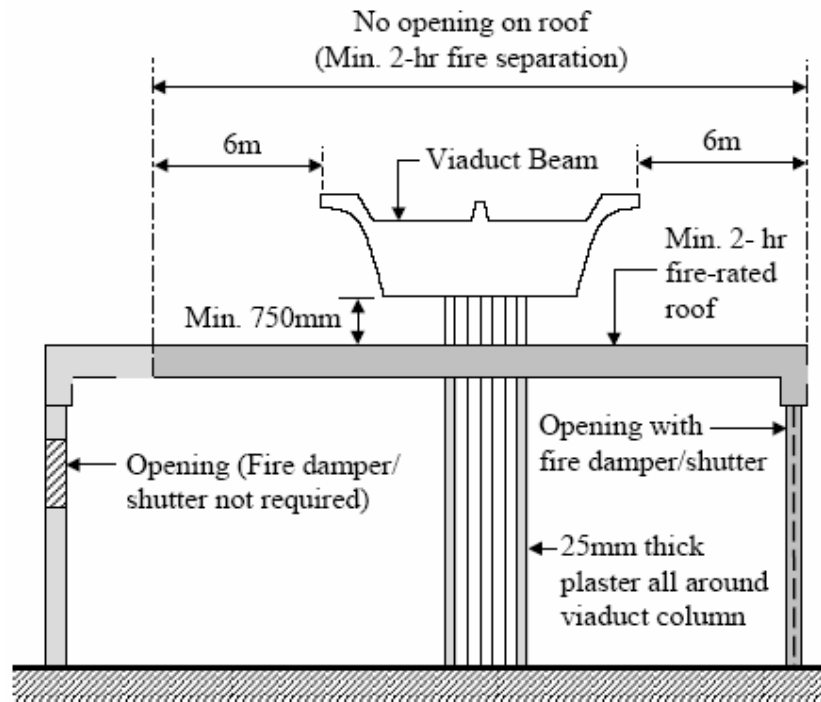


DIAGRAM 9.4.2.2 Proposed building below viaduct

9.4.3 Building over rapid transit system viaduct

9.4.3.1

Where there is building with habitable floor(s) directly above and around a trainway, as shown in Diagram 9.4.3.1,

- (a) The fire resistance of the elements of structure around the trainway shall be not less than 4 hours. The trainway shall be considered as an enclosed trainway. The fire safety provisions in the enclosed trainway shall comply with the Standard for Fire Safety in Rapid Transit Systems. These may include but not limited to the following :
 - (i) Exit signs and emergency lighting
 - (ii) Dry main system
 - (iii) Emergency ventilation system, etc.
- (b) The proposed building shall also take into consideration the space required for structure gauge clearance, viaduct beam replacement, etc. The qualified person must assess and demonstrate that the above conditions are met for enclosing the trainway.
- (c) The building facade facing the rapid transit system structures shall be designed such that incidence of "Killer Litter" or unauthorised access that will affect the safety of railway will not occur. Adequate screening of windows or openings shall be provided where necessary.

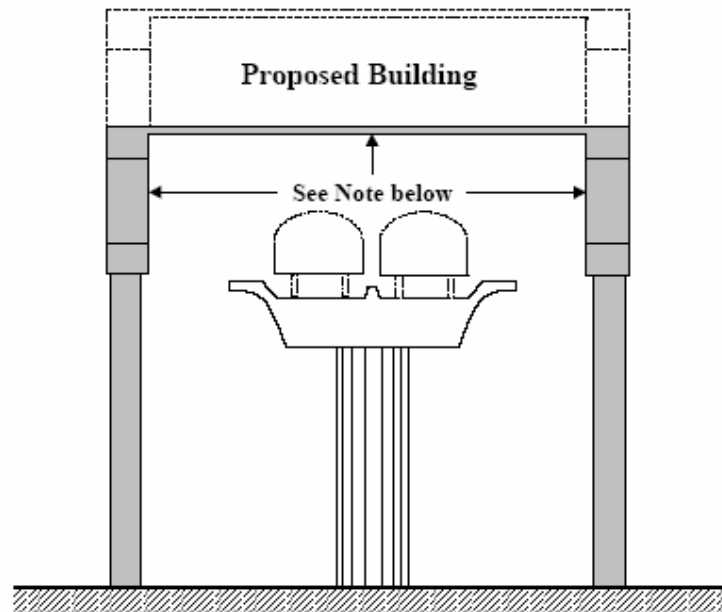


Diagram 9.4.3.1 Fire resistance of elements of structure around trainway

Note:

All elements of structure shall not be less than 4 hours fire rating

9.4.4 Building with integration or interface with rapid transit system station

9.4.4.1 General

- (a) Building with integration or interface with rapid transit system station shall satisfy the requirements of this section, where applicable.
- (b) Any structures and facilities to be handed over to the Authority for railway operation upon completion shall comply with Authority's prevailing requirements, which include :
 - (i) Civil Design Criteria for Road & Rails Transit Systems
 - (ii) Material & Workmanship specifications
 - (iii) Architectural Design Criteria
 - (iv) Engineering Standards (Environmental control systems, fire protection and electrical systems) and specification (lifts, escalators, etc).

The developer shall provide the necessary warranty and defects liability period required by the Authority for any structures and facilities to be handed over for railway operation.

9.4.4.2 Fire safety requirements

All building works including any fire safety works to be carried out within the boundary of the rapid transit systems shall comply with prevailing requirements of the Standard for Fire Safety in Rapid Transit Systems.

9.4.4.2.1

Where a proposed building integrates or interfaces with the entrance of an underground rapid transit system station, the conditions below shall be satisfied :

- (a) Unobstructed egress from the entrance to the external shall be provided. The egress width shall not be less than the total width of the entrance stairs and escalators.
- (b) The proposed building shall be separated from the station entrance, other than the egress opening to the external, with fire barriers having at least 2 hours fire resistance.
- (c) There shall be no unprotected openings of occupancy area within 3m of the ventilation openings located in the external wall of the entrance. A smoke barrier/screen shall be provided at the interface to prevent smoke at the ceiling level of the proposed building from entering the station entrance. The lower edge of the smoke barrier/screen shall be at least

500mm lower than the ceiling level or the facial beam at the external facade of the proposed building, which ever is lower.

- (d) In circulation space, fire shutter(s) can be used to provide the fire separation as required in (b) above. The automatic fire shutter(s) shall be activated by smoke detectors installed at both sides of the fire shutter(s) as well as by the fire alarm zone(s) in the integrated development nearest to the fire shutter(s). The developer shall make provision to link the open/close status of the fire shutter(s) to the station's Passenger Service Centre. Interface terminal board (ITB) shall be provided at fire shutter(s) for electrical control interface and should be placed within the station's boundary. The developer shall carry out regular maintenance of the fire shutter(s) and engage a qualified person (mechanical discipline) to carry out annual testing of the fire shutter(s) to be witnessed by the Authority. The qualified person shall submit a letter certifying that the fire shutter(s) and monitoring system are in good working condition.
- (e) Where motorised fire shutters are used, the fire shutters after activation by the smoke detectors or fire alarm system shall remain closed and be rendered inoperative until the control system, which the smoke detectors are connected, or the fire alarm system, is manually reset.
- (f) An alarm signal from the fire shutter control panel (on the closing of the shutters) shall be transmitted to the station. Upon receiving the alarm signal, an audible and visual alarm shall be activated at the Passenger Service Centre and/or the Operation Control Centre. A mean shall be provided to silent the audible alarm but not to cancel the visual alarm.
- (g) Where an existing entrance of an underground station is integrated into a proposed building and cannot comply with the requirements in Clause 9.4.4.2.1(a) to Clause 9.4.4.2.1(f), the following shall be complied with :
 - (i) A new entrance having an exit capacity not less than the existing entrance shall be provided to comply with the requirements of in Clause 9.4.4.2.1(a) to Clause 9.4.4.2.1(f);
 - (ii) The means of escape via the new station entrance shall comply with the prevailing requirements of the Standard for Fire Safety in Rapid Transit Systems;
 - (iii) The existing entrance be converted into a link to the building and shall comply with the requirements of 9.4.4.2.2; and
 - (iv) Where the new entrance also replaces the existing entrance as the source of fresh air intake for the station's smoke control system, the new entrance shall be provided with the same provisions as for the existing entrance to ensure the proper operation of the station's smoke control system.

9.4.4.2.2

Where a proposed building is linked (via circulation space) to an underground rapid transit system station, the conditions below shall be satisfied :

- (a) The link shall not be used as a means of escape.
- (b) The proposed building shall be separated from the station by fire shutter having at least 2 hours fire resistance.
- (c) The fire shutter shall be held at the open position normally and shall be activated by :
 - smoke detectors installed at both sides of the fire shutter
 - the fire alarm zone in the proposed building nearest to the fire shutter
 - fire alarm zones in the station public area.

The developer shall make provision to link the open/close status of the fire shutter to the station's Passenger Service Centre. Interface terminal board (ITB) shall be provided at fire shutter for electrical control interface and should be placed within the station's boundary. The developer shall carry out regular maintenance of the fire shutter and engage a qualified person (mechanical discipline) to carry out annual testing of the fire shutter to be witnessed by the Authority. The qualified person shall submit a letter certifying that the fire shutter and monitoring system are in good working condition.

- (a) Where motorised fire shutters are used, the fire shutters after activation by the smoke detectors or fire alarm system shall remain closed and be rendered inoperative until the control system, which the smoke detectors are connected, or the fire alarm system, is manually reset.
- (b) An alarm signal from the fire shutter control panel (on the closing of the shutters) shall be transmitted to the station. Upon receiving the alarm signal, an audible and visual alarm shall

be activated at the Passenger Service Centre and/or the Operation Control Centre. A mean shall be provided to silent the audible alarm but not to cancel the visual alarm.

9.4.4.2.3

Where a proposed building interfaces with the firemen's and emergency exit staircases and breeching inlets and firemen's intercom, the conditions below shall be satisfied :

- (a) The staircase shall discharge directly, or via a new exit passageway, to the external. The width of the new exit passageway shall not be less than the width of the staircase. This new exit passageway shall not be a shared means of escape of the proposed building.
- (b) All fire safety provisions in the staircase shall be extended to the new exit passageway.
- (c) The staircase and the new exit passageway (where provided) shall be compartmented from the proposed building with masonry structure having at least 2 hours fire resistance.
- (d) The entrance to the firemen's staircase shall be visible from the fire engine access road and shall meet the prevailing requirements of the Standard for Fire Safety in Rapid Transit Systems.
- (e) There shall be no unprotected openings within 3m of the staircase entrance.
- (f) Where breeching inlet or firemen's intercom is interfaced with the proposed building, the breeching inlet or firemen's intercom shall be visible from the fire engine access road and shall meet the prevailing requirements of the Standard for Fire Safety in Rapid Transit Systems.

9.4.4.2.4

Where a proposed building interfaces with the rapid transit system's ventilation shaft, the conditions below shall be satisfied :

- (a) The ventilation shaft shall be separated from the proposed building with masonry structure having at least 2 hours fire resistance.
- (b) Building works including any fire safety works to be carried out within the boundary of the rapid transit systems shall comply with prevailing requirements of the Standard for Fire Safety in Rapid Transit Systems.
- (c) Where the existing station's ventilation shaft is modified by the proposed building work, the qualified person for the proposed building work shall ensure that the performance of the station's ventilation system is not compromised and it shall comply with the Authority's Engineering Standard on Environmental Control Systems.
- (d) Design of the building shall protect the development from hot smoke emitting from the vent shaft at high velocity under smoke extraction scenario when there is a fire in the rapid transit systems.
- (e) Space around the vent shaft shall be designed such that exhaust air or smoke (in the event of fire in adjacent building) will not be drawn into the intake vent shaft.

9.4.4.3 Flood protection requirements

- (a) The flood threshold level for all entrances or openings of the proposed underground structures shall comply with the requirements of the Code of Practice for Surface Water Drainage.
- (b) Openings and services penetrations below the flood threshold level should be permanently sealed and made watertight.
- (c) Any part of the existing rapid transit system structures below the flood threshold level shall not be punctured unless the construction of the integrated structure and adjoining development has reached a level at or above the station threshold level.
- (d) Discharge pipes and sewer pipes shall be provided with a swan neck connection to prevent any back flow of water into the proposed underground structures integrating with the existing station. The invert level of the pipe at the swan neck location shall not be lower than the flood threshold level.
- (e) The developer shall carry out regular maintenance and annual testing of the flood protection systems to ensure that they are in good working condition. During commissioning and annual testing, the flood protection systems must be certified by a competent person such as a Professional Engineer in Mechanical or Civil disciplines or a Marine Surveyor with Lloyd Registry of Shipping, ABS who have relevant experience. A letter certifying that the flood protection system(s) is in good working condition shall be submitted to the Authority.

- (f) The link structure of the development shall be screed to fall and drain away from the rapid transit system structure.

9.4.4.4 Waterproofing requirements

- (a) The interface between the proposed building and the existing underground station shall be provided with a waterproofing system, which is robust and able to withstand the calculated hydrostatic pressure and differential movements between the connecting structures.
- (b) At least two levels of defence against water ingress shall be provided at every interface.
- (c) The waterproofing system shall have at least a ten-year warranty period. The developer shall be responsible for the maintenance and replacement of the waterproofing system at the interface. A warranty certificate covering the interest of the Authority shall be submitted.

9.4.4.5 Mechanical/electrical services and communication systems requirements

9.4.4.5.1

Where the proposed works modify/ affect the existing mechanical/electrical systems or/ and building services of the rapid transit system stations, proposals on the modification works shall be submitted to the Authority for approval. The proposals shall comply with the relevant Engineering Standards (Environmental control systems, fire protection and electrical systems) and specification (lifts, escalators, etc). The proposals may include but not limited to the following :

- (a) Fire protection systems e.g. relocation of sprinkler heads and detectors.
- (b) Air-conditioning and mechanical ventilation systems e.g. relocation of cooling tower, relocation of supply air grilles, revised emergency ventilation system, extension of ventilation shafts.
- (c) Electrical system e.g. relocation of cables and exit signs.
- (d) Plumbing and sanitary systems e.g. relocation of floor traps.
- (e) Communication systems e.g. relocation of PA speakers.

9.4.5 Temporary provisions by construction works affecting stations

- (a) Where additional and alterations works are to be carried out within a rapid transit system station, the existing fire safety measures (e.g. means of escape, fire compartments, etc.) and the existing fire protection systems (e.g. sprinklers, smoke detectors, etc.) shall not be affected. In addition, hoarding having at least 2-hour fire resistance shall be provided to separate the works area from station area. (2-hr fire-rated hoarding for walls and ceilings shall be PSB listed for stability, integrity and insulation. A copy of the Declaration of Compliance (DOC) form shall be submitted. If the Authority is satisfied that the construction activities will not pose any fire risk to the station, the hoarding may be constructed using non-combustible materials.
- (b) Clear minimum width for fire escape must be maintained at all times during the construction. Exiting time shall not exceed the time stipulated in the Standard for Fire Safety in Rapid Transit Systems.
- (c) Safe and protected passageway for commuters' access to the station entrance must be maintained at all times during the construction.
- (d) Construction activities in the vicinity of the vent shafts must not generate dust pollution, smoke & exhaust fumes that could affect the environmental control equipment, activation of fire protection system and the fire & smoke detection system of the station. Any exhaust from any building must not be directed towards areas where fresh air intake of the station is located or draught relief shaft of a station.
- (e) Where fire safety facilities such as fire hydrant, breeching inlets, fireman intercom, etc are affected and need to be temporarily relocated, proposal shall be submitted to the Authority for approval. The proposed installation shall be designed and supervised by a qualified person. Upon completion, the installation must be fully tested and commissioned. The qualified person shall submit a certificate of supervision to the Authority. The changeover operation must be done in accordance with the railway operator's requirements and must not have any adverse implication of the safe operation of railway. The qualified person shall also submit a certificate of supervision to the Authority upon reinstatement of the fire safety facilities.
- (f) Where the directional signage, passenger information display, station name sign, etc are affected by the development, proposal for relocation or replacement shall be submitted to the

Authority for approval. The design of the signage shall be compatible with the standard adopted by the Authority.

- (g) Lighting and ventilation in accordance with Building Control Regulation shall be provided. The developer shall engage a relevant qualified person to design and the proposal shall be submitted to the Authority for clearance.

PART III PROPOSALS IN RAILWAY CORRIDOR

SECTION 1 DEVELOPMENT PROPOSAL

1.1 General

1.1.1

This section stipulates the procedures and requirements for obtaining approval for a development proposal in the railway corridor.

1.1.2

Plan for development works in the railway corridor shall be submitted to the Authority for approval in accordance with Regulation 4.

1.2 APPLICATION FOR APPROVAL OF DEVELOPMENT PROPOSAL

1.2.1

An application for the approval of development proposal shall be accompanied by the following items :

- (a) Plan for development works; and
- (b) Engineering evaluation report accompanied by plan for engineering works.

1.3 INFORMATION TO BE INDICATED ON PLAN

1.3.1

Plan for development works shall be prepared in accordance with the requirements of the Regulations.

1.3.2

The qualified person shall sign on every sheet of the plans. This requirement shall also apply to plans submitted electronically.

1.3.3

The first sheet of the plan shall bear the standard declarations as given below :

<p>I, _____, NRIC no/ Passport no, _____, being the qualified person appointed under Regulation 4(3) of the Rapid Transit Systems (Development and Building Works in Railway Corridor and Railway Protection Zone) Regulations, hereby certify that the development or building works in the railway corridor as shown on these plans have been designed in accordance with the Code of Practice for Railway Protection and other conditions imposed by the Land Transport Authority.</p>

1.3.4

The plan shall be drawn to a scale of 1:100 or 1:200 or 1:250 generally, except for the site plan which is to be presented in a scale of 1:500.

1.3.5

Site and layout plans shall show the following items :

- (a) Scale of plans;
- (b) Location and clearances of the proposed development works in relation to the railway area; and
- (c) Basement line, if any.

1.3.6

Sections and elevations shall show the following items :

- (a) Scale of the plans;
- (b) Platform levels of the proposed development works; and
- (c) Minimum clearance between proposed development works and the railway area.

1.4 APPROVAL OF DEVELOPMENT PROPOSAL

1.4.1

The Authority will approve the development proposal in writing if the following requirements are complied with :

- (a) Qualified person has complied with the requirements of Clause 1.2 to Clause 1.3 of this section and that all items submitted are in order; and
- (b) Qualified person has fully demonstrated and confirmed that it is feasible for the development works to fully meet the technical requirements of Part III Section 4.

SECTION 2 BUILDING PROPOSAL

2.1 General

2.1.1

This section stipulates the procedures and requirements for obtaining approval for a building proposal in the railway corridor.

2.1.2

Plan for building works in the railway corridor shall be submitted to the Authority for approval in accordance with Regulation 4.

2.2 APPLICATION FOR APPROVAL OF BUILDING PROPOSAL

2.2.1

An application for the approval of building proposal shall be accompanied by one set of the following items :

- (a) Plan for building works;
- (b) Engineering evaluation report accompanied by plan for engineering works; and
- (c) Construction schedule for the proposed development.

2.3 INFORMATION TO BE INDICATED ON PLAN

2.3.1

Plan for building works shall be prepared in accordance with the requirements of the Regulations.

2.3.2

The first sheet of the plan shall bear the relevant standard declarations as given in Clause 1.3.3 of Part III Section 1.

2.3.3

The qualified person shall sign on every sheet of the plans. This requirement shall also apply to plans submitted electronically.

2.3.4

The plan shall be drawn to a scale of 1:100 or 1:200 or 1:250 generally, except for the site plan which is to be presented in a scale of 1:500.

2.3.5

Site and layout plans shall show the following items :

- (a) Scale of the plans;
- (b) Building and boundary lines of building;
- (c) Location and clearances of the building works in relation to the railway area and railway corridor;
- (d) Basement outline, if any; and
- (e) Main roads including special landmarks.

2.3.6

Sections and elevations shall show the following items :

- (a) Scale of the plans;
- (b) Building and boundary lines of building;
- (c) Horizontal and vertical clear distances between the railway area and the proposed development; and
- (d) Depth of basement, if any.

2.4 APPROVAL OF BUILDING PROPOSAL

2.4.1

The Authority will grant approval for the building proposal in writing if the following requirements are complied with :

- (a) Qualified person has complied with the requirements of Clause 2.2 to Clause 2.3 of this section and that all items submitted are in order; and
- (b) The building and engineering works layout fully satisfy the technical requirements of Part III Section 4.

SECTION 3 ENGINEERING WORKS

3.1 General

3.1.1

This section stipulates the procedures and requirements for obtaining a permit to commence engineering works within the railway corridor.

3.1.2

In accordance with Regulation 6, an application for a permit to commence any works for which the plans have been approved under Regulation 4 or Regulation 5 shall be made.

3.2 APPLICATION FOR PERMIT

3.2.1

An application for permit to commence a specific phase of engineering works shall be submitted by the qualified person appointed under Regulation 9 for supervision and accompanied by the following items :

- (a) Plan for engineering works;
- (b) Engineering evaluation report;
- (c) Construction schedule for the proposed development;
- (d) Form LTA DBC RAIL-PERMIT (to be submitted once only unless there is any change in the developer/ owner or qualified person appointed for supervision); and
- (e) Relevant documents indicating planning approval from the competent authority.

3.3 PLAN FOR ENGINEERING WORKS

3.3.1

Plan for engineering works shall be prepared in accordance with the requirements of the Regulations and endorsed by a qualified person.

3.3.2

Layout plans and cross sectional details shall indicate the following items :

- (a) Scale of the plans;
- (b) Building and boundary lines of building; and
- (c) Vertical and horizontal distances of the engineering works in relation to the railway area.

3.4 ENGINEERING EVALUATION REPORT

3.4.1

Engineering evaluation report shall be prepared and endorsed by a qualified person.

3.4.2

The evaluation report shall include an assessment of the likely effects of the construction and operation of the proposed rapid transit systems on the proposed development.

3.4.3

The report must clearly demonstrate that the design of the proposal has taken into consideration the effects due to the construction and operation of the proposed rapid transit systems.

3.4.4

Notwithstanding the above, the Authority reserves the right to specify any other requirements on the engineering evaluation report which are deemed necessary for the safeguarding of the proposed rapid transit systems.

3.5 COMMENCEMENT OF WORK

3.5.1

The Authority will issue the permit to commence works in writing if the following requirements are complied with :

- (a) Qualified person has complied with the requirements of Clause 3.2 to Clause 3.4 of this section and that all items submitted are in order; and

- (b) Qualified person has fully demonstrated that the proposal satisfies the technical requirements of Part III Section 4.

3.5.2

Clearance from the Development & Building Control Department of the Authority shall be obtained before the commencement of construction works including soil investigation and foundation works on site.

3.6 DEPARTURE OR DEVIATION FROM APPROVED PLAN

3.6.1

In accordance with Regulation 5, amendment plan shall be submitted to the Authority for approval if any building works depart or deviate from the approved plan.

3.6.2

An application for approval of amendment plans shall be accompanied by one set of the following documents prepared, signed and submitted by the qualified person :

- (a) A copy of the amendment plans showing the amended proposal; and
- (b) Engineering evaluation report accompanied by plans for engineering works (if applicable).

3.6.3

No person shall carry out any building works in departure or deviation from the approved plan unless the amendment plan has been approved.

3.7 COMPLETION OF WORKS

3.7.1

Upon completion of building works within the railway corridor, the qualified person shall make an application to the Authority to issue clearance for the release of the certificate of statutory completion.

3.7.2

An application for clearance of certificate of statutory completion shall be accompanied by one set of the as-built building, structural and foundation plans signed by the qualified person.

3.7.3

The Authority will issue clearance for the release of certificate of statutory completion in writing if the qualified person has complied with the requirements of Clause 3.7.2 of this section and that all items submitted are in order.

SECTION 4 TECHNICAL REQUIREMENTS

4.1 General

4.1.1

This section stipulates the general technical requirements for any development and building works in railway corridor.

4.1.2

Notwithstanding the provisions in this section, the Authority reserves the right to impose any other requirements that are deemed necessary for safeguarding of the rapid transit systems.

4.2 TECHNICAL REQUIREMENTS

4.2.1

Development and building works in the railway corridor shall comply with the requirements below :

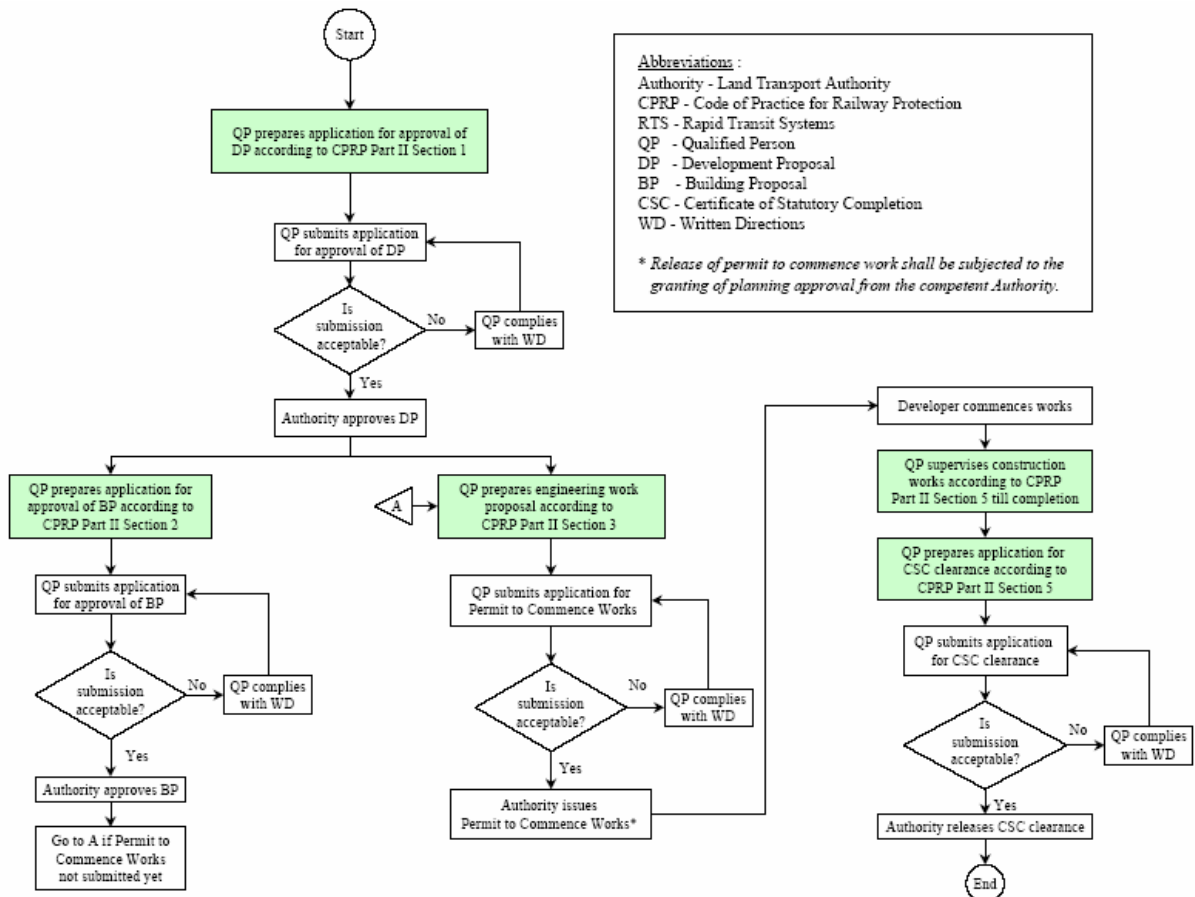
- (a) The design and construction of the proposed development shall comply with the Code of Practice for Railway Protection and other conditions under which the plans and amendments are cleared.
- (b) The proposed development may be affected by changes in ground conditions, vibration and noise as a result of the construction and the operation of the proposed rapid transit systems. The design of the proposal shall take into consideration these effects.
- (c) The proposed development shall not cause the proposed rapid transit system structures to be stressed beyond design loading catered for. The surcharge value at ground level for this assessment shall be obtained from the Authority.
- (d) Deep foundation, secant pile wall, contiguous bored pile wall, sheet pile wall, diaphragm wall or similar are not permitted within the railway area and 3m from it.
- (e) The platform level of the proposed development shall meet requirements for flood protection of rapid transit systems if there is connection to future underground station. The flood threshold level for all entrances or openings of the proposed development shall comply with the requirements of the Code of Practice for Surface Water Drainage.

4.2.2

In addition, when the rapid transit system structures are in place while the development and building works are in progress, the developer shall comply with the requirements stipulated for railway protection zone.

PART IV APPENDICES

Appendix A SUBMISSION PROCESS FOR DEVELOPMENT AND BUILDING WORKS IN RAILWAY PROTECTION ZONE



Abbreviations :
 Authority - Land Transport Authority
 CPRP - Code of Practice for Railway Protection
 RTS - Rapid Transit Systems
 QP - Qualified Person
 DP - Development Proposal
 BP - Building Proposal
 CSC - Certificate of Statutory Completion
 WD - Written Directions

** Release of permit to commence work shall be subjected to the granting of planning approval from the competent Authority.*

SUBMISSION PROCESS FOR DEVELOPMENT AND BUILDING WORKS IN RAILWAY PROTECTION ZONE

Appendix B PREPARATION OF CONTINGENCY PLAN AND EMERGENCY PROCEDURE

1.1 General

1.1.1 This section serves as a guide to the preparation of a contingency plan and emergency procedure. It aims to ensure that a set of the contingency plan and emergency procedure is in place for immediate implementation should the needs arise at site.

1.2 IDENTIFICATION OF EMERGENCY SITUATIONS

1.2.1 An emergency situation may arise due to various incidents at site. Such as :

- (a) Monitoring results exceed the alert levels specified by the qualified person;
- (b) Accidents such as construction material falls onto the viaduct, crane topples onto the viaduct; and
- (c) Water ingress into the station premises, etc.

1.2.2 The qualified person shall prepare an emergency plan stating the immediate actions to be taken in the event of an emergency in order to safeguard the integrity of the rapid transit systems. In addition, the follow-up actions to be taken after the implementation of control measures at site should also be provided.

1.2.3 The qualified person shall also identify all possible hazardous situations that may arise due to the proposed works and prepare a contingency plan.

1.3 EMERGENCY PROCEDURE REPORT

1.3.1 An emergency procedure report shall include the following items :

- (a) Descriptions of the project and proposed works or activities to be carried out in the railway protection zone;
- (b) List of possible hazard/ emergency situations that may arise due to the proposed works or activities;
- (c) Governing criteria for initiating an emergency procedure;
- (d) Step-by-step procedure or flow chart showing the actions to be taken by the qualified person and the project team should an emergency happens. Where applicable, the procedure shall incorporate the steps to review the monitoring results obtained, the re-examination of the method of work, the revision to the predictions, the review of instrumentation provisions, the contingency measures to be implemented, etc.
- (e) Call-up list stating the names and contact numbers of all key personnel including the qualified person, the project manager, the site supervisors, the instrumentation specialist. A flow chart for the emergency reporting shall also be included.

Appendix C APPLICATION FOR ACCESS TO TRACK AND STATION PREMISES

1.1 General

1.1.1 This section stipulates the procedure for submitting an application to gain access to the rapid transit system track or station premises.

1.1.2 Access to track can only be obtained during non-operational hours of trains.

1.1.3 All personnel working in rapid transit system premises shall abide by the rules and conditions of the Authority and its licensed transit operator.

1.2 APPLICATION FOR ACCESS

1.2.1 Application on access to track or into the station premises shall be made using Form LTA DBC RAIL-ACCESS to the Authority at least two weeks in advance of the access required.

1.2.2 The applicant shall clearly state the following items :

- (a) The reason(s) for requesting an access to the track or into the station premises;
- (b) The names and identification card numbers of all personnel gaining access to the track or into the station premises; and
- (c) List and details of equipment, tools to be brought to the track or into the station premises.

1.3 GRANTING OF ACCESS

1.3.1 The Authority will only proceed to arrange with the railway operator for the requested access if the application form is found to be in order and the reason(s) for requesting the access is acceptable.

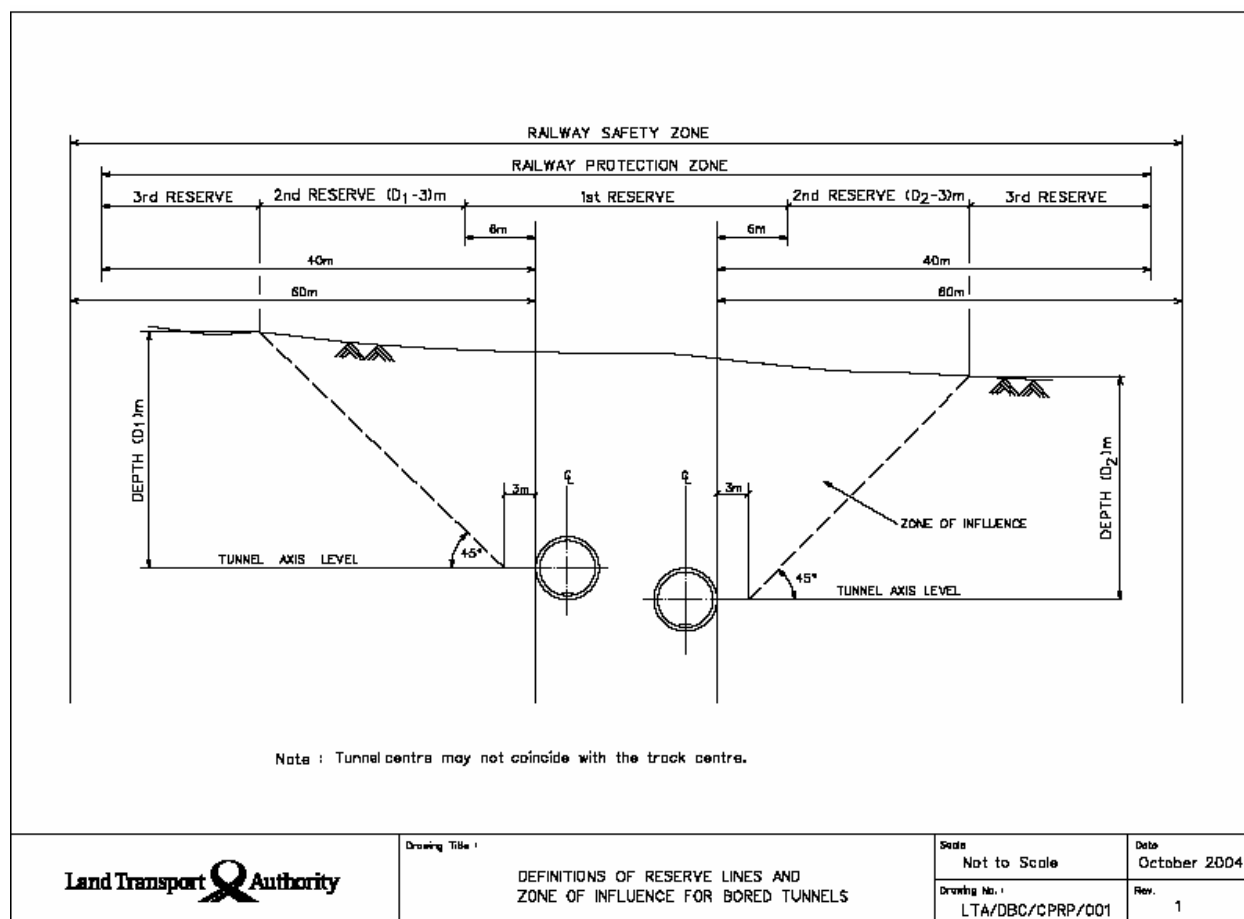
1.3.2 The applicant will be notified in writing once the access is granted. The actual date and time of track access are, however, determined by the railway operator. The applicant shall liaise with the Authority's officer to finalise the date of access.

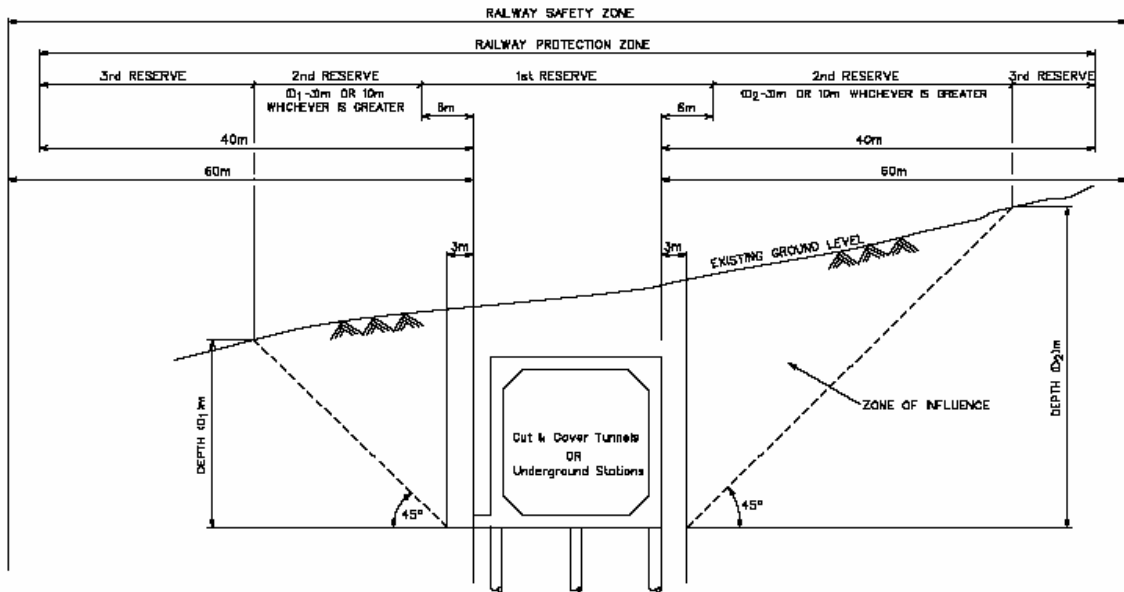
1.3.3 All persons working on track are required to wear proper clothing, high visibility vests and safety shoes. Those who fail to comply with this rule will not be permitted to access the track.

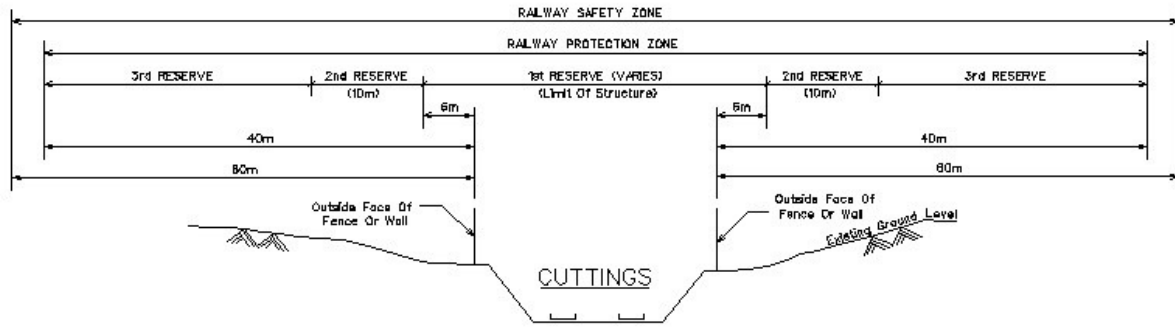
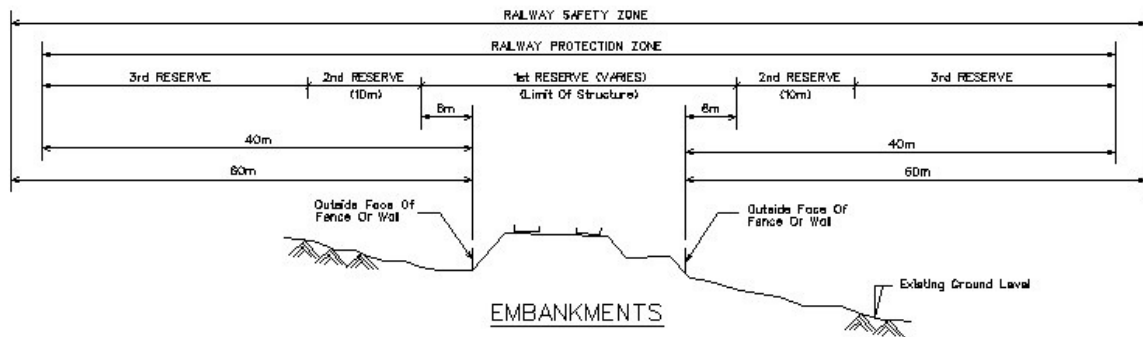
1.3.4 All persons working on track or within the station premises shall comply with the rules and regulations of the railway operator and instructions from the Authority's officer-in-charge.

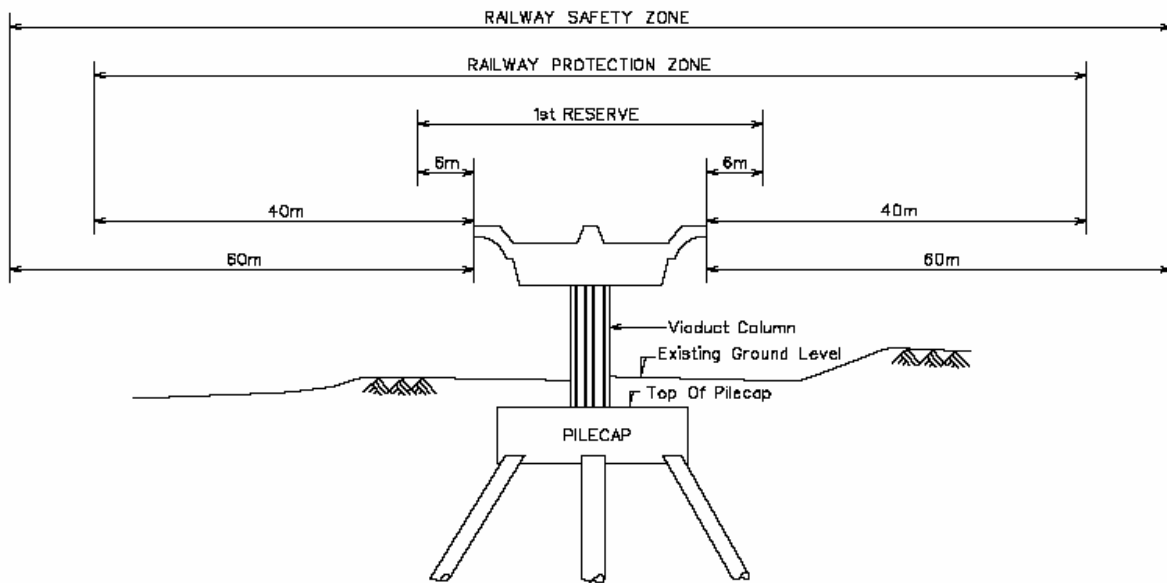
Appendix D Drawings

LIST OF DRAWINGS	
LTA/DBC/CPRP/001	Definitions of reserve lines and zone of influence for bored tunnels
LTA/DBC/CPRP/002	Definitions of reserve lines and zone of influence for underground and transition structures
LTA/DBC/CPRP/003	Definitions of reserve lines and zone of influence for at grade structures
LTA/DBC/CPRP/004	Definitions of reserve lines for above ground structures
LTA/DBC/CPRP/005	Trainway cross section Typical details for bored tunnels
LTA/DBC/CPRP/006	Trainway cross section Typical details for box tunnels
LTA/DBC/CPRP/007	Trainway cross section Typical details for viaduct
LTA/DBC/CPRP/008	Typical double casing debonding details
LTA/DBC/CPRP/009	Typical single casing debonding details
LTA/DBC/CPRP/010	Interpretation of track criteria









Land Transport Authority

Drawing Title :

DEFINITIONS OF RESERVE LINES FOR ABOVE GROUND STRUCTURES

Scale

Not to Scale

Date

October 2004

Drawing No. :

LTA/DBC/CPRP/004

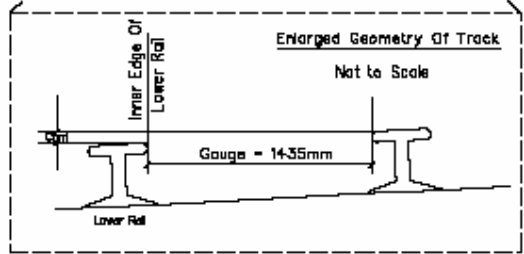
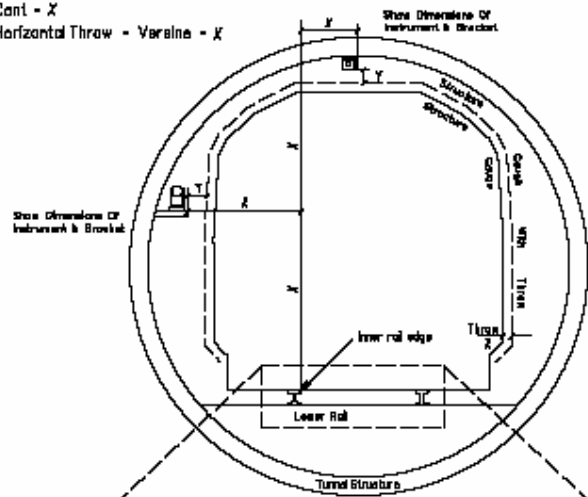
Rev.

1

Scale 1 : _____
 Chainage - _____
 Tunnel Profile Facing Towards _____ Station

TRACK GEOMETRY

Cont - X
 Horizontal Throw - Variable - X



- Note :**
1. Dimensions in mm
 2. " X " indicates site measurement.
 3. " Y " indicates computed value.



Drawing Title :
**TRAINWAY CROSS SECTION
 TYPICAL DETAILS FOR BORED TUNNELS**

Scale Not to Scale	Date October 2004
Drawing No. LTA/DBG/CRRP/008	Rev. 1

Scale 1: _____

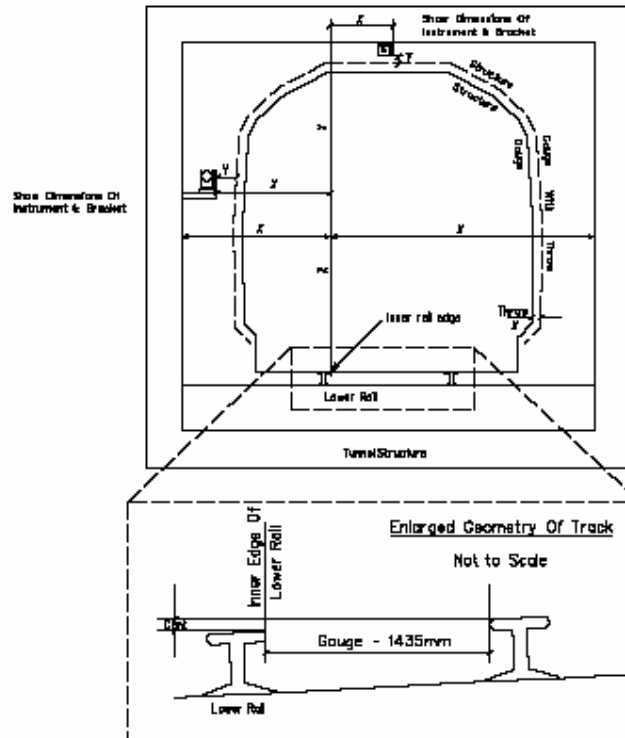
Chainage - _____

Tunnel Profile Facing Towards _____ Station

TRACK GEOMETRY

Cant - X

Horizontal Throw - Versine - X



Note :

- 1. Dimensions in mm
- 2. " X " indicates site measurement.
- 3. " Y " indicates computed value.



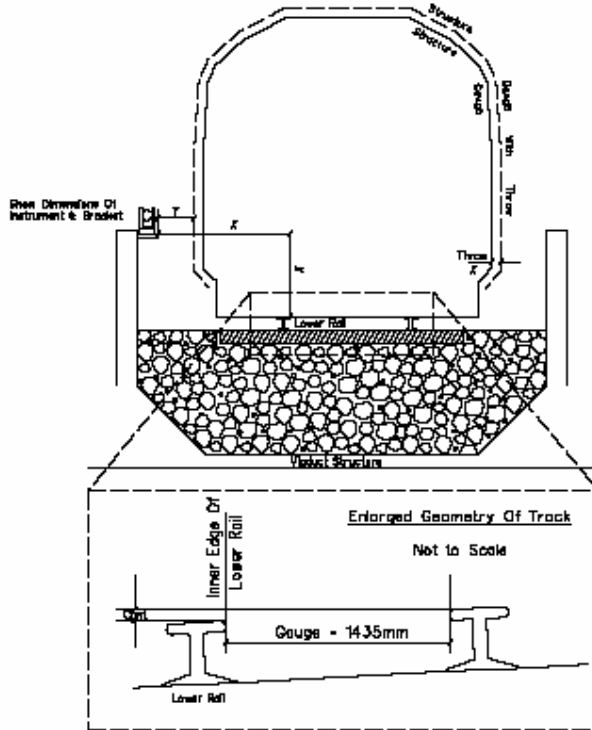
Drawing Title :
TRANWAY CROSS SECTION
TYPICAL DETAILS FOR BDX TUNNELS

Date Not to Scale	Date October 2004
Drawing No. LTA/DBD/CRP/008	Rev. 1

Scale 1: _____
 Chainage - _____
 Track Profile Facing Towards _____ Station

TRACK GEOMETRY

Chord - X
 Horizontal Throw - Versine - Y

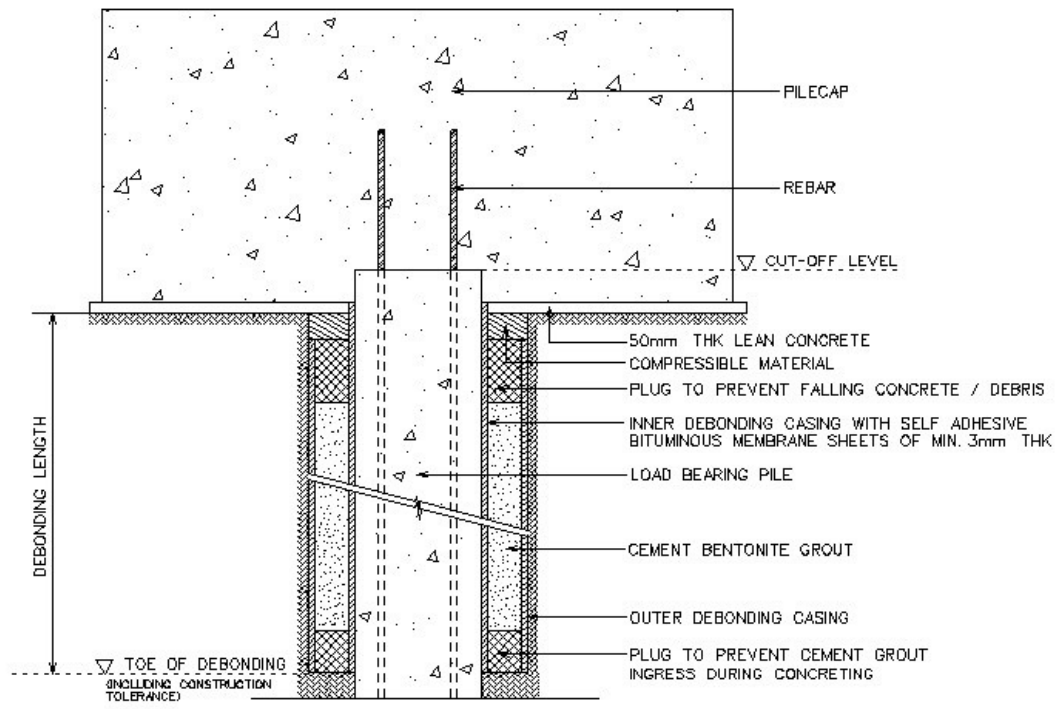


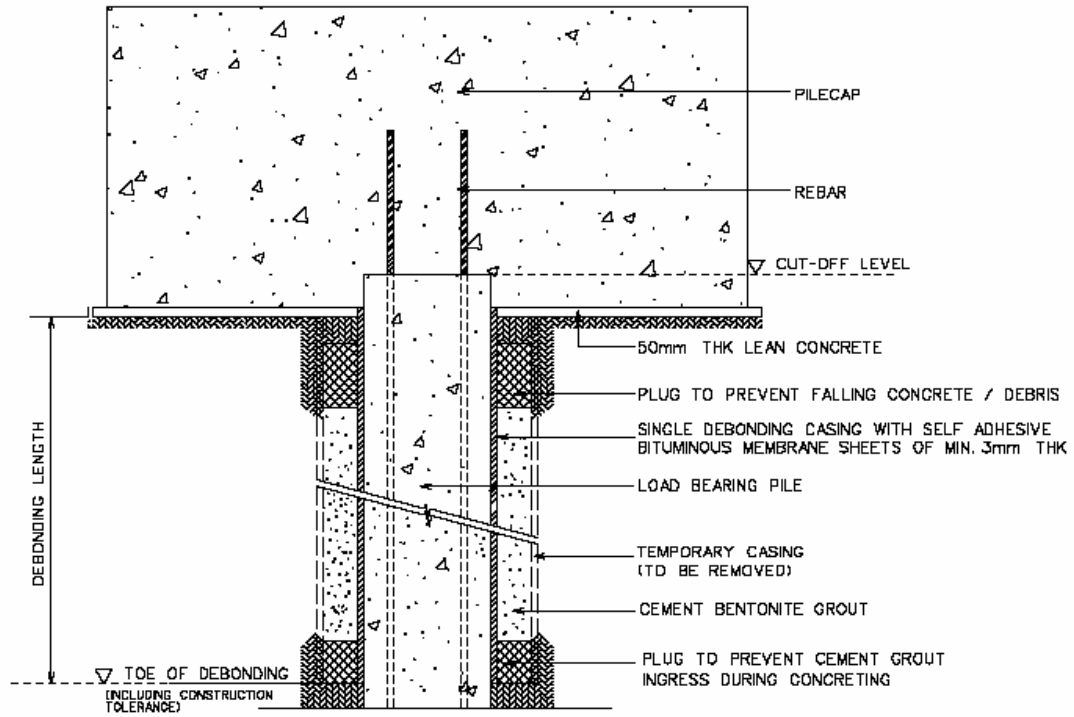
- Note :**
1. Dimensions in mm
 2. " X " indicates site measurement.
 3. " Y " indicates computed value.



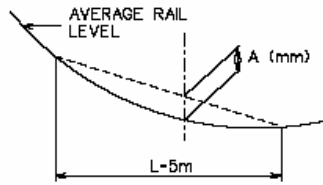
Drawing Title :
**TRAINWAY CROSS SECTION
 TYPICAL DETAILS FOR VIADUCT**

Scale Not to Scale	Date October 2004
Drawing No. : LTA/DEG/DRP/007	Rev. 1



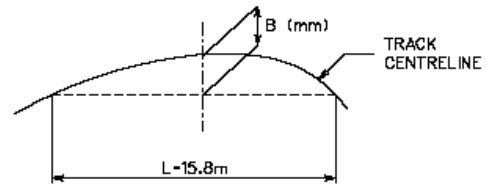


VERTICAL ALIGNMENT



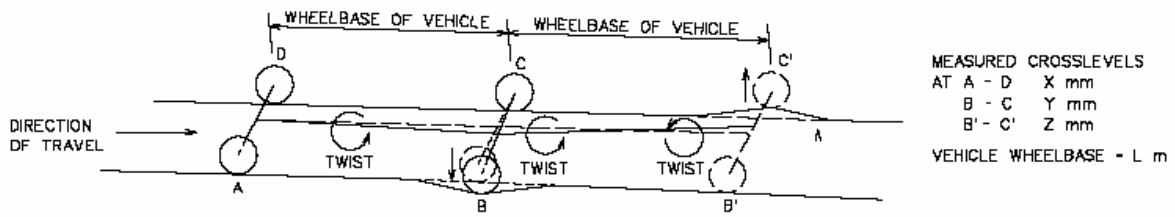
A : MEASURED DIP OR PEAK
RELATIVE TO L (m) CHORD

HORIZONTAL ALIGNMENT



B : CORRESPONDING VERSINE
MEASURED ON L (m) CHORD

TWIST



TWIST PRODUCED BY THE DIP AT BC WITH THE VEHICLE AT ABCD OVER L (m) = $Y - X$

TWIST PRODUCED BY THE DIP AT B'C' WITH THE VEHICLE AT BB'CC' OVER L (m) = $Z + Y$



Drawing Title :

INTERPRETATION OF TRACK CRITERIA

Scale
Not to Scale

Date
October 2004

Drawing No. :
LTA/DBC/CPRP/010

Rev.
1