

Category 1 Standard

S1053 Civil Engineering – Building and Station Structures

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1 Purpose

- 1.1 The purpose of this Standard is to define the whole life cycle civil and structural engineering requirements for Building and Station Structure assets. These assets comprise:
- a) Building Structures:
 - (i) Office blocks;
 - (ii) Storage buildings;
 - (iii) Workshops;
 - (iv) Depots;
 - (v) Train washing facilities;
 - (vi) Sub-stations;
 - (vii) Roof structures and supports.
 - b) Station Structures:
 - (i) Station buildings;
 - (ii) Ticket Halls;
 - (iii) Platforms;
 - (iv) Canopies (Entrance and Platform);
 - (v) Pump rooms;
 - (vi) Equipment rooms;
 - (vii) Control rooms;
 - (viii) Staff mess and locker rooms.
 - c) Building and Station Ancillary Structures:
 - (i) Stairs;
 - (ii) Ramps;
 - (iii) Ladders;
 - (iv) Handrails;
 - (v) Barriers;
 - (vi) Impact protection;
 - (vii) Escalator support structures;
 - (viii) Lift support structures.
- 1.2 In defining requirements specifically applicable to Building and Station Structure assets this Standard complements LU Standard S1050 “Civil Engineering - Common Requirements” that defines mandatory requirements generally applicable to all Civil Engineering assets, including the Building and Station Structure assets.
- 1.3 A supporting LU Guidance G0053 “Civil Engineering – Buildings and Station Structures” gives guidance and explanation on Building and Station Structure assets.
- 1.4 Building and Station Structure assets serve a functional requirement which is provided by:
- a) civil and structural elements together with;
 - b) finishes;
 - c) drainage; and
 - d) electrical and mechanical services.
- 1.5 This standard covers the civil and structural engineering aspects of the asset.
- 1.6 This standard does not cover the functional requirement of the asset, the architectural appearance, the finishes or the plant and equipment.

Note: Covered Ways and Subsurface (i.e. cut and cover) tunnels and subways are included in LU Standard S1051.

Girdering within station structures is included in LU Standard S1051.

Earth retaining structures are included in LU Standard S1051.



Structural elements of stations within tunnels are included in LU Standard S1055.

Drainage to Station Structures is included within LU Standards S1052 and S1056.

Station Planning requirements including spatial requirements are included in LU Standard S1371.

Station platform finishes, tolerances tactile warning strips and safety markings are included in LU Standard S1135.

Stairways and ramp requirements are included in LU Standard S1133.

Escalators and escalator trusses are included within LU Standard S1092.

Ladders and Step Iron requirements for drainage installations are included within LU Standard S1052.

Guidance on the requirements for barriers is given within LU standard S1132.

2 Scope

2.1 This Standard applies to Building and Station Structure assets owned by LU.

2.2 This Standard defines the civil engineering requirements for Building and Station Structure assets through the following life cycle stages:

- a) Inception and design;
- b) Construction, installation, testing & commissioning;
- c) Inspection;
- d) Analytical assessment;
- e) Condition assessment and certification;
- f) Maintenance;
- g) Strengthening and renewal;
- h) Decommissioning.

3 Requirements

3.1 Inception and Design

3.1.1 General

3.1.1.1 The inception and design of new works, including works of Strengthening and Renewal, shall ensure that Building and Station Structure assets will satisfy their Required Duty.

Note: The Required Duty for Building and Station Structure assets as defined in the Foundation Document (Bridges and Structures) is as follows:

1 Meet railway operating requirements (within the performance specification at system installation or at the most recent system upgrade).

1.1 Maintain inherent structural integrity (support itself so as not to suffer complete or partial collapse).

1.2 Maintain the ability to carry without restriction any permitted applied static and dynamic design loads.

1.3 Maintain the planned design envelope and adequate clearance to permit the safe passage of rail vehicles.



- 1.4 Provide appropriate access and egress for all planned uses (including Maintenance), and for reasonably anticipated emergency uses.
- 1.5 Sustain a condition and state so as not to cause unplanned interruption to, or restriction of, any aspect of the operating railway; this includes externally sourced wear or damage which is greater than that currently accepted for the asset.
- 1.6 Sustain a condition and state so as to maintain all interfacing non-railway services and facilities at full design capability.
- 2 Ensure support at asset interfaces without undue wear and tear.**
 - 2.1 Minimise the degradation of all interfacing assets (e.g. as evidenced through Maintenance cycles). This includes interfaces with the railway and adjacent infrastructure (e.g. track, structures, stations and premises).
 - 2.2 Minimise the degradation of all interfacing assets which support non-railway services or facilities (e.g. as evidenced through Maintenance cycles). This includes interfaces with dynamic and static assets (e.g. roads, buildings, walkways, etc).
- 3 Match LU policy in respect of realistic user perceptions.**

Ensure the asset does not cause undue degradation of interfacing assets, disruption to railway operations or unacceptable environmental nuisance.
- 4 Provide resistance against external interference and events.**
 - 4.1 Asset minimises the likelihood and consequence of asset abuse. Asset abuse includes, vandalism, planned/unplanned work, damage due to external event, etc.
 - 4.2 Asset minimises the likelihood of occurrence and enhances the ability to respond to personal attack on passengers or staff.
- 5 Present acceptable environmental impact.**

Present an acceptable societal environmental impact (noise, vibrations, vegetation cover, adverse weather management, etc).
- 6 Minimise environmental impact throughout lifecycle.**

Minimise environmental impact and demands at all stages in the lifecycle; this includes effects now and into the future, including successive refurbishment, final decommissioning, and disposal routes.
- 7 Function within the legal and standards framework.**

Ensure the asset functions within the framework defined by legislation (including environmental); regulatory guidance; LU, Infraco and applicable national and international standards; and LU and Infraco policies.
- 8 Ensure safe operation as defined by LU.**
 - 8.1 Ensure safe operation and Condition as specified by LU requirements; this includes passengers, employees and members of the general public.
 - 8.2 Ensure safe ingress/egress by passengers, general public, employees, and emergency services in planned & reasonably anticipated emergency scenarios.

This includes the means of transfer from the bridges and structures asset to the principal interfacing assets and transfer mediums (e.g. public footpaths).
 - 8.3 Safeguard the health and safety of passengers, employees and members of the general public.

**9 Provide above within reliability and availability targets.**

Provide all aspects of the Required Duty within the defined LU requirements.

10 Ensure Required Duty is performed without incurring excessive or prohibitive costs.

3.1.1.2 All Building and Station Structure assets shall meet the requirements of The Building Regulations.

3.1.1.3 Station Structure assets shall be classified in accordance with Purpose Group 5 in Table A2 of Approved Document B of the Building Regulations.

3.1.1.4 Building and Station Structure assets shall be designed to the principles of asset management planning.

3.1.2 Inception

3.1.2.1 All proposals for new works, including Strengthening and Renewal, made by Suppliers to LU shall be initiated and controlled in accordance with LU Standards S1538 “Assurance” and S1050.

3.1.3 Design Process

3.1.3.1 The design shall proceed in a staged manner in accordance with LU Standard S1538.

3.1.4 Ground Investigation Information

3.1.4.1 Ground Investigation and desk top studies for Ground Investigations shall be carried out in accordance with LU Standard S1050.

3.1.5 Design Standards

3.1.5.1 The design of Building and Station Structure assets, including Strengthening and Renewal, shall be carried out in accordance with:

- a) BS EN 1997-1;
- b) BS 8007 (water retaining construction);
- c) BS EN 1992;
- d) BS EN 1993;
- e) BS EN 1995;
- f) BS EN 1996;
- g) BS EN 81 (lift support structures – not heavy duty lifts).

Note: The design rules given in BS EN 81 are not wholly adequate for LU heavy duty lifts and should be validated for specific applications.

3.1.6 Design Life

3.1.6.1 The Design Life of Building and Station Structure civil assets shall be 120 years. The premises elements shall have design lives as specified in Premises standards. Foundation life for non-civil assets shall only reflect the expected design life of the asset and their usage.



- 3.1.6.2 In the design of Underground Structures, reliance shall not be based solely on the recommendations of British Standards or on existing environmental conditions. The probabilities of variations in soil, water and atmospheric conditions shall be considered and designs shall offer a reasonable probability of maintaining structural integrity for a period of at least 400 years.
- 3.1.6.3 The Design Life of load-bearing walls in brickwork shall be 120 years.
- 3.1.6.4 The Design Life of non load bearing walls in brickwork and blockwork shall be 60 years.
- 3.1.6.5 The Design Life of structural timber shall be Level 3 (condition based maintenance plus repair) as defined in BS 7543. A minimum of 120 years is required for structural timber.
- 3.1.6.6 The Design Life for waterproofing shall be 120 years. Where this cannot be achieved, the design shall facilitate remedial works.
- 3.1.6.7 The design shall state any monitoring and Maintenance liability required to achieve the Design Life and this shall be identified in the design report.

Note: The requirements for a design report are given in LU Standard S1050.

3.1.7 Structure Gauge and Clearance

- 3.1.7.1 Assets shall conform to LU Standard S1156 “Guaging and Clearance”, under any loading combination.
- 3.1.7.2 The maximum practicable lateral clearances shall be provided from structural supports to the railway track.
- 3.1.7.3 Unless the physical constraints of the location make it impractical, a clearance of 4.5m shall be provided from structural supports to the nearest running rail.
- 3.1.7.4 Where a support is provided at a distance less than 4.5m from the nearest running rail the following requirements shall apply:
- a) piers shall be of continuous construction rather than composed of individual columns, or, a solid plinth shall be provided up to a height of not less than 915mm above the level of the adjacent track;
 - b) the ends of the pier or plinth shall have suitably shaped ends to deflect derailed trains away from the support.
- 3.1.7.5 Places of safety shall be provided in accordance with LU Standard S1156.

3.1.8 Service Fixings and Connections

- 3.1.8.1 The design shall comply with the requirements for service fixings and connections in accordance with LU Standard S1050.

3.1.9 Finishes

- 3.1.9.1 Finishes shall be provided in locations as required by LU Standard S1135 “Premises – Finishes”.
- 3.1.9.2 Where the function of the asset includes its use as a part of the ventilation system the finish shall be as required by LU Standard S1067 “Tunnel and Public Area Cooling and Ventilation”.
- 3.1.9.3 The structural design shall provide space for installation or application of finishes consistent with structure tolerances.
- 3.1.9.4 The structural design shall be coordinated with the design of the finish to ensure durability and structural integrity of the asset.
- 3.1.9.5 Finishes shall allow the structure to be inspected.



3.1.9.6 Structural elements shall have a surface finish that is:

- a) compliant with fire resistance and durability requirements;
- b) graffiti resistant.

3.1.10 Fire Resistance

3.1.10.1 Structural members shall be designed to provide the fire resistance given in the Fire Safety Strategy Document produced in accordance with LU Standard 1-080 “The Application of Fire Safety Engineering Principles to London Underground Premises”.

3.1.10.2 For the purpose of determining the required fire resistance of structural elements in accordance with Table A2 of the Approved Document B of the Building Regulations, railway property shall be classified as:

- | | |
|-------------------------|-----------------|
| a) Offices | Purpose Group 3 |
| b) All Station Premises | Purpose Group 5 |

3.1.10.3 Main structural elements in sub-surface locations shall have a fire resistance of at least 60 minutes.

3.1.10.4 Any steelwork supporting a Building Structure over the operational railway track shall achieve a fire resistance of at least 120 minutes.

3.1.10.5 Designs for Station Structures shall be subject to review by the local fire authority during design development.

3.1.10.6 When major refurbishment is undertaken, existing structural members shall be checked for the ‘Fire Limit State’ as described in BS EN 1993-1-2.

3.1.11 Groundwater

3.1.11.1 The design shall take account of the following:

- a) Changes in long-term Groundwater levels as defined by LU;
- b) Seasonal variations in Groundwater levels.

3.1.12 Impact on Operational Railway and Adjacent Structures

3.1.12.1 The design shall comply with the requirements of LU Standard S1050.

3.1.13 Water Resistance and Drainage

3.1.13.1 Sub-surface structures shall be designed and constructed to attain a performance level of Grade 3 as specified in Table 1 of BS 8102.

3.1.13.2 Sub-surface structures shall provide a water resistance performance equivalent to concrete designed in accordance with BS EN 1992-3 with an external vapour proof membrane and external water-bars at construction joints.

3.1.13.3 Platforms shall be waterproofed to retain their structural integrity throughout their Design Life.

3.1.13.4 Platforms within Section 12 Stations that are fully enclosed shall not require waterproofing.

3.1.13.5 Junctions between new and existing waterproofing shall be designed to ensure that no weakness is created in the waterproofing envelope.

3.1.13.6 Assets shall be designed to shed water and avoid the accumulation of water.

3.1.14 Stray Electrical Currents

3.1.14.1 Where structures are to be placed in areas which contain 750V third-rail electrified railways or 25kV overhead line electrified railways, the likelihood of damage being caused by stray electrical currents shall be assessed.



- 3.1.14.2 All metal structures and steel reinforcement in concrete that are prone to corrosion due to stray electrical currents shall be earthed in accordance with LU Standard 1-106 “Earthing and Bonding of LU Electrical Networks”.

Note: Guidance on protection of structures against stray currents is given in LU Guidance G0053.

3.1.15 Structural Design

3.1.15.1 General

- a) Existing LU structures that are to remain shall be checked for stability and movement in all conditions during all phases of construction and loading;
- b) Structural elements carrying railway and highway dynamic loading shall be designed in accordance with the requirements of S1051 “Civil Engineering – Bridge Structures”.

3.1.15.2 Structural Independence

Where new LU buildings or station structures may be required to support a third party commercial development then the requirements of LU Standard S1050 “Civil Engineering – Common Requirements” shall be followed.

3.1.15.3 Foundations

- a) The design and proposed methods of construction shall minimise effects of construction-related ground movements on adjacent buildings, structures and utilities.
- b) Settlement and damage predictions shall be undertaken in accordance with LU Standard S1050.
- c) The design and proposed methods of construction shall control construction-related ground movements to ensure that damage to adjacent buildings, structures and utilities does not exceed Category of Damage 2 (Slight) as defined by Burland et al (1977).

Note: Burland et al defined slight damage as “Cracks easily filled. Redecorating probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repainting may be required externally to ensure weather tightness. Doors and windows may stick slightly.”

The approximate crack width (in masonry construction) was suggested as 5mm. The limiting Tensile Strain 0.075% to 0.15%.

- d) The owners of adjacent buildings, structures and utilities shall be consulted on the assessment of the effects of settlement on movement and serviceability.

Note: Reference may be made to CIRIA Special Publication 200, 2001: Volume 1 (of 2) Projects and Methods: Building Response to Tunnelling, Case Studies from Construction of the Jubilee Line Extension, London. Editors J B Burland, J R Standing, F M Jardine

- e) Suitable provision shall be made to allow for movement of foundations without detrimental effect to services and utilities.
- f) The foundation system shall be designed such that the net downward load is always positive, in the construction, operation and accident conditions.
- g) NHBC Standards shall be considered for the design of low rise building foundations.



- h) The design of temporary or permanent Underground Structures and of dewatering systems shall, as far as is reasonably practical, avoid lowering of the external water table and shall minimise the reduction of piezometric head in the adjacent soils.

Note: Guidance on underpinning is given in LU Guidance G0053.

3.1.15.4 Escalator Support Structures

- a) The asset structure, including the escalator support structure, shall not rely on the escalator truss structure for lateral stability or vertical support.
- b) The escalator truss structure shall not provide support to any other structural element other than minor enclosure support elements.

3.1.15.5 Lift Support Structures

- a) The lift support structures shall be in accordance with BS EN 81 except the designer shall recognise that the design rules given in BS EN 81 are not wholly adequate for LU heavy-duty station lifts and shall be validated for specific applications.

Note: Guidance on lift support structures is given in the LU Guidance G0053 supporting this standard.

- b) The design process shall demonstrate that full consideration has been given to not locating the lifts directly over railway tracks, platforms, booking halls and other public or staff areas.
- c) Where it has been demonstrated that the requirements in (b) above are not practicable and where, by the granting of approval in principle, it has been accepted that the requirements in (b) above are not practical, additional safeguards in accordance with LU Standard S1093 “PMVT Lifts (Including Managed Evacuation Lifts)” shall be incorporated into the design.
- d) Separate supports for guide rails shall be provided for each lift.

3.1.15.6 Lift Pits

The construction of the lift pit, including the walls of the pit, shall be continuous reinforced concrete cast in situ.

3.1.15.7 Precast Concrete Nosing Slabs

Precast concrete nosing slabs shall support the applied loads as given in Section 3.1.16. Details of nosing slab dimensions and reinforcement are given in Appendix 7.1.

Note: Platform nosing slabs are part of the platform finish and further details are given in LU Standard S1131.
Brackets or minor supports are particularly vulnerable to damage in an Incident.

3.1.15.8 Structural Glass

- a) Structural glass shall be designed using the modified Damage Equivalent Load and Resistance method (DELR), set down in draft European Standard pr EN 13474.
- b) Glass blocks shall not be used for any load bearing wall.
- c) All structural glass must comply with LU standards, in particular the requirements of LU Standards 1-083 “Passive Fire Protection Systems”, 1-085 “Fire Safety Performance of Materials” and S1134 “Premises – Doorsets & Glazing”.



- d) Glass shall comply with BS6262 “Glazing for Buildings – Part 6: Code of Practice for Special Applications”.
- e) Sealants shall comply with the requirements of BS EN 15434 “Glass in Building Product Standard” for structural and/or ultra-violet resistant sealant (for use with structural sealant glazing and/or insulating glass units with exposed seals).
- f) The requirements of PD 6512-3 “Use of Elements of Structural Fire Protection” with particular reference to the recommendations given in BS5588 “Fire Precautions in the Design and Construction of Buildings – Part 3: Guide to the Fire Performance of Glass” shall be complied with.

3.1.16 Loading

3.1.16.1 General

- a) The loads set out within this standard are characteristic loads. For both the Ultimate and Serviceability Limit States the loads shall be factored using appropriate load factors.
- b) Design loads shall incorporate all service and imposed loads, all temporary loads for access and Maintenance and requirements for the current design loads arising from adjacent buildings and structures.

Note: This Section defines the loadings to be applied in the design of Building and Station Structures, including any Strengthening and Renewal, refurbishment and Maintenance work.

3.1.16.2 Dead Loading

- a) Dead loading shall be calculated in accordance with BS EN 1991-1-1.
- b) Unit weights shall be the actual known weights of the materials used with reference made to BS648 when appropriate.

3.1.16.3 Imposed Floor or Horizontal Surface Loading

- a) The imposed floor or horizontal surface load shall be in accordance with BS EN 1991-1-1 unless specified in Table 1 below;
- b) Structural members shall be designed for the distributed load and shall be checked for the ability to carry the concentrated load applied separately in the most onerous positions.
- c) Where existing buildings are adjacent to proposed works they shall be individually assessed and the surcharge loading from each shall be determined. Calculations shall be produced to confirm the current load conditions.
- d) Where there are no existing buildings adjacent to the structure, a uniform surcharge of 10 kN/m² applied at ground level shall be assumed to be applied alongside (but not over) Underground Structures. This surcharge shall be deemed to cater for the effect of future buildings adjoining the LU structures.



Type of floor or horizontal surface	Distributed load (kN/m ²)	Concentrated load (kN)
Ticket halls (including halls on raised floors), Concourses Platforms and all other passenger areas (see also 3.1.16.10 regarding loads applied from platform edge doors) Station offices	5	20 on a 300 x 300 mm square
Platform Ramps	Nil	1kN at 1m centres
Lift Pit Floors	5	As per Clause 3.1.16.11
Toilets	2	Nil
Staff rooms	2.5	1.8
Staircases	The greater of the loadings of the floors to which they lead.	
Nosing stone (stability)	5	1.3 at 600 mm centres
Interlocking Machine Rooms, Communications Equipment Rooms, etc.	5	20 on a 300 x 300 mm square
Store rooms Plant rooms with the exception of traction and distribution sub-stations	10	20 on a 300 x 300 mm square
Signal gantries Access gantries Service and access platforms in depots Vent shaft mesh screening	3	1.8
Traction and distribution sub-stations. Sewage ejector room: the weight of the tank plus its maximum content at overflow conditions shall be used for the area occupied by the tank.	To be determined from actual weight of equipment to be used.	

NB: The floor loads set down in Table 1 are for the structural floor of the building, they do not apply to proprietary raised floors, but it is recommended that the proprietary raised floors resist safely the same distributed load as the structural floor. Heavy permanently imposed loads should be carried by plinths.

Table 1 - Imposed floor or horizontal surface loadings

3.1.16.4 Station Ceiling Service Loads

- a) Station building ceilings shall be designed for a load from services of the following or greater:
- (i) supported areas up to 10m²: 2.0kN/ m²;
 - (ii) supported areas between 10 and 30 m²: 1.5kN/ m²;
 - (iii) supported areas greater than 30 m²: 1.0kN/ m².

Note	The supported area is the plan area of the structure supported by the structural element under consideration.
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- b) The designer shall consider whether these service loads are to be classified as Dead Load or Live Load.