Appendix B

B. DURABILITY

B.1 Slabs

The slabs have been designed and detailed for a maximum Exposure Classification of B1 (near coastal) in accordance with AS 3600-2001. Less severe classifications may be appropriate for fully enclosed carparks or for carparks in cities away from the coast.

For durability and aesthetic reasons, the slabs have been designed in accordance with AS 3600-2001 to achieve a strong degree of crack control. Special attention should also be given to the need for additional reinforcement in the vicinity of restraints, openings and discontinuities particularly on the top level, which is subjected to a great deal more moisture in the form of rainfall.

The regions of the slabs in negative bending have been designed for crack control in accordance with Proe, Patrick & Goh (1997). The regions at the ends of the primary and secondary beams have also been checked for crack control in accordance with Adams & Patrick (1998). This has resulted in additional reinforcement being provided around some columns and over some primary beams. Propping of the slabs or beams, where the system has been designed as unpropped, may result in excessive crack widths. Hence, propping should be avoided in all schemes except Scheme S3A.

Movement joints traditionally require high maintenance and should be avoided if possible. When required, they should be detailed so that in the event of leakage through the joint, there will not be any adverse effect on the durability of the structure or damage to the paint on the cars below. Consequently, the joints must not be placed over the flange of a steel beam. A suitable detail is given in Figure B1.

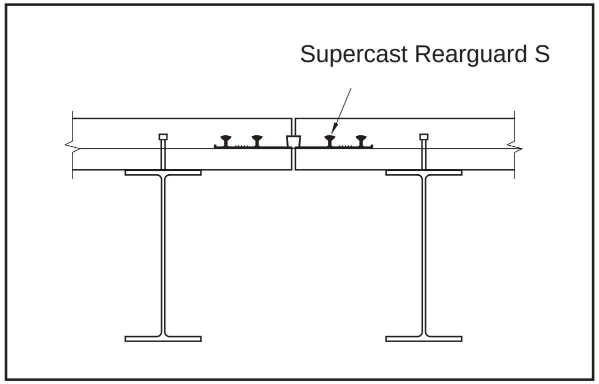

Figure B1 - Expansion Joint Detail

The concrete should be screeded or boxed locally around the steel column so that water will not pond at the column. In addition a sealant with a high modulus of elasticity (e.g. ROADseal) should be provided at the interface of the concrete and the steel column so that water can not penetrate when the concrete shrinks away from the column.

B.2 Profiled Steel Sheeting

It is recommended that the galvanized coating on the profiled steel sheeting complies with Table B1. (BlueScope Steel, 2004) The atmospheric classifications in AS/NZS 2312:2002 are appropriate for steel sheeting and have been adopted herein (refer to Table B3). For exposed edge forms, a drip arrester should be incorporated along the edge (see drawing No S1, Section 2.3, page 25 for a suitable detail), and should be made from Z450 galvanized steel. For edges not exposed to the weather, a standard edge form of Z450 galvanized steel is recommended.

Atmospheric Corrosivity Category	Zinc Class
A	Z350
B	Z350
C	Z350
D	Z450*
E	Z450*
F	Z450*

NOTE: * Supply of Z450 may have a longer lead time and refer to manufacturer's recommendations.

Table B1 - Minimum Recommendations for Profiled Steel Sheeting Coatings

B.3 Structural Steelwork

Considerable care has been taken to avoid details that will lead to premature deterioration of the paint system. The selection of the steelwork finish will often be governed by aesthetics as well as durability.

The top flange of the composite steel beams should not be coated with materials that would prevent the satisfactory welding of shear studs through the profiled steel sheeting. Shear studs can be welded through the profiled steel decking and a 25-50µm coating of a zinc phosphate primer onto the steel beam. For atmospheric corrosivity category A it is recommended that this sort of weld through primer be used.

For higher atmospheric corrosivity categories it is recommended that the steelwork be protected as indicated in Table B2. However, a strip wide enough to accommodate the shear studs is to be to be initially left untreated by masking the appropriate area on the top flange. A special tape is available to accommodate a hot-dip galvanized treatment. This area is latter treated with a 25-50µm coating of a zinc phosphate primer.

Exposed perimeter steelwork is in a more severe environment than the internal steelwork and therefore should have a higher level of protection. Therefore, for perimeter beams with a slab edge exposed to the weather, it is recommended that at the very least, the top flange should be given a complete coat of the protection indicated in Table B2, while the beam should be galvanized in marine and tropical environments. This means that perimeter beams in these cases would need to be non-composite as the whole top flange of the beam would be treated making the welding of shear studs to this surface difficult.

Table B2 gives the minimum recommended surface treatment based on AS/NZS 2312:2002. In some situations, it may be better to adopt a more durable surface coating with a higher initial cost and reduced maintenance. Different systems can be compared by determining the life cycle cost, using the Net Present Value method (AS/NZS 2312:2002) of each alternative including allowances for taxation benefits. Systems alternative to those given in Table B2 that can be considered include:

- Class 2.5 blast clean (AS 1627.0-1997) followed by one coat of inorganic zinc silicate (75µm), a

Atmospheric Corrosivity Category[2]	Steelwork Treatment		
	Preparation	Protection	Top Coats for Aesthetics
A	Blast Clean to Class 2	75µm Alkyd Primer (Zinc Phosphate[1])	Alkyd Gloss
B	Blast Clean to Class 2	75µm Epoxy Zinc Phosphate Primer	50-75 µm Polyurethane or Catalised Acrylic
C	Blast Clean to Class 2½	75µm Epoxy Zinc + 125µm High Build Epoxy	50-75 µm Polyurethane or Catalysed Acrylic
D	Blast Clean to Class 2½	75µm Epoxy Zinc + 150µm High Build Epoxy or Hot-dip Galvanized	50-75 µm Polyurethane or Catalysed Acrylic
E	Blast Clean to Class 2½	75µm Epoxy Zinc + 200µm High Build Epoxy or Hot-dip Galvanized	50-75 µm Polyurethane or Catalysed Acrylic
F	Blast Clean to Class 2½	75µm Epoxy Zinc + 125µm High Build Epoxy	50-75 µm Polyurathane or Catalysed Acrylic

NOTE: 1. Masking of top flange is not required. Shear studs to be installed through Zinc Phosphate coating
2. Refer to Table B3 for descriptions of Atmospheric Corrosivity Categories

Table B2 - Minimum Recommended Surface Treatment options for Various Atmospheric Classifications in Accordance with AS/NZS 2312:2002

functional system where aesthetics are less important;
- Class 2.5 blast clean followed by 50µm epoxy zinc and 50µm 2 pack acrylic (epoxy cross linked catalysed acrylic) to provide an architectural finish in a range of colours

Szokolik & Rapattoni (1997) has shown that a single coat of water borne inorganic zinc silicate will out perform multi-coat systems. However the multi-coat system is given for situations where a different colour top coat is desired.

Table B2 is a guide only. The corrosion protection system should be designed in accordance with AS/NZS 2312:2002. Labour rather than material cost drives the applied cost of coating systems. Often similar corrosion resistance can be achieved independent of aesthetics.

Reference should be made to Appendix D for costs of alternate coating systems

B.4 Monitoring

In accordance with normal practice, an inspection would be undertaken towards the end of the contract defects-liability period. This should identify items which require ongoing monitoring such as expansion joints.

References

Adam, J. C. & Patrick, M. 1998, *Crack-control Investigation for Steel-framed Carparks*, BHPR/N/1998/098, BHP Research - Melbourne Laboratories, Melbourne

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Proe, D. J., Patrick, M. & Goh, C. C. 1997, “Simplified Design of Continuous Composite Slabs including Moment Redistribution and Crack Control”, *Fifteenth Australasian Conference on the Mechanics of Structures and Materials*, Melbourne, pp. 147-152

Standards Australia 1997, *AS 1627.0-1997 Metal finishing - Preparation and pretreatment of surfaces - Method selection guide*, SAI, Sydney

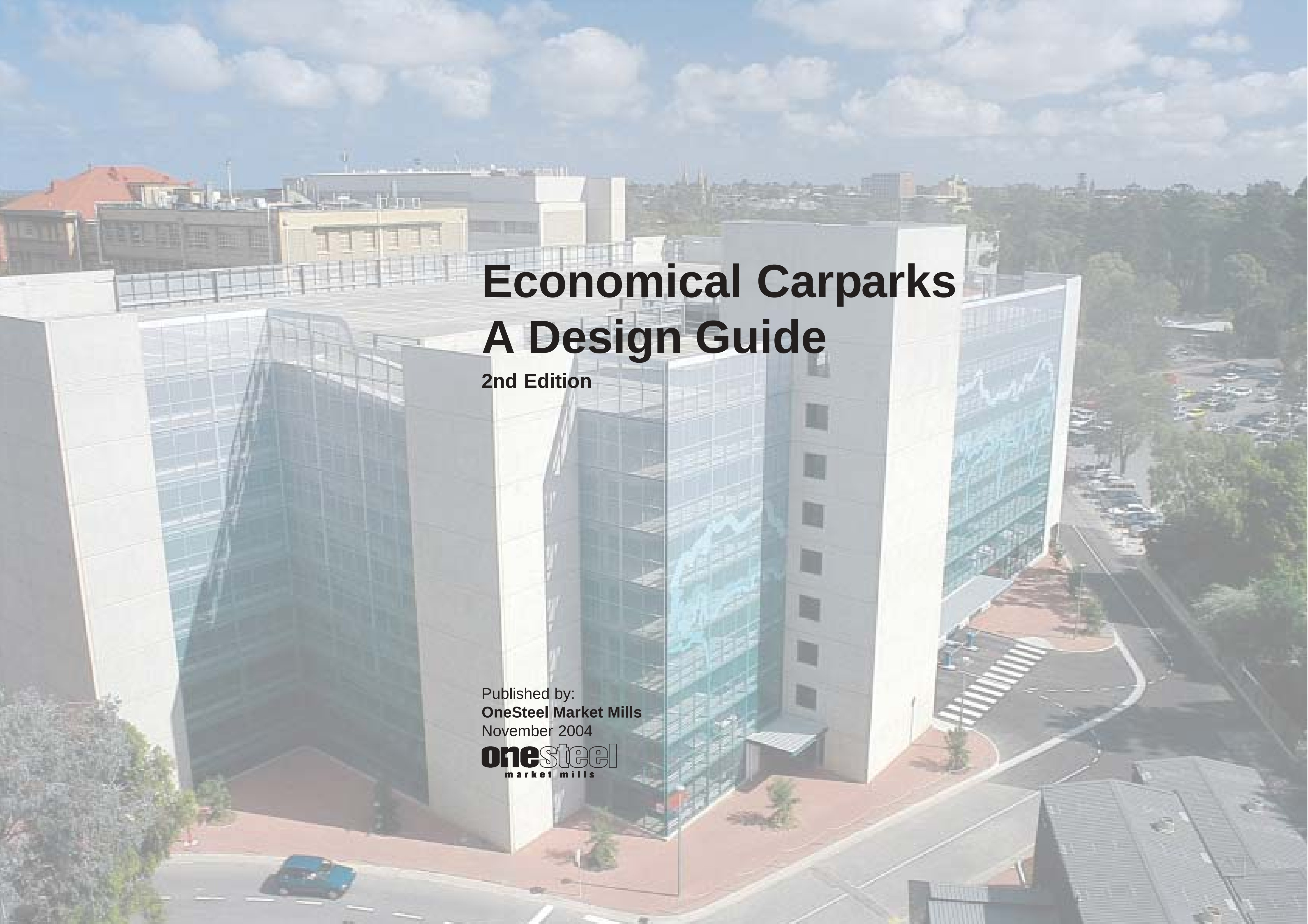
Standards Australia/Standards New Zealand 2002, *AS/NZS 2312:2002 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings*, SAI, Sydney

Szokolik, A. & Rapattoni, F. 1997, “Single-coat Inorganic Zic Silicate. Is this the Definitive Answer for Surface Protection of Steel Bridges?”, *Preceedings of the 1997 Bridge Conference*, Sydney

Atmospheric Corrosivity Category	Description
Category A: Very low	Environments in this category are most commonly found inside heated or air conditioned buildings with clean atmospheres, such as most commercial buildings. They may also be found in semi-sheltered locations remote from marine or industrial influence and in unheated or non-air conditioned buildings. The only external environments in Australia or New Zealand are some alpine regions although, generally these environments will extend into Category B.
Category B: Low	Environments in this category include dry, rural areas as well as other regions remote from the coast or sources of pollution. Most areas of Australia and New Zealand beyond at least 50 kilometres from the sea are in this category, which can however, extend as close as 1 kilometre from seas that are relatively sheltered and quiet. Typical areas occur in arid and rural inland regions, most inland cities and towns such as Canberra, Ballarat, Toowoomba, Alice Springs and Hamilton, NZ and suburbs of cities on sheltered bays, such as Melbourne, Hobart, Brisbane and Adelaide (except areas within 3 to 6 kilometres of the coast near Adelaide). Unheated or non-airconditioned buildings where some condensation may occur, such as warehouses and sports halls, can be in this category. Proximity to the coast is an important factor.
Category C: Medium	This category mainly covers coastal areas with low salinity. The extent of the affected area varies significantly with factors such as winds, topography and vegetation. Around sheltered seas, such as Port Philip Bay, Category C extends beyond about 50 metres from the shoreline to a distance of about one kilometre inland. For a sheltered bay or gulf, such as near Adelaide, this category extends from the shoreline to about 3 to 6 kilometres inland. Along ocean front areas with breaking surf and significant salt spray, it extends from about 1 kilometre inland to between 10 to 50 kilometres inland, depending on the strength of prevailing winds and topography. Much of the metropolitan areas of Wollongong, Sydney, Newcastle, the Gold Coast, Auckland and Wellington are in this category. In South Australia, the whole of the Yorke peninsula falls within this or a more severe category, and in the south-east of the state, from Victor Harbour to the Victorian border, this category extends between 30 and 70 kilometres inland. Such regions are also found in urban and industrial areas with low pollution levels and although uncommon in Australia and New Zealand, exist for several kilometres around major industries, such as smelters and steelworks, and in the geothermal areas of New Zealand. Micro-environmental effects, such as result from proximity to airports and sewage treatment works, may also place a site into this category. Interior environments with Category C corrosivity can occur in humid production rooms, such as food-processing plants, laundries, breweries, printing works and dairies.
Category D: High	This category occurs mainly on the coast. Around sheltered bays, Category D extends up to 50 metres inland from the shoreline. In areas with rough seas and surf, it extends from about several hundred metres inland to about one kilometre inland. As with Categories B and C, the extent depends on winds, wave action and topography. Industrial regions may also be in this category, but in Australia and New Zealand these are only likely to be found within 1.5 kilometres of the plant. This category extends inside the plant where it is best considered as a micro-environment. Damp, contaminated interior environments such as occur with swimming pools, dye works, paper manufacturers, foundries, smelters and chemical processing plants may also extend into this category.
Category E: Very High E-I: Industrial E-M: Marine	This category is common offshore and on the beachfront in regions of rough seas and surf beaches. The region can extend inland for several hundred metres. (In some areas of Newcastle, for example, it extends more than half a kilometre from the coast.) This category may also be found in aggressive industrial areas, where the environment may be acidic with a pH of less than 5. For this reason, Category E is divided into Marine and Industrial for purposes of coating selection. Some of the damp and/or contaminated interior environments in Category D may occasionally extend into this category.
Category F: Inland Tropical	A tropical environment is found in coastal areas of north Queensland, Northern Territory, north-west Western Australia, Papua New Guinea and the Pacific Islands, except where affected by salinity. Corrosivity in inland regions is generally low (similar to that of Category B), but the aggressiveness of the environment to organic coatings means special protection is required.

Note: If a site is considered to be in more than one category, for example an industry on the coast in a tropical region, then a selected coating should be capable of resisting the most severe of the environments involved.

Table B3 - Atmospheric Classification in Accordance with AS/NZS 2312:2002



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