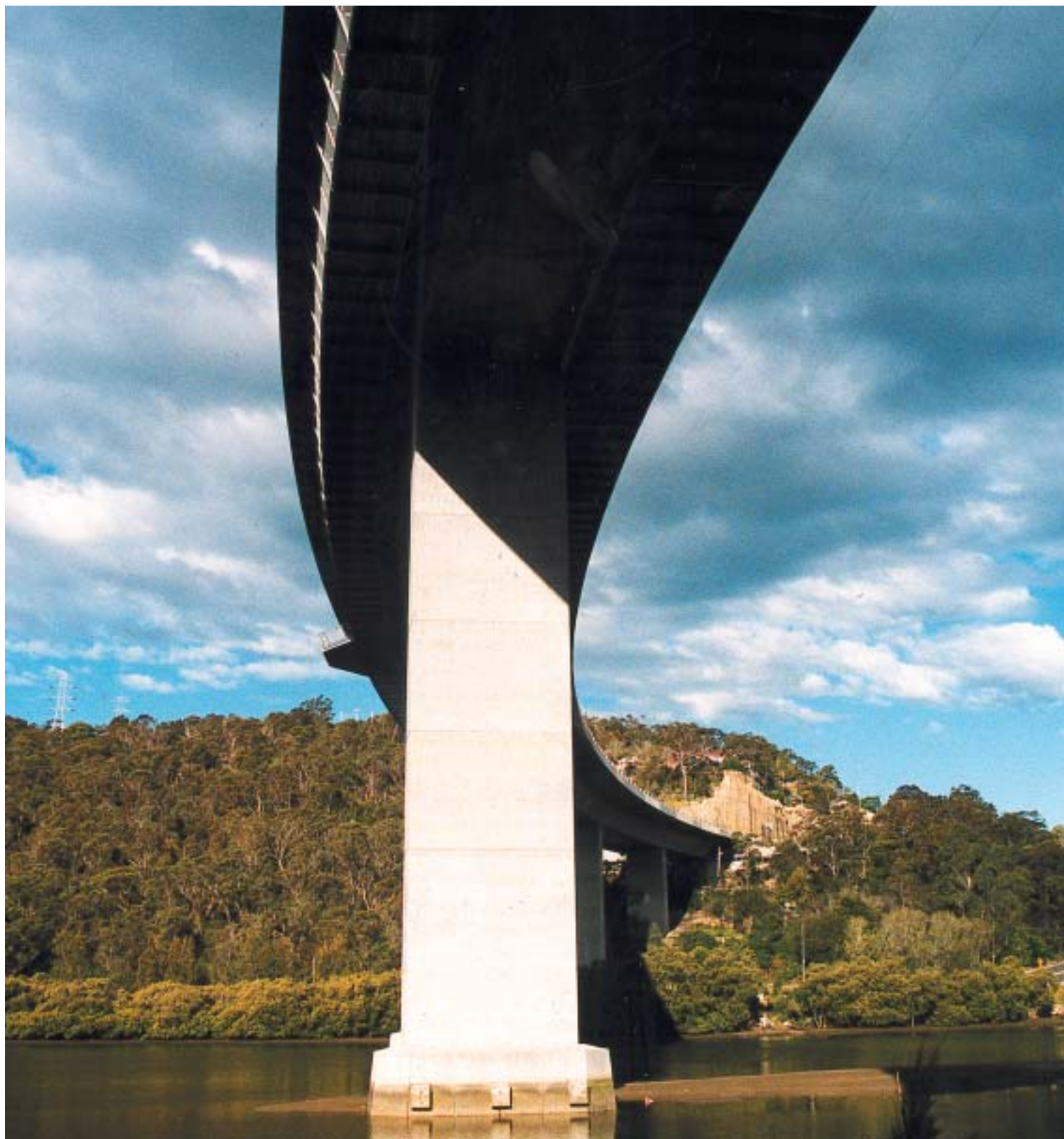


Bridge Aesthetics

Design guidelines to improve the appearance of bridges in NSW





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The information in this document is current as at July 2003.

Foreword

It is nearly four years since the RTA published *Beyond the Pavement: RTA Urban and Regional Practice Notes*. In that time the RTA has significantly changed the way it deals with the design of its roads and transitways.

In keeping with the *Beyond the Pavement* philosophy, this document addresses the design and appearance of our bridges in a systematic and practical manner. It draws from the wealth of design excellence in our bridge inventory as well as from past design problems.

It stresses that good bridge aesthetics need not be costly nor a maintenance burden, but are integral to good engineering design.

I commend these guidelines to the RTA and everyone involved in road and bridge design and look forward to the outcomes.



Paul Forward

Chief Executive, RTA

November 2003

Bridges have been part of human settlement for thousands of years. Historic bridges stand as evidence of the power and influence of past societies. They vary greatly in style and reflect the culture and engineering innovation of their society.

They show the daring, engineering skill and craftsmanship of their builders and even in the simplest bridges we can find inventiveness and subtlety in working with the local context.

Great bridges are audacious or beautiful enough to evoke wonder. Their primary function of linkage soon adopts a symbolic function.

A bridge in the landscape helps us interpret that landscape by providing a scale and a reference to human intervention. This was well defined by the famous Swiss architect Mario Botta when he said, "the bridge defines the valley".

Modern bridges exploit the latest technologies and construction techniques. They allow us to challenge the landscape in new ways and so impose our hand on the landscape. It is important to do so well. Our impact on the environment should be minimised, our understanding of the context should guide our solutions and our concern for design should consider the look as well as the span. In short, our bridges should be beautiful.

Major infrastructure will serve the community for many decades. It should not just last, but also provide a lasting legacy of excellence for future generations. Minor bridges at the least should have good manners, a low maintenance objective and a degree of finesse. This guide is intended to be a small step towards that goal.



Chris Johnson

Government Architect

November 2003

Introduction

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1.1 Purpose of the guidelines

'Bridges are among the most ancient and honourable members of society with a background rich in tradition and culture. For countless generations they have borne the burdens of the world and many of them have been great works of art. As in most large families there are numerous poor relatives. The modern bridge too often appears as a workman performing its task for a minimum wage, mechanically efficient but uneducated and ignorant of its own ancestry. A worthy subject for serious consideration.'

Charles S Whitney 1929

The purpose of these guidelines is to help design teams produce bridges of aesthetic value.

In addition, these guidelines will also help the RTA and its advisors set down unequivocal aesthetic outcomes so that consultants and contractors are made aware of RTA requirements and can focus on innovation in achieving those requirements.

The document is not intended for special iconic landmark bridges such as the Anzac Bridge which have their own design champions, but rather the more common road bridges which are an abundant and highly visible element of NSW highways.

A number of photographs of NSW bridges have been included. It is not the intention to critically evaluate these bridges but to use the images as lessons for future bridge design.

There are always exceptions to design rules and it is not the intention to provide a formula for good design.

'A formula is a good servant but a bad master at any time.'

Charles Holden

Rather it is the intention to set down considerations and principles, which will help, eliminate the worst aspects of bridge design and encourage the best.

Introduction



The twin bridges over Mooney Mooney Creek demonstrate how good engineering design and good aesthetics are synonymous.

1.2 Aesthetics

'Beauty has been thought of as extraneous to considerations of function, practicality, economy and advancing technology. To many the word 'aesthetics' has meant superfluous or artificial, like cosmetics.'

Paul Harbeson, Bridge Aesthetics

It is the intention of this work to encourage aesthetics to be considered as an integral part of the design process. Every part of the bridge has a role to play both structurally and aesthetically in the whole.

As such the document is based around the premise that there are a myriad ways to design and express structural form and additional or 'add on' treatments are generally unnecessary. Good bridge engineering and good aesthetics are synonymous and only limited by the imagination and skills of the bridge designer.

Finally it should be said that whilst personal tastes differ, beauty is not simply a matter of taste alone. When qualities such as proportion, order and symmetry are applied well, people often agree that the object has aesthetic value (whether they like it or not is another matter). When applied badly there is often public outcry.

1.3 The designers

The designers are responsible for the look of bridges, they must consider appearance as a major design imperative along with strength, safety and cost.

For aesthetics to be successful, it must first be considered. It should be an integral part of design and must be considered both in the general form and all the details that support it. The parts must be considered as to how they contribute to the whole.

Standard details when used need to be reviewed for their appropriateness to each project. They should be regularly updated.

The designers of bridges are faced with many choices. These guidelines aim to inform those choices and act as a memory jog during the design process. Aesthetic ability is a skill that can be developed, however, it must be seen as an essential requirement for that development to occur.

Introduction



The structure of the bridge over the Brunswick River at Brunswick Heads is not visible from the Pacific Highway, yet it forms a small but significant part of the landscape when seen from a local scenic viewpoint.

1.4 Perception of bridges

Bridges are seen from many angles and the viewers see them from a variety of conditions. Bridges may be isolated objects in the landscape, part of a suite of engineered infrastructure or on a city street. They are seen from close up, faraway, from rivers and other roads. Viewers can be standing still or moving to or across a bridge at varying speeds and in a variety of vehicles.

These guidelines assume viewing from all angles. The first step of the design process is to establish the critical views for the bridge. Further, there is the issue of illusion whereby the assembly of the parts can use visual devices to enhance the bridge by emphasising its apparent slenderness or visual continuity.

Generally bridges seem aesthetically more pleasing if they are simple in form, the deck is thinner (as a proportion of its span), the lines of the structure are continuous and the shapes of the structural members reflect the forces acting on them.

Introduction

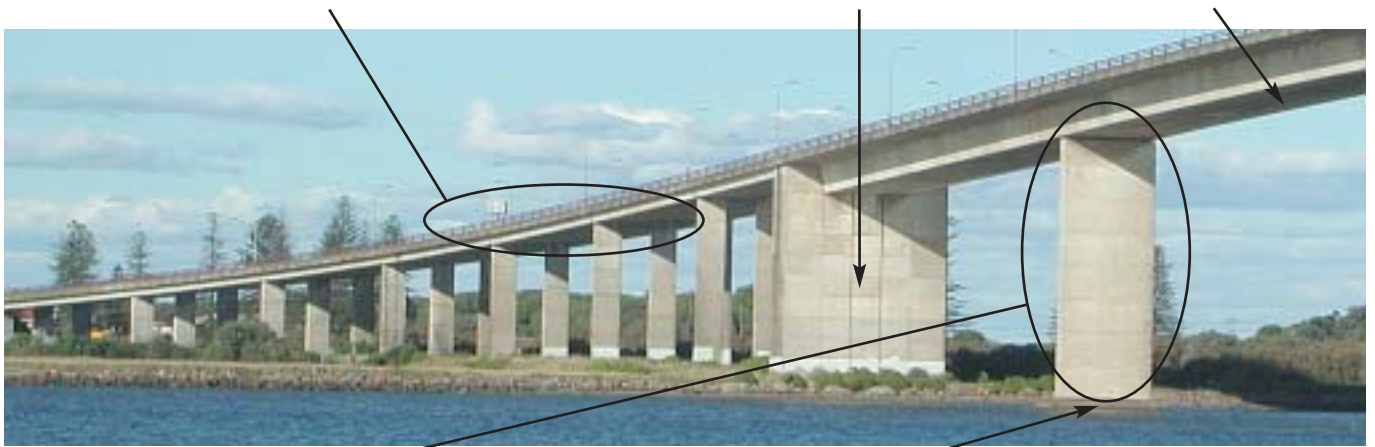
1.5 Terminology

A problem that can hamper meaningful debate between designers is consistency of terminology. The following annotated photographs set down the terminology used throughout these guidelines and should be understood by all involved in the bridge design process. (Definitions sourced from RTA Structural Drafting Manual and the RTA Road Design Guide).

Superstructure – that part of the structure which supports traffic and includes deck, slab and girders.

Transition pier – pier separating different superstructure types.

Soffit – undersurface of the bridge superstructure.



Substructure – that part of the structure, ie piers and abutments, which supports the superstructure and which transfers the structural load to the foundations.

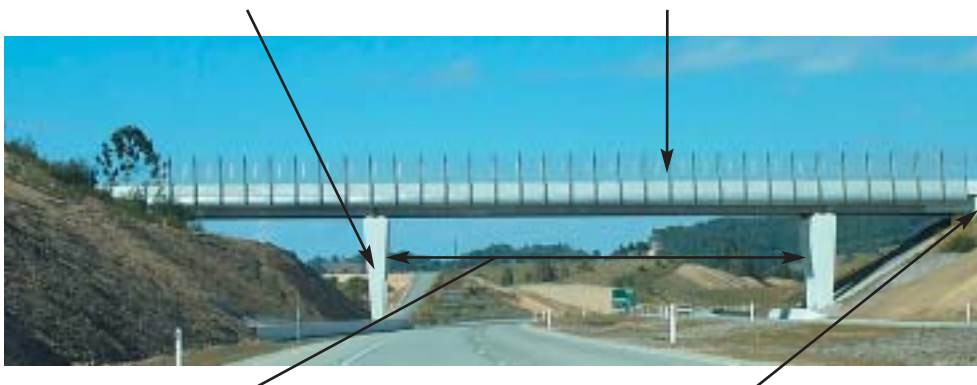
Pile cap – A reinforced concrete mass cast around the head of a group of piles to ensure they act together and distribute the load among them.

Pile – a slender member driven into or formed in the ground to resist loads.

Pier – a part of the substructure which supports the superstructure at the end of the span and which transfers loads on the superstructure to the foundations.

Safety / throw screen – protective fence to deter the launching of objects from the bridge onto the highway below.

Deck – bridge floor directly carrying traffic loads.



Span – the distance between points of support (eg piers, abutment).

Abutment – the part of the structure which supports the superstructure at its extremities and retains earthworks.

Spill through abutment – an abutment which allows fill to form a slope into the end span rather than retaining it with a face wall.



Traffic barrier

Parapet – low protective concrete wall at edge of bridge deck.

Railing – on top of parapet to restrict lateral movement of traffic.

Introduction



Plank bridges – bridges which utilise a simple concrete plank and cross support construction system.

Planks – structural units.



Haunching – increase in the depth of a continuous beam at the point of support to withstand the increased moment of bending on the beam.



Parapet – (outer face).

Bearing – a component which supports part of the bridge and which transmits forces from that part to another part of the structure whilst permitting angular and/or linear movement between parts.



Pedestrian barrier – a railing placed on edges of bridge structure for pedestrian safety.

Pier Cap / Headstock – a component which transfers loads from the superstructure to the piers.

Beam / Girder – load bearing member which supports the deck.

Design approach

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Design approach



Each of the overbridges along the Hume Highway are part of distinct families of bridges.

2.1 Design values

The following design values are important to creating a bridge of aesthetic merit and should run through the design process from inception to delivery.

1. Commitment to aesthetics.
2. Context sensitive design.
3. Comprehensive design process.
4. Collaboration in the design team.
5. Cost and aesthetics can be complementary.

2.1.1 Commitment to aesthetics

A commitment to aesthetics is needed from both the client and contractor. A valued bridge is not likely to be produced if aesthetics is not championed and adequately weighted in selection and assessment processes. Furthermore this commitment must be carried through the implementation process, as a well designed bridge can be marred by poor workmanship.

2.1.2 Context sensitive design

The aesthetic value of a bridge is dependent on its context. A bridge may be acceptable or beautiful in one location whilst unacceptable or ugly in a different location. Starting the design process by picking a bridge design, before understanding its context, is therefore inadvisable.

Beautiful and locally valued bridges are more likely to be produced if the design process starts when the natural, built and community context is understood and significant constraints identified.

A family of bridges

The appearance and proximity of other bridges is an important contextual factor.

New bridges generally become part of a family of other bridges along a route. The impact and relationship to this family should be considered.

Where a new bridge is located in close proximity to an existing bridge, special attention must be paid to their relationship. The new bridge should respect the role, form and design of the existing bridge.

Design approach



This bridge was a halfway landmark on the Hume Highway. Although bypassed it can still be seen from the highway and is now a part of the history of the area.

Visibility

Visibility of the bridge is an additional important contextual factor.

A bridge which is looked on by the community needs to be carefully considered in terms of its impact on residents or road users. However if 'only the cows' can see a bridge it does not mean that aesthetics should not be considered. Sound aesthetic principles need not be costly and situations can change. Bridges are built to last and the development of new roads, footpaths, buildings and settlements within a bridge's viewshed are likely within its lifespan.

2.1.3 Comprehensive design process

The aesthetics of a bridge should be considered at the conception of a project and through every stage of development. Aesthetics is not something that can be added on at the end, it is the final product of the planning, design and procurement process, from initial route selection, through environmental assessment, to detail design and construction.

2.1.4 Collaboration in the design team

A lack of collaboration in the design process will affect the aesthetic outcome. Collaboration can only be achieved if design professions understand and value each other's role in the design process. Those concerned with the visual qualities of a bridge must work alongside those concerned with the engineering and economic aspects of a bridge.

Likewise a balance must be achieved between the requirements of the road engineers and the bridge engineer. Forcing a bridge to fit a road alignment can lead to aesthetic problems. It is better to allow some flexibility in the road alignment to achieve a good fit between bridge and landscape.

2.1.5 Cost and aesthetics can be complementary

Bridges of aesthetic merit need not be more expensive than ugly bridges.

For example the shape of a parapet, abutment or pier might have a negligible impact on costs but a significant improvement visually.

However if a bridge is designed to be as cheap as possible then it is unlikely that it will be of aesthetic value. This is not to say that the cheapest bridge is necessarily the ugliest bridge, however it does mean that cost and aesthetics as driving forces in the design process need to be balanced.

'It is unwise to pay too much. But it is worse to pay too little... There is hardly anything in the world that someone can't make a little worse and sell a little cheaper and people who consider price alone are this mans lawful prey.'

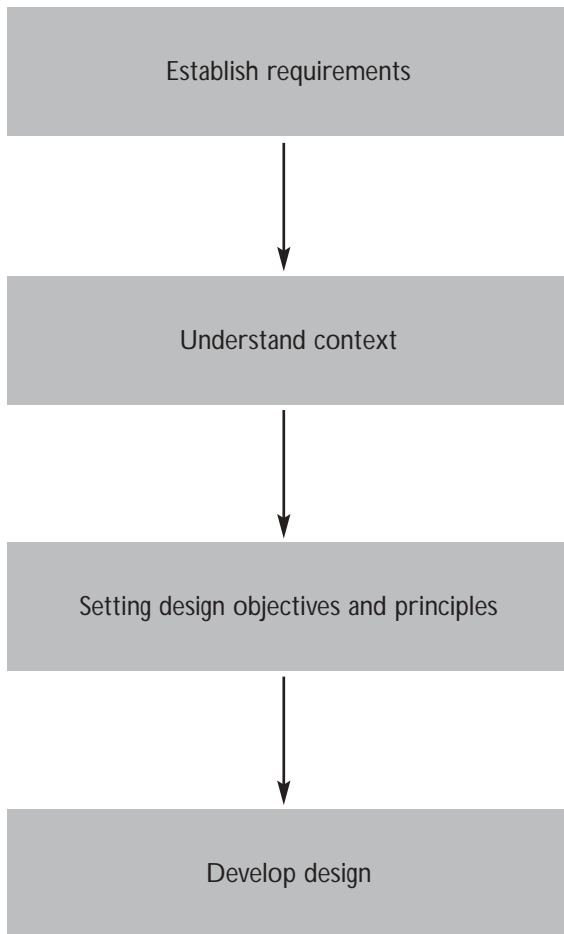
Ruskin

This interrelationship between cost and aesthetics becomes more pronounced when the whole life cost of a bridge is considered. When this is the case materials are often used wisely with consequent refinement and elegance.

Maintenance costs

The RTA is responsible for over 17,700km of road and 4500 bridges. The resources required to maintain these assets are considerable. Therefore, for reasons of cost and sustainability, it is incumbent on designers, in all design stages, to address the maintenance burden placed on the future custodians of the bridge. This aim does not frustrate the creation of a beautiful bridge. Simple, elegant and refined bridges are likely to be sustainable and self-reliant also.

Design approach



2.2 Design methodology

The following process and checklists should be addressed in the methodology of designing a bridge.

In the case of simple, small span, plank bridges, this method may be circumvented and a review of the applicability of the principles in this document will be sufficient to assist in ensuring a quality design outcome.

2.2.1 Establish requirements

An understanding and appreciation of the unavoidable transport and functional requirements of the bridge.

For example:

- The level of flexibility in the vertical and horizontal road alignment.
- The span and load requirements and considerations of most appropriate superstructure type.
- Signage and lighting requirements.
- Safety barrier criteria.
- Traffic volumes and speeds.
- Pedestrian cyclist and public transport requirements.
- Environmental requirements.
- Political issues.

2.2.2 Understand context

An understanding of the natural, built and community context of a bridge that would influence the design.

- Topography, water bodies and water courses.
- Other bridges in the area and along the road corridor.
- Soils and geology.
- Biodiversity.
- Views to and from the bridge location.
- Local vernacular.
- Landscape and built character.

2.2.3 Setting design objectives and principles

Broad objectives regarding the outcome of the bridge and approaches stemming from stages 1 and 2.

- Unobtrusive or landmark?
- Integration with landscape.
- Proportions: symmetrical slender / stocky.
- Simple/refined.
- Conform to suite of bridges along corridor.

Design approach



Photomontage of the bridge over the Karuah River.

2.2.4 Develop design

If the concepts and design development of the bridge naturally flow from the project requirements, context and objectives then a rationale can be seen for the bridge design.

In an **environmental assessment report** (EIS or REF) the following information should be considered to illustrate the bridge.

- Plans of the bridge approaches and bridge in context.
- Elevations of the bridge illustrated with background context.
- Cross sections, axonometrics and models illustrating three dimensional shape and proportions of piers, pile caps, abutments, parapets, beams.
- Typical details illustrating barriers connections between barriers, jointing, lighting, signage and landscape.
- Artist illustrations and photomontage of the bridge structure as seen from the highway and surrounding key viewpoints.

In a **design and construct contract** a 'define and capture' method should be adopted.

Define

The design objectives and principles in these guidelines should be used to inform the development of the performance specification for the contract and must be stated clearly and unequivocally.

Capture

This performance specification must be supported by a list of information requirements including drawings and schedules, to be provided by the proponents. These must be in sufficient detail to assess and capture the design. (Drawing scales and sizes must be defined in the tender documents to allow comparison between tenders and ensure capture).

The whole

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Bridge over Middle Harbour at Roseville. The simple elegance of the structure complements the landscape of the National Park.

3.1 Context sensitive design

All design requires an understanding of its context. With bridges the immediate setting offers both constraints and opportunities that must be considered in the design process. Issues such as landform, landscape, near and distant views should all be considered.

Context sensitive design is something that tended to happen naturally in the past.

For example it would have been rare to use anything but local materials. Local labour would have particular ways of using those materials. Both materials and labour would have had to be used wisely.

Furthermore major earthworks would have been difficult, bridges and highways would have had to respond to the local landform to a greater extent than today.

Perhaps most importantly design standards were not so exacting. Due to rapid changes in vehicle design, public spending and safety awareness, design has become very sophisticated and precise. Cambers, super elevation, sight lines, drainage, barriers and other requirements all encourage a centralised design approach rather than a site specific one.

However design sensitive to context is valued by communities. Structures and landscapes that fit and enhance context are good for community pride and local identity, they are often more sustainable and self-reliant.

3.1.1 Bridge type

Perhaps the most fundamental response to context is the choice of bridge structure.

This choice is affected by many contextual factors including the following.

- The size of the span required.
- The topography either side of the span.
- Local geology.
- The load to be carried.
- The nature of the load.
- The nature of the land or water being crossed.
- The visibility or visual presence of the structure.

It should be understood that all these factors will have a powerful influence on the choice of bridge type, however in most instances it is span length that is the most significant factor in determining the form (and cost) of a bridge.

The whole



Bridge over the Georges River at Alford's Point. The minimal profile maximises views of the landscape.



Bridge over the Woronora River at Alford's Point. The minimal profile maximises views of the landscape.

The accepted approximate relationship between span and superstructure type is as follows.

- Short span (up to approximately 18m): pre-stressed concrete plank bridges.
- Short to medium span (approximately 18-40m): pre-stressed concrete girders or pre-stressed concrete voided slabs.
- Medium span (approximately 40-80m): steel or post-tensioned concrete box girders or incrementally launched girders.
- Medium to long span (up to approximately 300m): balanced cantilever.
- Long span (up to approximately 800m): cable stay.
- Very long span (longer than 800m): suspension bridges.

These values are only a rule of thumb and are likely to be challenged by new technology and lateral thinking, however it is important for the design team to recognise these relationships and the consequences of working outside them.

3.1.2 Bridges in the landscape

There are a number of ways to approach bridge design in landscape settings these include the following.

1. Make the bridge as invisible as possible to hide it in the landscape.
2. Make the bridge as distinctive as possible to contrast and stand out in the landscape.
3. Make the bridge as simple and elegant as possible to complement the landscape.

The first of these approaches, although suited to smaller bridges, does not always encourage good design. The second approach can be expensive and perhaps better suited to urban situations. The third approach is a practical, cost effective objective for overpasses and larger bridges and can lead to good looking bridge solutions.

In areas of high scenic value the following principles should be considered.

Maximise views of the landscape through the bridge.

Minimise the profile of a bridge to allow the landscape setting to dominate the view and be appreciated from all viewpoints.

The whole



The twin bridges over the Mooney Mooney Creek employ a two rail parapet which optimises views of the landscape.



The slung footpath on the bridge over the Woronora River allows dramatic views of the valley. A widened viewing area in the middle of the bridge allows pedestrians to stop and appreciate the structure in its setting.

The view from the bridge towards the surrounding landscape setting should be maximised.

Allowing good views of the landscape from the bridge helps establish milestones and landmarks on the route, makes the most of the height of the bridge, improves road user interest and helps make drivers more alert and aware of their surroundings.

For example a view of a river landscape creates a far more impressive and natural gateway between landscape types or political boundaries than any contrived feature.

The requirements of cyclists and pedestrians and motorised road users will vary and the bridge design should take account of the variation in time it takes to cross the bridge for different bridge users.

The whole



The simplicity of this bridge in Queenstown, New Zealand provides an appropriate contrast against the rugged mountain backdrop.



The simple uncluttered shape of the twin bridges over Mooney Mooney Creek does not detract from the natural bushland of the Hawkesbury valley.



The horizontal and symmetrical nature of the rail bridge over the Hawkesbury River complements the landscape. (The oddly positioned piers in the background are remnants from an old bridge).

The complexity of a bridge should be minimised in a natural landscape setting.

Complexity tends to attract the eye and competes with views of the landscape. A simple structure frames the landscape and provides an aesthetically pleasing contrast with the natural textures of the backdrop.

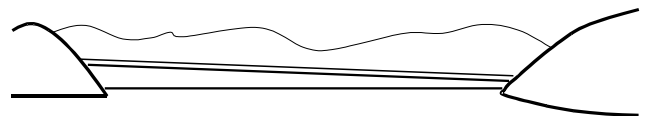
Minimal facets and simple shapes provide a good landscape contrast. Accentuating the primary elements of a bridge and reducing road furniture to the barest minimum is also important.

Landscape tones are generally subdued and dark, therefore light colours (for bridge primary elements) provide a good contrast.

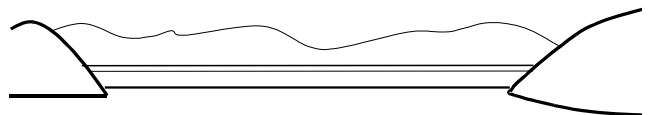
Bridges with a horizontal form are generally preferable to bridges on a grade over flat simple landscapes and significant expanses of water.

If this is unable to be achieved due to differing levels either side of the water body then fine tuning the location of the bridge should be considered, or adjusting the levels along the bridge approaches.

Water always forms a horizontal plane and a structure, which is skewed to this plane appears discordant.



This may be because it introduces another plane adding unnecessary complexity. Consider a horizontal bridge in the same location.



The whole



The giant tingle trees in Western Australia are the sole reason for the valley of the giants Tree Top Walkway.



Designing the bridge so that planting is located on the bridge structure itself, further integrates nature and structure. This bridge on the Pacific Highway, Yelgun to Chinderah upgrade provides a wildlife connection and will ultimately have a visible vegetation cover on the deck.



Rail bridge over the highway at Coffs Harbour.



Landmark pedestrian bridge over the M4, Sydney.

Natural vegetation should be protected and recovered.

The aesthetic value of a bridge will be greatly enhanced if the natural bushland around the bridge is protected and recovered.

- By the careful siting and design of the bridge and approaches, so that significant stands of existing vegetation are retained.
- By minimising the footprint of the bridge (eg pile caps, abutments) so that the retention of local vegetation is maximised.
- By minimising the presence and extent of intermediate structures and hard surfaces between the bridge and landscape.
- By recovering local habitat, in the landscape around the bridge, through careful design of earthworks and planting and the selection of endemic species grown from locally collected seed.

3.1.3 Urban bridges

The urban environment usually has more hard surfaces and vertical elements. The volumes of traffic may require a larger bridge. From the road the bridge is usually seen at lower speeds than from country highways.

An achievable objective when resources are limited is to ensure the bridge complements the local vernacular and benefits the local community.

Some design considerations which could help deliver this objective include the following.

- Creating a landmark structure which complements or contrasts with its visual catchment.
- Maximising views from the bridge of the local urban setting.
- Maximising views through the bridge from the urban setting.
- Minimising visual impacts.
- Designing a well proportioned pleasing structure.
- Respecting locally valued structures and their curtilages.
- Complementing local styles and materials.
- Ensuring the spaces under the bridge are not dark, degraded and unsafe.

The subsequent parts of this document provide guidance on all these principles.



An overbridge with a slenderness ratio of approximately 1:12.



Captain Cook bridge, a slenderness ratio of approximately 1:18.



A simple pier and girder bridge, which without the noise walls may have appeared more slender. The visual slenderness ratio is approximately 1:6.

3.2 Form

3.2.1 Proportion

The dictionary defines proportion as the proper relationship between things or parts. Proportion is also a ratio or comparison of the relative size of one thing to another. But what does 'proper' mean?

Certainly the designer needs to think about proportion, a random, thoughtless approach to the proportion between different elements of a bridge is unlikely to lead to an aesthetically valued structure. However there are no hard and fast rules as to what is good proportion, a designer may have a natural flair for proportion or require years of study, experience and observation.

However guidelines can be provided which help eliminate some of the worst ratios between bridge elements and assist in achieving 'proper' proportion. Nevertheless all of these guidelines will have an exception, such is the nature of design.

- Using excessively imbalanced proportions between significant elements should be considered carefully.
- Repeating similar proportions or ratios throughout a structure can lead to a harmonious structure.
- The proportion between depth of superstructure and bridge spans is an important ratio. It is referred to as the slenderness of the bridge and is defined as the span length divided by beam depth.

Common ratios can vary from five to 30. The ratio of five can result in a very chunky bridge although with appearance of strength while 30 can lead to very slender bridge. For a common pier and girder bridge, ratios generally vary between 15 and 20.

However it is important to differentiate between the slenderness ratio and the visual slenderness of a bridge which can be affected by solid parapets and opaque noise walls on top of the superstructure.

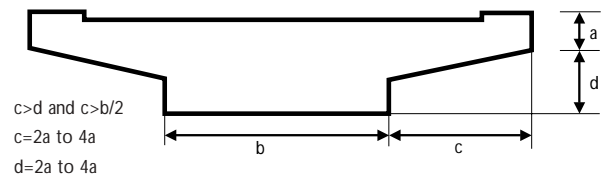
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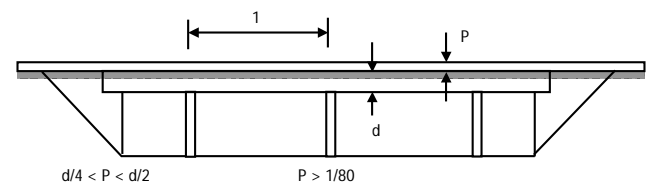
The proportions of elements in the cross section of a bridge are an important aesthetic consideration. (Bridge over the Hunter River at Stockton).

Furthermore a high slenderness ratio does not necessarily indicate a good appearance. It is a guide only and the setting and scale of the bridge can influence whether slenderness or 'chunkyness' is appropriate.

- The ratio of pier dimension to superstructure depth should also be considered carefully. Bridges with thin piers relative to superstructure depth can sometimes appear odd.
- The ratio of deck overhang relative to parapet depth is also considered a significant aesthetic proportion and guidelines have been developed by Cardiff University School of Engineering.



- A ratio has been developed by Frederick Gottemoeller in his book for the relationship between span and depth and parapet height. These formulae form the basis for a guide to visual proportions.



The whole



The outer spans of this bridge are not the same dimension and the symmetry of the bridge is affected.



Rock abutment in contrast with the smooth concrete superstructure creates a simple and appropriate outcome. (Bridge over the Karuah River at Karuah).

3.2.2 Symmetry

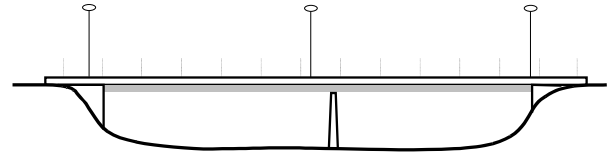
Another important aspect of form is symmetry. Symmetrical bridges are often more aesthetically pleasing than non symmetrical bridges and symmetry should not be departed from unless for a good reason.

3.2.3 Order and rhythm

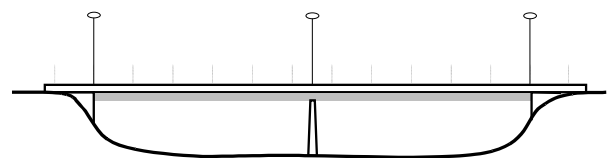
Designing a rational order and rhythm to a bridge and its parts can improve appearance. A designed order to individual bridge elements can look more pleasing than chaotic randomness.

Developing a rhythm to the bridge is also important, for example, spans should match where possible or at least demonstrate a consistent order. The cumulative effect of all bridge elements including lighting columns, barrier supports and piers should be considered.

For example all the bridge elements can be well designed but lacking an order and rhythm creates a discordant appearance.



However rearranging the parts provides an ordered and pleasing whole.



3.2.4 Contrast and harmony

'Sometimes referred to as tension and release' a departure from order – but with artistic sensitivity – can create pleasant poetic tension.'

Mies van der Rohe

For example natural features such as vegetation, stone or landform can create a good contrast with the order, precision and simplicity of a concrete bridge.

The whole



The consideration of the vertical pier to separate the varying deck depths, the recessed girders to catch the shadows, and the continuous parapet all well resolve a difficult junction.



The attention to detail on the 1939 upgrade of the suspension bridge at Northbridge is exemplary.

3.2.5 Simplicity

Refinement of design should generally be pursued. Embellishments and ornamentation often do little to change the basic aesthetics of a structure.

Refinement of a structure so that it better represents the forces that it is designed to withstand is generally a feature of a bridge of aesthetic merit. This is often referred to as honesty of form and design integrity.

However it is unwise to insist that a bridge is perfect only if nothing can be omitted and there may be good reasons for avoiding total refinement based upon local context.

3.2.6 Unity of design

A bridge is a whole not an assemblage of parts. Neglecting the whole or the parts will result in an unsuccessful bridge in aesthetic terms. Consequently consider the parts as to how they contribute to the whole of a bridge.

The approaches to the bridge are an integral element of the whole bridge design and must be considered in the design process.

The landscape design, the approach road design, and all the associated signage contribute to the bridge design as a whole.

3.2.7 Consistency along the corridor

Consistency of form is an important aesthetic consideration. This is not to say that everything must look the same but that in a particular context there should be a relationship between elements in terms of materials, proportion, colour or details.

This aesthetic aspect is very important when the bridge structure is but one element in a road corridor and a degree of consistency is desirable along the corridor.

3.2.8 Detail is important

Good detailing is essential to good bridge design and lack of attention to detail can spoil an otherwise beautiful bridge.

Careful consideration of interrelationship of each element, and their relationship with the whole is necessary at all stages of the design process.

The parts

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The parts



Bridge over Woronora River at Sutherland. The line of the parapet is an important bridge element. It is sharp, smooth, catches the light, helps provide shadow and unifies the structure.



Overbridge in Canberra. The continuous, clean lines of the parapet, which continue past the abutment, help visually anchor the bridge in the landscape.

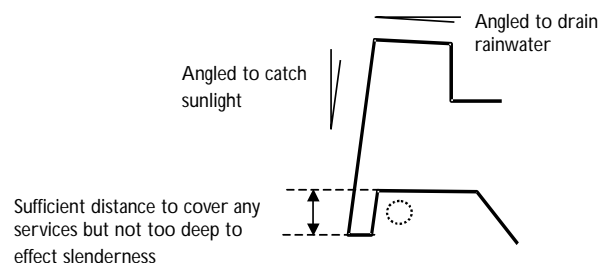
4.1 Superstructure

4.1.1 Parapet

The outer face of the parapet can be one of the most important aesthetic elements of a beam bridge. It is the highest piece of the bridge and often the most dominant in long distance views. It can also be the longest piece of the bridge and as such an opportunity to express the span and horizontal nature of the structure.

The following principles should be considered in the design of the parapet.

- They should appear as continuous uninterrupted lines, extending the full length of the bridge with a generous overlap of the abutments.
- The proportions between their depth, the deck overhang and the girder depth should be carefully considered (see section 3.2).
- A neat, sharp edge will help define them against the background.
- Maximising the shadow cast on the superstructure will further accentuate and express their form.
- The outer face should be a smooth single plane surface, slanted slightly outwards towards the bottom, to better catch the sunlight.
- The top should angle towards the road, to channel rainwater onto the bridge, minimising staining of the outside face.
- If the deck soffit is visually complex, consideration should be given to hiding this complexity, by extending the parapet soffit below the deck soffit.



The parts



Haunched girders on the twin bridges over Mooney Mooney Creek, NSW.



Haunched girder on bridge over the F3 Freeway at Blackhill Road, near Newcastle. The haunching is made less elegant by the abrupt angle of transition between haunched section and horizontal beam. (Also note the solid parapet and its effect on bridge slenderness).



Three span haunched girder on the twin bridges over Mooney Mooney Creek, NSW.



Simple single depth beam on bridge over the F3 at Cowan, NSW.

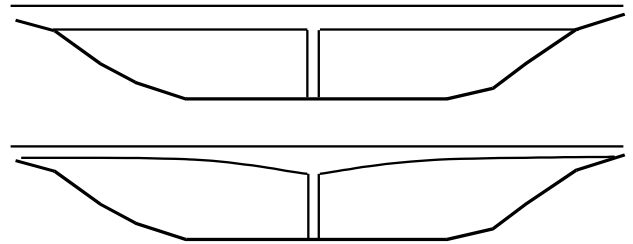


Haunched girder on bridge over Taren Point Road. It is unfortunate that the planting design is not integrated with the bridge design and obscures the fact that the bridge is a single span.

4.1.2 Girder

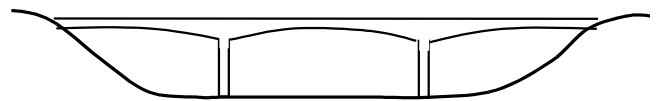
Girder elevation

Haunched girders are expressive and responsive to the forces in the bridge. They can often be more distinctive and elegant than single depth beams.

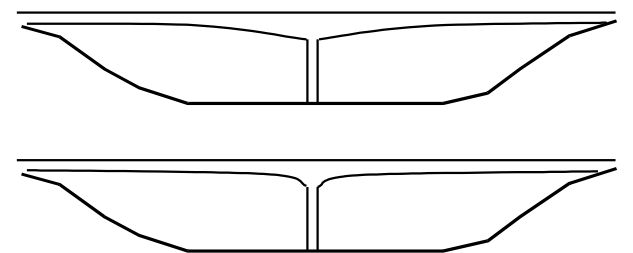


The following principles should be considered in the design of haunched girders.

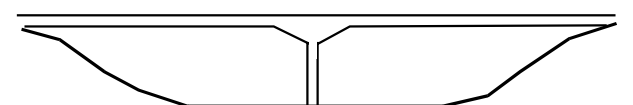
- Three or five span span haunches are aesthetically very elegant balanced structures.



- Long haunches smoothly tapering out are much more graceful and responsive than short abrupt haunches.



- Avoid a sharp angle between haunch and beam.



Even with single spans curving the girder can provide an expression of elegance.

The parts



Bridge over the Hunter River at Stockton shows the effect of a right angled girder shape in afternoon sunlight.



Bridge over the Hawkesbury River at Brooklyn. The angled girder increases the shadowing effect and emphasises the bridge deck and parapet.



Deep overhang and acute angle of deck on this bridge on Victoria Road at Huntley's Point.



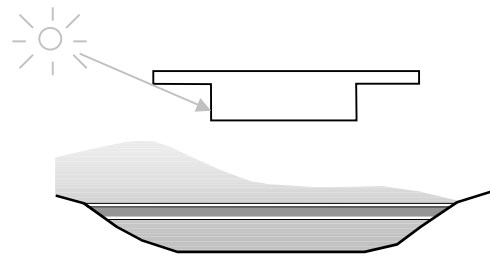
Curved soffit on the Pacific Highway bridge over the Camden Haven River near Port Macquarie.

Girder cross section

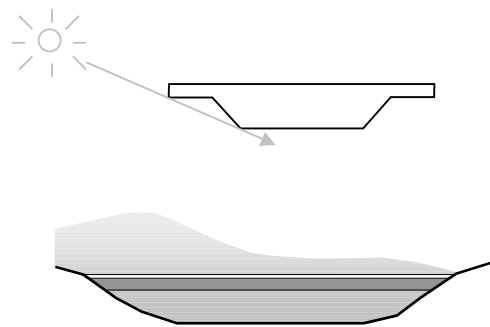
Different girder cross sections can have different aesthetic effects. The cross sectional shape of the girder should be considered in accordance with the following principles.

A right angled connection can catch the light and a double line may be visible.

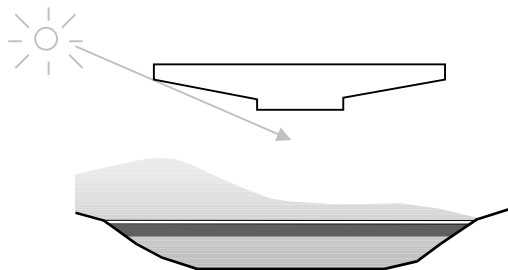
Maximising the overhang will increase the shadow.



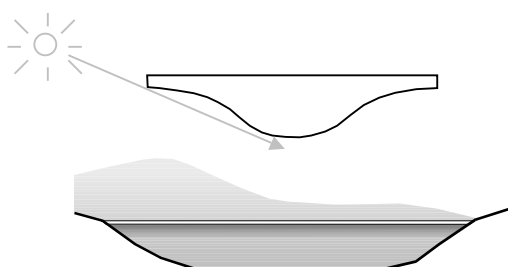
An angled connection will minimise this effect.



A very acute angle provides a deep shadow nearly all of the time.



A curved soffit will provide a gradation of tone and minimise a sharp line at the base of the beam.



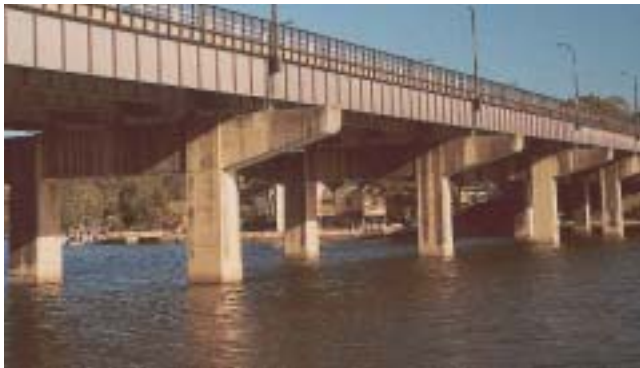
The parts



The pier and headstock combination on this bridge over Darling Harbour provides a reassuring impression of strength as well as a high degree of permeability for light and pedestrian movement.



The headstock and pier combination on this bridge adds unnecessary complexity and detail.



The headstocks on this bridge over the Lane Cove River, Sydney are well considered and integrally designed bridge elements.



The large headstock design on this bridge over the F3 covers the gap between girders, required to accommodate mining subsidence. Its presence lacks elegance, particularly on short piers.

4.2 Substructure

4.2.1 Headstocks

Headstocks transfer the load from multiple girders to the pier.

When they are used they draw attention to the pier and the method of support, if avoided they better allow the superstructure to dominate the bridge view.

The aesthetic value of the headstock is dictated by context.

A headstock in an urban setting or a setting where vertical forms are present and only close views available, may provide a reassuring sense of strength and durability, as well as visual interest.

Headstocks in a rural open setting or a setting where horizontal forms predominate, can be overly complex and should be carefully considered and designed with their visual impact in mind, or avoided.

On over bridges in rural locations, wall type piers rather than headstocks, should be considered.

If possible headstocks should not extend across the outer face of the girder. This introduces unnecessary complexity and appears in elevation as if the headstock is supporting the deck rather than the girder.

The parts



Plethora of piers on bridge over inlet to Lake Illawarra.



Graceful pier spacings on Captain Cook Bridge over the Georges River.

4.2.2 Piers

Longitudinal pier spacing

Pier choice will be affected by the balance of superstructure cost against pier cost.

Too many piers can appear cluttered, while too few piers can result in an overly dominating deep beam.

A balance is required which should respond to the best structural form and the wisest use of resources.

A slender appearance depends on the context and the ratio of span to superstructure depth (see section 3.2). However it should be considered that barriers and noise walls can make the superstructure depth appear to be deeper than it needs to be, whilst heavy shadow from the deck and curved soffits can reduce the apparent depth of the superstructure.

Bridges which have pier spacings or spans which are roughly proportional to the bridge's height above ground level are subtly more aesthetically pleasing than bridges which do not follow this proportion. They seem more responsive to their context.

The parts



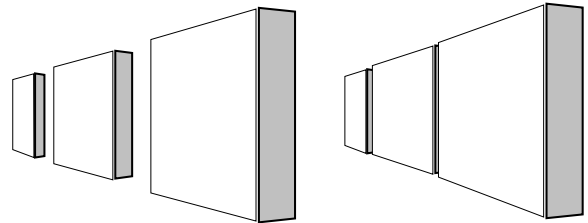
Multiple piers on the bridge over the Tarban Creek are visually distinctive and help create a strong sculptural effect.



Multiple piers both along the bridge and across the bridge can be a significant feature of a bridge and if well designed can provide character and great strength. (Twin bridges over the Mooney Mooney Creek).

Multiple piers

Where multiple piers are used consideration should be given to allowing them to be read as separate elements. When placed too closely multiple piers can appear complex or wall like.



Piers should be able to be read as separate elements, clearly the angle of view will vary this effect and for acute angles a round pier cross section will exist.

Single pier units are simple, reduce the number of elements in the view and allow the superstructure to dominate.

Whereas multiple piers can provide a sense of strength and durability and provide interest and character.

The selection of multiple or single piers should be a consequence of the context and the requirements of the bridge.

Collecting multiple piers into pairs or clusters can open up views below the deck and also give rhythm and elegance to the supports.

The parts



Sharp crisp lines and well defined edges are a feature of the bridge over the Hunter River at Stockton.

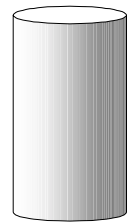
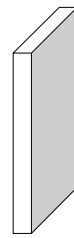


Clean, well designed rounded ends on the piers on this bridge over the Hume Highway complement the bridge and rural setting.

Pier cross section

Pier shapes with only two lines of symmetry (eg rectangles or ellipses) and transverse to the centreline of the deck are preferable to squares and circles as they present the thinnest edge to the side view.

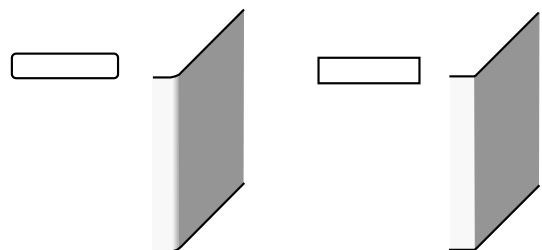
Elliptical shapes have the additional feature of providing a softer graduated reflection of light when seen in elevation.



Where complex shapes are used, such as a rectangle with semi circular ends, care must be taken to ensure a consistent smooth finish. Joints in shuttering and different colour and finish between concrete pours can cause visual problems.

Rounding off the corners of rectangular piers provides a softer form, which may be preferable in certain contexts. For example where the presence of the pier needs to be down played so that superstructure is dominant, eg in a rural setting.

A sharper edge may be preferable where the pier is to be accentuated because it is the dominant element, for example in an urban context or where piers are particularly high.



The parts



The piers of the bridge over the Woronora River have a slight taper of 1:100 sufficient to demonstrate refinement economy and elegance.



The shorter piers on this bridge over the F3 Freeway are also tapered.



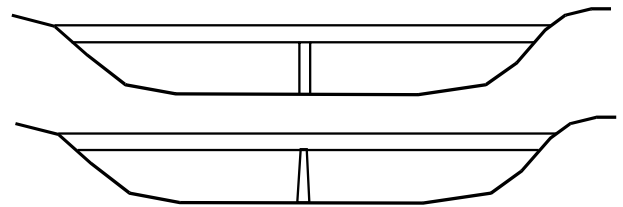
Bridge over the Pacific Highway on the Yelgun to Chinderah upgrade. The reverse taper appears refined and well detailed. It creates an impression of strength and solidity between pier and superstructure and eliminates the need for a headstock.

Also of note is the safety screen, which extends to the ends of the span.

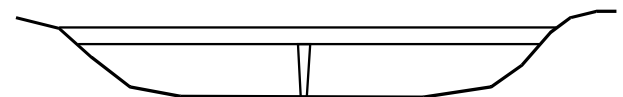
Pier short elevation

Where it is important to accentuate the horizontal linear form of a bridge, pier shapes which have a slight taper can add elegance by visually adding weight to the bottom where stresses are greatest.

They appear more refined and have a lighter connection with the superstructure. They also respond in design terms to the forces acting upon them, demonstrating refinement of form and economy of material. A taper of around 1:80 is desirable.



A pier with a reverse taper creates a quite different impression indicating a strong connection between superstructure and pier, rather like a table leg. The point of contact with the ground is accentuated rather than the pier to superstructure contact.



The appearance suggests a strong resistance to forces along the bridge and because the pier and girder have such a solid visual connection the effect of a horizontal 'floating superstructure' is not as apparent. The reverse taper has the advantage of being used to provide a wide support where two girders meet.

However the reverse taper should only be used where the appearance of rigidity is required between superstructure and pier. Otherwise the appearance of the top heavy pier can be imbalanced and does not reflect the forces acting on the pier well.

The parts



With the opposite taper the shape difference between pier heights is not so apparent, possibly because attention is focused on the point of contact with the superstructure.

Furthermore with piers of varying heights, differences between pier shapes are more marked with the reverse taper, whether the angle of taper is kept constant or the top and bottom dimension of the pier is kept constant. Pier shapes can vary from almost triangular to tall and slender (see left).

The combined effect of tapers on both short and long elevations should be considered bearing in mind simplicity of form.



Tapered piers on Sydney Harbour bridge are of varying height yet a consistent angle and top dimension is maintained.

The parts



The piers on the bridge over the Georges River at Tom Uglys are reminiscent of the bow of a ship. They are well proportioned and suitably simple considering the proximity of the adjacent truss bridge. (The taper on the piers is 1 in 8).



The bridge over the Georges River at Alford's Point also displays a taper although with the addition of an open pier.



The bridge over Georges River.



The bridge over Victoria Road at Huntleys Point.



Yelgun to Chinderah, Pacific Highway upgrade.

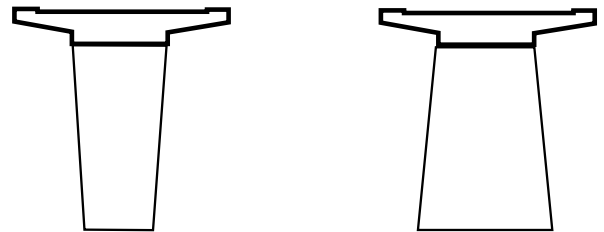
Pier long elevation

The long elevation of the pier can also be tapered.

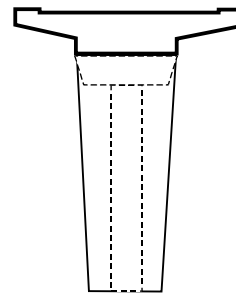
Again a taper can appear elegant and better represents the structural forces acting upon the pier.

However in the long elevation the taper has a different effect. Whereas in the short elevation the top taper is generally preferable to the reverse taper, in the long elevation either taper is acceptable.

A strong rigid connection between pier and superstructure can be desirable with a light connection to the ground or a wide splay on the ground supporting any side forces.



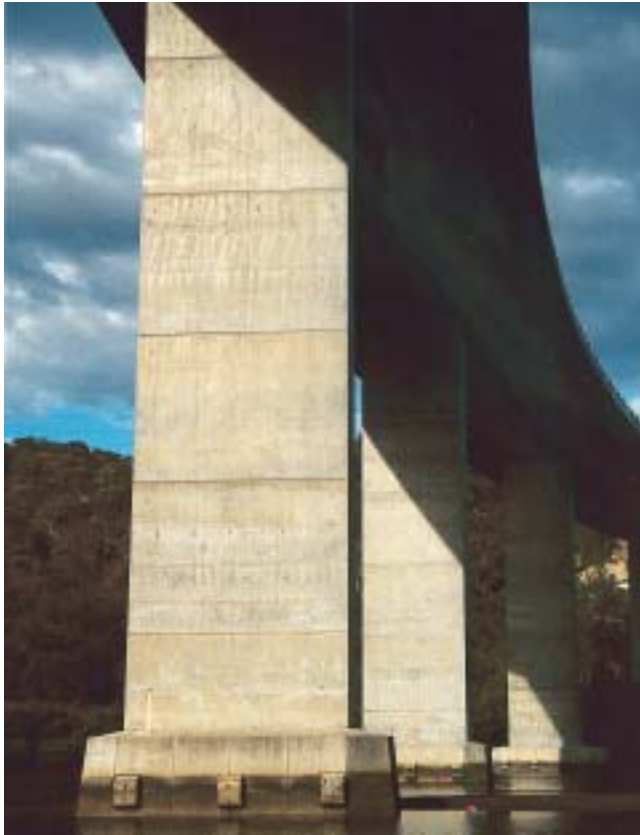
One significant advantage with a reverse taper is that it facilitates the elimination of the headstock although it does provide a greater surface area to obstruct views, (bridge design often requires balancing design objectives).



The open pier is refined and allows views however care should be taken not to introduce further complexity than is necessary. Is the pier the object to be accentuated or the superstructure?

Furthermore the shape of the void in an open pier should be considered. An equilateral triangle void has a different appearance than an isosceles triangle void. Voids at the top of the pier have a different effect to voids at the bottom of the pier.

The parts



Piers and Pile caps on the bridge over the Woronora River are in proportion with each other. The cap provides a solid and appropriate footing for the slightly tapering pier.



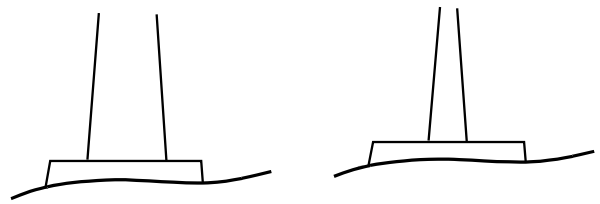
The pile caps on the Gladesville Bridge are also in keeping with the large piers providing a suitable structural termination in the park. Note the headstocks which in this context are entirely appropriate and echo the shape of the pier footing.

4.2.3 Pile caps

As piles are needed to support piers in soft ground, pile caps are often a feature of bridges crossing water courses. They perform an additional function in navigable waterways in that they help protect the pier.

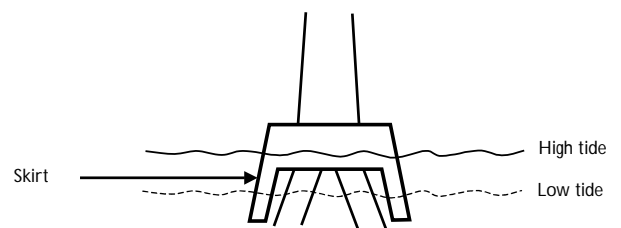
Also they need to be visible to boats and shipping as a safety measure.

Therefore they present an aesthetic challenge in that they form the footing to the pier.



There are some guiding principles.

- They should mimic the shape of the pier as far as possible.
- The proportion of pier size to pile cap size should be considered. Imbalanced proportions should be avoided.
- In a tidal watercourse, if the view of the piles is to be minimised, the pile cap may require a skirt.



The parts



Bridges over the F6 and M2 Infilled abutments are often dominating structural elements with little aesthetic merit especially in a landscape setting. If possible, they should be avoided or eliminated in the design process.



Spill through abutment opens views to landscape beyond. (Hume Highway).



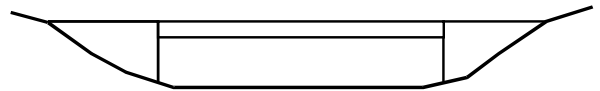
Well designed bridge and walled abutment, Southern Cross Drive at Gardners Road, Sydney.

4.2.4 Abutments

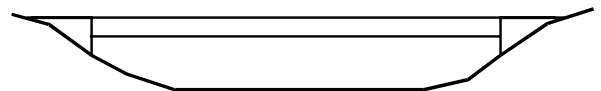
In an open landscape setting, spill through abutments are generally preferable, as walled abutment structures can block views. If unavoidable the use of planting should be considered to screen the abutment walls.

However in some circumstances walled abutments can be appropriate and help provide a good fit with surrounding built form.

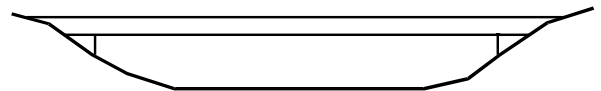
Large walled abutments can reduce the slenderness of the span, they block the flow of the landscape as well as confine views. This may be appropriate to help accentuate a change in landscape types and view sheds.



Reducing the abutments can create a more refined and better looking bridge. It does however increase the span and therefore depth of beam.



Continuing the superstructure or the parapet allows the shadow line to reduce the dominance of the abutment, and makes the bridge appear longer and more elegant.

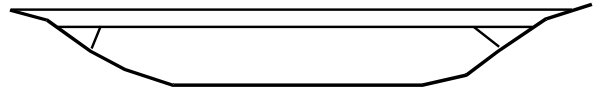


The parts

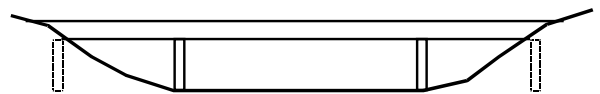


Bridge over Eddy Avenue, Central Station, Sydney. The slight taper on the abutment and piers adds character and responsiveness to the bridge and makes a more pleasant pedestrian experience.

Angling the abutments provides a more open sleek look and helps visually anchor the span.

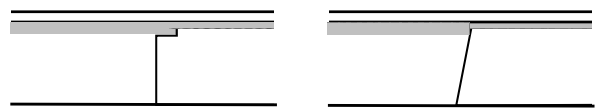


Spill through abutments allow open views to the landscape and better visibility to the road beyond.



Where unavoidable, walled abutments should be simple and unobtrusive.

- The deck and parapet should extend beyond the abutment wall.
- Overly elaborate patterning or colouring should be avoided.
- Consideration should be given to extending the wall up and around the girder to remove the notch.
- A slight angle on the taper can make the wall appear less dominating especially if next to a footpath. This avoids visual crowding.



The parts



The curtilage of this bridge detracts from an otherwise fine structure (Environ Road bridge over the Pacific Highway, Yelgun to Chinderah upgrade). However the magnificent wider landscape setting compensates for this effect and in time planting and weathering may ameliorate the view of shotcrete.



The curtilage of the bridge over Woronora River presented the opportunity for a viewing area to appreciate the bridge and its setting.



The curtilage of the bridge over Woronora River does not benefit the bridge or the landscape context. However the bridge is such a fine structure and the landscape so scenic that this is a minor issue. However this example does demonstrate the need for careful landscape integration in a natural setting. The coloured shotcrete and coloured blocks do not fit with the sandstone landscape and there is too much constructed complexity in the view.

Real sandstone blockwork would have provided a far greater level of integration. This may have been more expensive in the short term but if decided at the outset of the project might have been seen as an integral project cost.

4.3 The bridge curtilage

The curtilage of a bridge is the space around and under the bridge. It is distinct from the context of the bridge in that it is designed not existing. The design of the bridge curtilage is integral to the success of the bridge as a whole.

4.3.1 The space around the bridge

The space around the bridge, as an interface between the bridge and its context, serves several aesthetic functions.

- It is the setting for the bridge in views to the bridge.
- It is the foreground in views from the bridge.
- It provides an opportunity to frame and contrast the bridge.

Generally there should be continuity between the existing landscape and the curtilage of the bridge.

Where possible the space should be designed, so that it complements the adjacent landscape character.

The parts



Space under bridge is undefined and erosion prone.



The height of this bridge allows the landscape and streetscape to flow under the bridge.



This space is designed for cyclists and pedestrians planting has been located to the edges of the space.



This vast under bridge space is suitable for new development, which should be designed to suit the environmental conditions of the space and the aesthetics of the bridge.



Providing for business use between the piers on the bridge approach is a traditional way to utilise the space under the bridge.



The height of the structure allows a gradation of light which provides a variety of niches for flora and fauna habitation.



The gradation is less marked on this bridge. Planting stops at the edge of the shadow line. The underspaces are used for illegal tipping and car dumping.



Footpath connection under the bridge.



Bridge on the City West Link. A smooth curved soffit on this low bridge and pedestrian underpass helps create a pleasant environment. Note the transparent noise walls and consider the same view if the noise walls had been solid.

4.3.2 The space under the bridge

The space under a bridge must be considered in the conceptual design phases of the bridge and integrated into the design of the whole structure.

If these spaces are not considered then bridge aesthetics will be impaired by the sterilisation of valuable space, the presence of dead or dying plants and eroded rubbish strewn surfaces.

There are a range of strategies in dealing with this space which includes the following.

- Consider the surface treatment of the space. These spaces tend to be very dry and if in deep shade plants are unlikely to survive. Where plants are used they should be located to the outside of the space and irrigation may be required. Generally only the most shade tolerant and low water demanders should be specified which tend to be Australian and NSW natives. Combining planting with a hard paved or gravel surface is often appropriate.
- Consider the function of the space.
 - Footpath and cycleway networks can benefit from additional connectivity a bridge provides.
 - The potential use of this space for future development should be considered. It may be that the bridge aesthetics would benefit from undercroft development or not.
 - The creation of a varied habitat from light to a dry and shady rocky habitat, connecting and benefiting local biodiversity may be worth considering.
- Consider thick screen planting to block views and access to the space.

Soffit design

Where the underside of the bridge is visible, consideration should be given to the design of the soffit. Clean uncluttered surfaces, neat connections and simple layout of girders will help to give a neat appearance.

Consider bracing, when it is required, and ensure an orderly and regular pattern where possible.

The details

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| 5.8 | Colour | 48 |



The details



Joint detail on Fitzgerald Bridge in Raymond Terrace and photomontage of joint detail without staining. The joint is a neat simple and expressive way of supporting the girder on the piers, however staining has marred the appearance.



Bridge over the Tarban Creek. Recessing the pier and joint might have masked the inevitable gaps in the joint in shadow and accentuated the horizontal girder improving an otherwise well considered detail.

There are four important aesthetic considerations in the detailing of a bridge.

1. The aesthetics of the bridge details must be considered as part of the whole bridge design.
2. The design of the details should minimise the potential for staining.
3. The bridge detail should not impair the view from the bridge.
4. Access for maintenance should be considered early in the design phase.

The following bridge elements should address these issues.

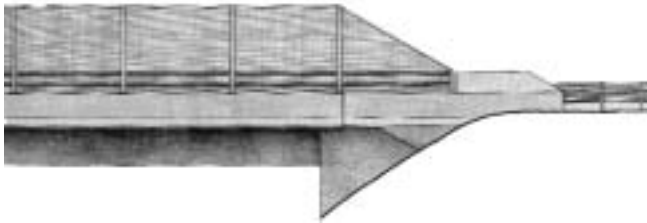
5.1 Joints and connections

The joints in bridge structures at the ends of the span or along the superstructure are an opportunity to enhance the bridge design and provide another level of detailed aesthetic interest.

Differentiate between bearing and moment connections and recognise these in the design.



The bridge at Environ Road, Yelgun to Chinderah, shows a simple resolution maintaining constant height between road and bridge barriers.

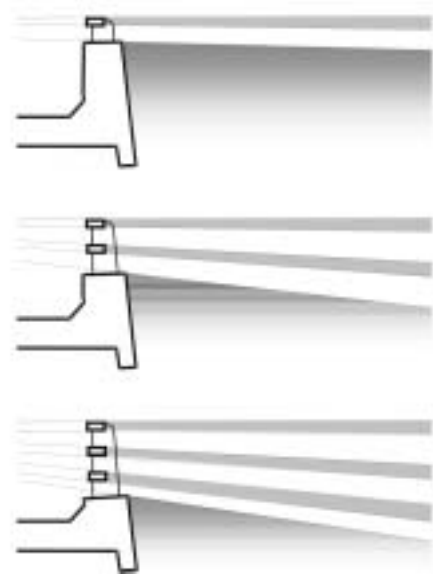


This illustration from the Karuah bypass project is part of a suite of details for bridges and overpasses, and resolves the junctions between bridge and road barriers and safety screen.

5.2 Bridge barriers

The design of the bridge barrier can influence the apparent depth of the superstructure and reduce the slenderness ratio. If slenderness is to be maximised the bridge barrier should be as transparent as possible.

A two rail barrier is better than a single rail barrier in this respect. Consideration should be given to the possibility of developing a three rail option for use in areas of great landscape value and/or low traffic speed.



Consideration should be given to the transition between the bridge barrier and the road safety barrier. A neat simple connection should be designed.

Furthermore the combination of safety barrier, bridge barrier and safety screen needs careful consideration.



In this example on the Yelgun to Chinderah section of the Pacific Highway, the two elements are separate yet are related in design and material. A slight misalignment in supports would effect the design outcome.

However a more sustainable solution would be an integrated barrier and screen.

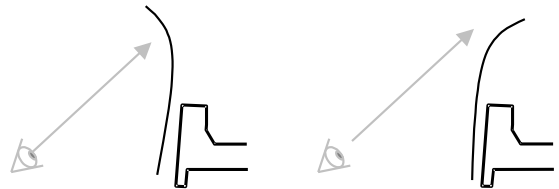
5.3 Safety screens

The safety screen is a relatively new bridge element in NSW designed to prevent objects being thrown from the bridge and damaging vehicles or injuring people below.

These screens should be an integral part of the bridge design.

There are several aesthetic considerations.

- An outward curving screen creates a more open feeling for bridge users and reduces the opaqueness of the top of the mesh for road users. However it presents a greater apparent depth of structure for onlookers.



- The bridge screen being a peripheral element to the true function of the bridge should avoid obscuring the superstructure.
- The screens should extend to the ends of the bridge span.



- Consideration should be given to integrating the bridge barrier and safety screens.

The details



Whilst this sign on the Anzac Bridge is necessary the photograph shows how the sign interferes with the aesthetics of the bridge.



This fine pedestrian bridge over Victoria Road, Sydney, is now used as a signage gantry.



These bridges over the M4 demonstrate the impact of signage and how avoiding signs is the best aesthetic policy.

5.4 Signage

With the exception of name plates and navigation signs, signage should be kept off bridges if at all possible. They add clutter and complexity and detract from the structure. They also obstruct views from the bridge.

The details



Lighting columns on the Gladesville Bridge are located and integrated with the deck support structure.



On this bridge on Victoria Road at Huntleys Point lighting is not integrated with an otherwise well designed bridge (note the tapered beam and the deep shadow line). The already complex junction between bridge barrier and safety fence needs careful consideration of details if a light column is to be included as well.



Anzac bridge is lit at night for defined periods of time to avoid light impacts on surrounding properties.



Drainage pipes on the bridge over the Woronora River hang below the outer face of the parapet.

5.5 Lighting

Where possible lighting on bridges should be minimised or avoided.

If necessary lighting should be used in the median as far from the parapet as possible to reduce clutter.

Or designed into the parapet structure.

The light columns should relate to the other bridge elements in position and form.

There is also the opportunity to light the bridge structure itself. If considerable effort is put into the design of the appearance of the bridge it is better value for money to allow the bridge to be viewed at night (dependent on context, cost, safety and environmental issues).

5.6 Drainage

Generally bridge drainage is dealt with on or within the bridge structure and is more of a water quality issue than an aesthetic one. However where the drainage system is exposed aesthetics must be considered and the design of the drainage feature must be considered as part of the whole.

The colour and grade of the pipe system must be considered as these aspects can jarr with the overall bridge design.

The details



Acrylic panels on the M5 East maintain the slenderness of the bridge structure whilst minimising the dominance of the structure on surrounding areas.



Noise walls on this bridge over the M2 significantly increase the apparent depth of the bridge, and alter the slenderness ratio.



Noise walls designed to integrate with the bridge structure (Fishmarkets, Sydney).



Noise Walls on the bridge on the Pacific Highway near Raymond Terrace also add to the perception that the bridge is less slender than it is.

5.7 Noise walls

Where possible avoid the use of noise walls on bridges.

If necessary, noise walls must be considered at the outset of the bridge design process and become an integrated part of the whole bridge design.

The use of transparent panels should be considered so that the apparent slenderness of the superstructure is not affected.

Noise wall design is the subject of a further RTA guidance document entitled *Noise Wall Design Guidelines*.



The primary colours on this rail bridge over the Pacific Highway at Coffs Harbour help create a distinctive bridge and route landmark.

5.8 Colour

The choice of colour can cause the bridge to relate to its setting or contrast with it. It can relate to the land colours or sky colours. The effects of colours will not always be dramatic eg when seen in silhouette or gloomy conditions. The use of bright primary colours, whilst initially striking tend to date (the exception is when they are culturally appropriate such as traditional Chinese bridges or unique icon bridges such as the Golden Gate).

A neutral palette of black, grays and white tend to give a clear definition of the bridge as an object in the landscape.

The urban context may give better opportunities for the use of colour, but as bridges tend to be highly visible elements in the townscape, the use of colour should be carefully considered.

Particular conditions

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Particular conditions



The bridges over the Hawkesbury River at Brooklyn. The proximity of these bridges results in an interplay between the designs. The two bridges are not separate but seen as one visual entity.



Seen from this angle there are several inconsistencies. Most notably the difference in grade and the white colorations of the barriers and lighting columns.

6.1 New bridges next to existing bridges

'The relationship between two bridges, almost side by side spanning the same stretch of water, is like the relationship between two musical instruments playing a duet. The music sounds better if the two instruments are in harmony with each other and keep to the same rhythm and tempo. The two instruments should produce sounds that contrast, in order to create a melody that is more interesting and colourful.'

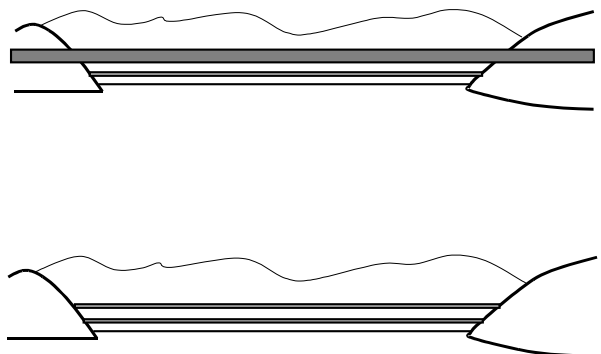
Foster and Partners

Designing a new bridge next to an existing bridge can be a significant challenge. Competition between structural forms can create clutter and neither bridge can be presented well, irrespective of individual aesthetic value. Alternatively where structural forms are complementary a memorable landmark can be created where the experience of crossing a bridge is enhanced by the view of an adjacent bridge.

The following guidelines will assist in overcoming this challenge.

Most importantly if possible the new bridge should be located so that the two bridges are as separate elements in the landscape.

This may be achieved through horizontal separation, and sometimes vertical separation.



Where adequate separation can not be achieved the new bridge and the existing bridge must be considered as one object in aesthetic terms. The following two strategies should be considered.

Particular conditions



Bridges over the George River at Tom Ugly's Point. The two bridges work well together as one does not attempt to replicate the other in structural form and detail.

6.1.1 A new design

If accurate duplication is not possible an entirely different bridge design should be produced.

- Very importantly, the designs should not compete but be complementary.
- Where possible the bridges should be parallel in vertical and horizontal alignment.
- Consideration should be given to matching the following elements: pier spacing, pier alignment colours and texture.

Where the existing bridge is of a high design standard and a valuable local and regional asset it is appropriate that the new bridge be as respectful as possible. The new bridge design should be simple and understated, and superstructure type should be selected for simplicity.

6.1.2 Duplication of the existing design

This approach tends to be more applicable to modern bridges than older bridges, where technology and safety standards have changed and old design and construction skills lost or expensive to relearn.

Again where possible the bridges should be parallel in vertical and horizontal alignment.

If there are any concerns that the bridge cannot be closely duplicated then the new design approach should be considered.

Particular conditions



Concrete bridge over Victoria Road, Gladesville.



Cable stay bridge over Pennant Hills Road.



Haunched concrete feature bridge over the Great Western Highway, Falconbridge.



Steel truss bridge over Bexley Road.



Simple beam bridge over the Pacific Highway, Sydney.

6.2 Pedestrian bridges

There are a number of important differences between pedestrian and vehicular bridges.

- Pedestrian bridges carry lighter loads than vehicular bridges. As such greater flexibility in the shape and proportion of the bridge can be exploited, within a reasonable budget, which can lead to great variety and character.
- Pedestrians and cyclists spend more time on a bridge than traffic and the opportunity for enjoying the view from the bridge should be addressed.
- Pedestrian bridges have ramps. The ramp is often folded or coiled at the ends of the structure. If the ramp is not well designed it can dominate views and detract from the essential element of the bridge – the span.

Particular conditions



Bridge over Bexley Road. The gradient of the access ramp can be minor if the road is on a slope.



The ramp and bridge connection on this pedestrian bridge is seamless, note the attention to detail of the narrowing of the edge of the deck as it passes over the thicker section of girder above the pier.

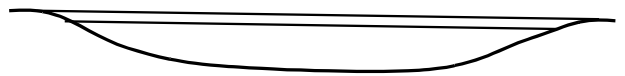


A simple connection between ramp and bridge is not achieved on these pedestrian bridges.

6.2.1 Ramps

Ramps may not be needed if the bridge is inaccessible to those needing to use a ramp (although accessibility may improve in the future necessitating the construction of a ramp). However if they are needed the following guidelines should be considered.

- Minimise the impact of the ramp by using natural or new landform. For example crossing a road in cutting avoids ramps entirely.



Also where a road is at a grade approach ramps on the uphill side can be relatively flat.



If an elevated constructed ramp is required the design needs to be carefully considered.

- Connections between ramp and superstructure must be as simple and seamless as possible.

Particular conditions



The simple spiral connection of the ramp adds to the value of the bridge. However adequate space is required for this solution.

- The ramp design and geometry should be also be simple and thoughtfully designed. Compact spirals are sometimes preferable to long switchbacks. They also appear to be shorter.
- Like the approach to a road bridge the ramp may have a closer relationship to the land than the span. Separating the ramp and span by integrating the ramp into the adjacent urban or landscape form should therefore be considered. For example a ramp rising through a grove of trees is a feature in itself and visually separates the ramp from the span.



Complex and poorly considered stairs and walls.



The ramp on this bridge over Victoria Road in Rozelle is well integrated with planting and provides an interesting user experience walking up into the canopy of the Casuarinas.



Where space is limited, stairs should be simple and compact as on this bridge over the Pacific Highway. Note the neat detail of the connection between superstructure and ramp marred only by staining. The handrail could have been a lot simpler.

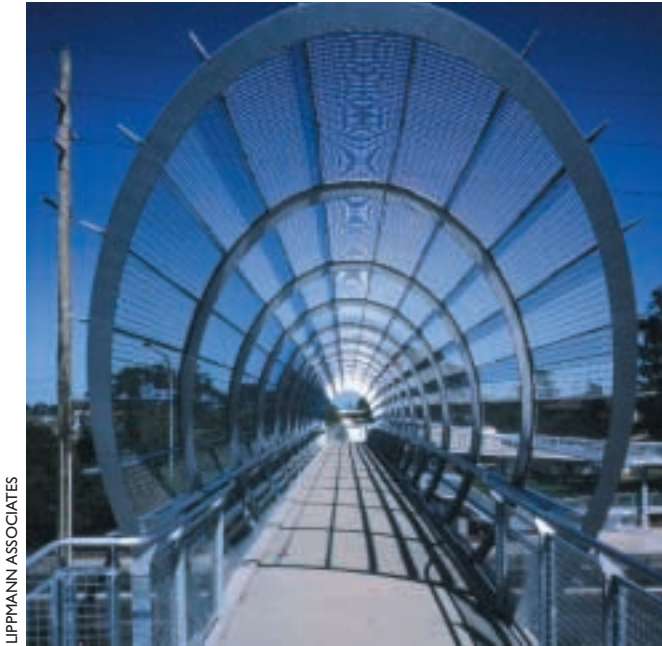
Particular conditions

6.2.2 Safety screens

In terms of comfort in using the bridge the following should be considered.

- The cage effect should be minimised.
- If a closed system is required then the design of the cage should ensure that the experience of crossing the bridge is positive.
- Lighting at the entrance to the bridge and along the bridge (floor lighting may be sufficient and aesthetically desirable).
- Avoiding hidden secluded spaces, which will make it easier to monitor personal safety.

Finally providing an opportunity to stop and enjoy the view from the bridge should be considered and seating or a widened space to stop and rest may be possible and desirable. However; its impact when viewed from below needs to be carefully considered.



Pedestrian bridge over the Horsley Drive in Fairfield. The safety screen totally surrounds the walkway however the oval shape softens the cage effect. The user experience would be interesting both day and night.

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