Technical Information Sheet ED022

Durability of Light Steel Construction

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The durability of materials is an important factor in the construction solution selection process. The performance of light steel construction has been studied over many years, in a wide variety of environmental conditions, and has been found to give excellent results with long design life predictions. Light steel construction is used for many types of buildings including; residential, commercial, health care, educational and industrial.

Key benefits

The benefits of light steel construction in relation to durability are:

- Design life predictions for light steel framing in a 'warm frame' environment are in excess of 250 years.
- The NHBC and other housing warrantee providers, require a design life in excess of 60 years, and accept the use of light steel construction.
- Light steel sections are protected from corrosion by continuous hot-dip zinc coating.
- Steel does not shrink, warp or change its shape.
- Light steel construction can be used for walls, floors, roofs and suspended ground floors.
- Steel does not creep under load.
- Galvanised steel does not suffer from fungal or biological deterioration and is not susceptible to insect infestation.
- Even in uninsulated roof constructions light steel sections provide a design life in excess of 100 years.

Protection from corrosion

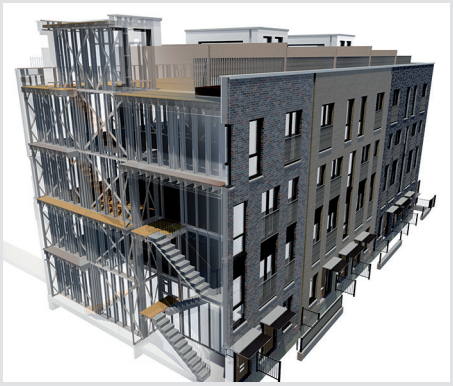
Corrosion occurs when the surface of bare carbon steel reacts with oxygen, water and airborne pollutants to form the complex series of oxides generically known as rust. In dry, warm environments this process does not occur.

The standard form of corrosion protection for cold-formed steel sections is the continuous hot-dip zinc coating applied as a pre-coat to the roll of strip steel from which the sections are formed. Galvanized steel strip and its coating is supplied to the specifications in BS EN 10346 and BS EN 10143.

Galvanized strip steel is usually produced with a standard Z275 coating, meaning 275 grams of zinc per square metre summed over both faces of the steel strip. This corresponds to approximately 0.02 mm overall thickness of zinc per face. Other coating thicknesses are available for special applications.

Zinc-aluminium coatings are also available, and are more commonly used in other countries such as Australia. Zinc-aluminium coating AZ150 is an acceptable alternative to Z275.

Detailed information relating to durability of light steel framing is presented in the SCI publication: *Durability of Light Steel Framing in Residential Building – Second Edition* (SCI P262).



BIM model with 'warm frame' construction

(Image courtesy of Metek UK)

Light steel extra care housing scheme

(Image courtesy of Kingspan Steel Building Solutions)

Light steel sections in an external wall application

(Image courtesy of Ayrshire Metal Products)

Durability Performance

Forms of protection

Hot-dip galvanizing provides both of the following forms of protection:

- Encapsulation - where a coherent barrier is used to exclude corrosive agencies from the surface.
- Sacrificial - where another metal, which corrodes preferentially to steel, is used in proximity to the surface.

The durability performance of galvanised light steel has been researched and assessed through the monitoring and measurement of zinc coating thickness over a period of years. The following case studies demonstrate the galvanised steel durability performance in various exposure conditions. The results from the case studies are summarised in Table 1. Further details and case studies are provided in SCI publication P262.

Student residence at Oxford Brookes university

In 1996, a student residence was constructed at Oxford Brookes University using a light steel framing system, see Figure 1. The building included innovative features such as habitable roof systems, and a composite suspended ground floor.

CASE STUDY LOCATION	EXPOSURE TIME (Months)	TOTAL COATING LOSS (g/m^2)	RATE OF LOSS ($g/m^2/yr$)
Oxford – Cold loft	60	0.57	0.11
	124	0.63	0.06
Oxford – Upper wall cavity	60	0.47	0.09
	124	0.45	0.04
Oxford – Lower wall cavity	60	1.25	0.25
	124	1.31	0.13
Oxford – Below ground floor slab	60	2.13	0.43
	124	2.04	0.20
Yorkshire – Roof space	81	1.00	0.15
Yorkshire – First floor walls	81	0.79	0.12
Yorkshire – Walls below windows	81	4.12	0.61
Edinburgh – Insulated cladding	57	1.83	0.38
	156	3.87	0.30
Port Talbot – Non-insulated cladding	60	6.66	1.33
	128	10.18	0.95

Table 1 Galvanising weight loss from case studies

Figure 1 Three storey student residence in Oxford

Several sets of coated steel coupons were suspended in the wall cavities, loft and in the ventilated void below the suspended ground floor. These coupons were removed at intervals to assess the loss of coating weight over time. As can be seen from Figure 2 the visual appearance of the galvanised steel after 10 years exposure was excellent. A general trend is that the rate of coating loss reduces as the exposure period increases.

Modular house in Yorkshire

In 1998, two light steel modular houses were built in Gilberdyke, East Yorkshire. In 2001, steel coupons were placed in accessible areas of both houses and in 2008 several of the coupons were collected and analysed for loss of coating (see Table 1).

Cladding environments

Galvanised steel coupons were placed behind various forms of cladding system to ascertain the durability performance in partially protected environments.

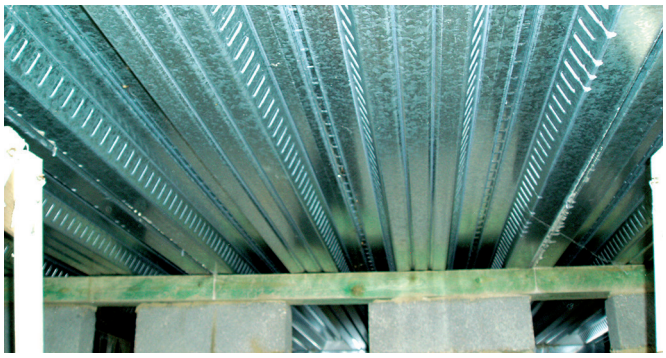


Figure 2 Galvanised steel decking supporting a suspended ground floor after 10 years exposure

Design life predictions

The case study data shows that the rates of zinc loss on galvanized steel coupons in dry environments are very low and it has been observed that the rate of zinc loss reduces with time. This is because a zinc oxide layer forms on the surface and protects the zinc beneath.

Design life predictions for galvanised steel in different applications have been established from recorded data. The design life predictions presented in Table 2 are based on the following conservative assumptions:

- Rate of zinc loss is linear over time.
- Design life duration is taken as when only 50% of the total coating weight remains.
- The rate of coating loss is taken as twice the rate observed from case studies.

Cut edges

It is generally not necessary to provide additional protection at cut edges. This is because corrosion protection to cut edges arises from the sacrificial galvanic action of the zinc adjacent to the edge. There is no practical evidence that higher levels of corrosion occur at edges.

White rust

White rust can occur on galvanised steel and is caused by moisture trapped between components during storage or transportation. For light occurrences of white rust no remedial action is required. Over time white rust deposits will slowly convert to a protective layer of zinc carbonate.

Warm frame construction

In 'warm frame' construction the light steel framing is in a warm, dry environment which ensures that the light steel components are kept above a certain temperature. This minimises the risk of condensation forming on the steel and therefore of corrosion.

To qualify as 'warm frame' construction at least 33% of the thermal insulation of the wall must be on the external side of the light steel frame. An example of a 'warm frame' wall construction is shown in Figure 3.

Accidental temporary exposure to water will not affect the design life of the light steel frame.

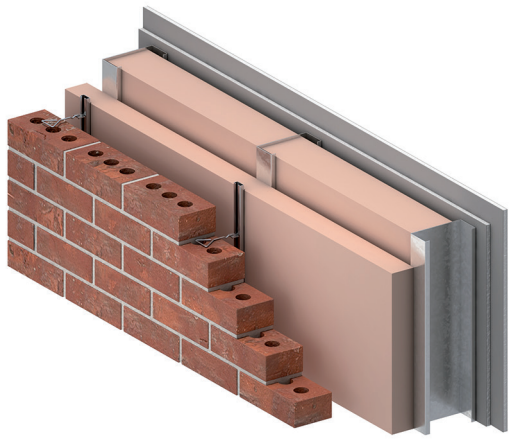


Figure 3 Typical example of warm frame construction
(Image courtesy of BW Industries)

PRODUCT APPLICATION	ENVIRONMENTAL CONDITIONS	PREDICTED DESIGN LIFE
Walls and floors in warm frame applications	No risk of water ingress or condensation	250 years
Non-load bearing stud partitions	Warm internal environment and no risk of water ingress	250 years
Infill external walls in multi-storey buildings	Warm frame and no risk of water ingress	250 years
Roof structures (insulated)	Low risk of condensation	200 years
Suspended ground floors (with over-site membrane)	Low risk of water ingress; some risk of condensation	100 years
Roof structures (uninsulated)	Some risk of condensation	100 years
Purlins and side rails supporting metal cladding	Low risk of condensation; some dust and pollution	60 years
Sub-frames to over-cladding panels	Low risk of water ingress; risk of condensation	60 years
Suspended ground floors (without over-site membrane)	Low risk of water ingress; higher risk of condensation	50 years

Note: All values are for Z275 (Total weight of zinc coating on both surfaces = 275 g/m^2).

Table 2 Predicted design life for galvanised steel in different applications

Sources of Information

The building in Figure 4 has been exposed in an un-protected condition without cladding for over 5 years. The light steel framing shows only minor signs of deterioration.

Figure 4 Light steel frame structure after 5 years exposure
(Image courtesy of Fusion and Evolusion)

Bibliography

The following publications may be referred to for more information on durability and light steel construction.

Way, A. G. J. et al
Durability of Light Steel Framing in Residential Building – Second Edition (P262)
The Steel Construction Institute, 2009

Lawson, R. M., Way, A. G. J. and Yandzio, E.
Building design using cold formed steel sections: Residential buildings (P402)
The Steel Construction Institute, 2014

BS EN 10346: 2009
Continuously hot-dip coated steel flat products. Technical delivery conditions
BSI, 2009

BS EN ISO 14713-1:2009
Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures. General principles of design and corrosion resistance
BSI, 2010

Lawson, R. M.
Sustainability of steel in housing and residential buildings (P370)
The Steel Construction Institute, 2007

Other technical information sheets

The following technical information sheets give further details.

- ED010: Light Steel Solutions for All Applications
- ED011: Light Steel Residential Buildings
- ED012: Light Steel Framed Housing
- ED013: Light Steel Infill Walls
- ED014: Light Steel Modular construction
- ED015: Acoustic Performance of Light Steel Construction
- ED016: Fire Safety of Light Steel Construction
- ED019: Thermal Performance of Light Steel Construction
- ED020: Sustainability of Light Steel Construction
- ED021: Robustness of Light Steel Construction

Manufacturers

The following manufacturers are active in the light steel and modular construction sector and may be contacted for further information.

Ayrshire Metal Products Ltd. - www.ayrshire.co.uk

BW Industries Ltd. - www.bw-industries.co.uk

Fusion Building Systems - www.fusionbuild.com

Kingspan Steel Building Solutions - www.kingspanpanels.com

Metek UK Ltd. - www.metek.co.uk

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www.steelbiz.org - 24×7 online technical information

www.lightsteelforum.co.uk - Light Steel Forum

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