THE DUTY OF CARE IN DESIGN—CAN ENGINEERS RELY ON CODES OF PRACTICE?

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INTRODUCTION

Contracts for engineering design normally include the obligation that the services will be performed with the reasonable skill, care and diligence that would be applied by a normally skilled member of the profession in similar circumstances. The profession makes considerable use of codes of practice, or 'standards', which codify current design practice.

The prevailing view of the design profession is that such standards represent the 'state of the art' that they are expected to apply. But does compliance with the current applicable standard mean that the designer has discharged his/her contractual duty of care? Might something more be required? Does the designer need to anticipate how the design standards may evolve?

This paper addresses these questions in the light of a recent case, in which the judge's findings on the applicable standard of care in relation to the use of current design standards may be surprising to many designers.

CODES OF PRACTICE AND STANDARDS

WHAT IS A STANDARD?

Standards can be guidance documents including the following types of documents:

- Australian Standards
- International Standards and Joint Standards
- Codes of Practice
- Specifications
- Handbooks
- Guidelines

The following definitions from a UK publication define the different meanings ascribed by engineers to 'Standards' and 'Codes of Practice':

Standards 'set out certain tests, dimensions, tolerances and qualities for a product or process. Historically in certain areas, e.g. structures, they have set out prescribed methods for specific calculations and even prescribe permissible stresses. More recently these kinds of standards have become normative'.[1]

Codes of Practice 'are not standards but do set out the standard to be followed. The specific requirements in a code of practice must be followed either for best practice or because the document has a legal status. For example specific partial factors of safety are stated in structural codes. Requirements for tying together tall buildings, to ensure robustness and prevent progressive collapse are set out in the UK Building Regulations. The ways of complying are set out in codes that are deemed to satisfy that part of the Building Regulations'.[2]

In the context of the engineer's duty of care and for the purposes of this paper, there is no significant difference between 'Standards' and 'Codes of Practice, and the terms are used interchangeably.

PROCESS FOR ISSUE OF AN AUSTRALIAN STANDARD

Australian Standards are issued by 'Standards Australia', an independent company whose principal activity is the development of Australian Standards. Whilst Standards Australia is an independent company, it is acknowledged by the Australian Government (via a Memorandum of Understanding) as Australia's peak non–government Standards–writing body and the Australian representative on the International Organisation for Standardisation (ISO).

In developing a Standard, Standards Australia uses a process based on:

- Consensus;
- Transparency; and
- Balance of representation.

Consensus means: 'General agreement, characterised by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments'.[3]

Notwithstanding the requirement for general agreement, consensus need not imply unanimity within the broad spectrum of stakeholders brought together as the Standard Committee to draft the final Standard.

Transparency means: 'that information on current work programs and proposals is available to all interested parties. Transparency also includes the concept of openness, participation on a non–discriminatory basis, impartiality and a balanced participation in the development process by interests that will be significantly affected by the final Standard'.[4]

Transparency is intended to avoid the potential for skewing the provisions of a Standard towards particular commercial interests. However, where there are few, or only a single Australian manufacturer, it is often difficult to separate implicit commercial interests from provisions that appropriately cover the spectrum of Australian manufactured products. Thus, if these Australian manufactured products do not represent world's best practice, then the Standard may reinforce inferior standards. However the movement towards bringing national standards in line with other major trading nations, and the associated drive towards greater commonality with International Standards Organisation (ISO) Standards, works against such parochial practices.

Balance of Representation: 'The membership of a Standards Australia Committee is formally balanced as part of the constitution of the Committee to represent the broadest possible spectrum of stakeholder interests'.[5]

In reality, participation on all Standards Australia Committees is voluntary in nature, as participants are not remunerated for their efforts by Standards Australia. Participation typically requires time given by employers, so membership on a Technical Committee may often be additional to normal work duties, and/or done in personal time as an extra curricula activity. Consequently, the best qualified persons or leading practitioners, are not always available for such sustained participation.

Thus, the balance achieved in the 'spectrum of stakeholder interests' can be subjective and once established, can by its own make–up be self–perpetuating in the interests and expertise being represented.

The entire process of writing Standards is itself formalized and documented in a series of Australian Standards:

- SG–001 Preparing Standards
- SG–002 Structure and Operation of Standardisation Committees
- SG–003 Standards and Other Publications
- SG–004 Roles and Responsibilities in Standardisation
- SG–005 Technical Governance and Advisory Structures for the Standards Development Process
- SG–006 Rules for the Structure of Australian Standards
- SG–007 Adoption of International Standards
- SG–009 Preparation of Standards for Legislative Adoption
- SG–015 Australian Involvement in International Standardisation
- SG–017 Drafting of Standards Referenced Under OH&S Legislation
- SG–018 Standards Referenced by Water Utilities
- SG–020 Participation by Consumers in Standardisation.[6]

INTERESTED PARTIES

The content of a Standard is the responsibility of a Technical Committee. The basis for the composition of a Technical Committee is to ensure balanced participation by those interests that are significantly affected by the resulting Standard. Individual members of a Technical Committee are selected by Nominating Organisations that may include, but are not restricted to, government bodies, industry associations, community–based and consumer organisations, employee organisations and professional, technical or trade associations.

For example, the following 17 interested parties represented on Committee BD–025 that was responsible for AS2870–2011 Residential slabs and footings shows a wide range of representation:

(1) Australian Building Code Board

(2) Australian Chamber of Commerce and Industry

(3) Australian Geomechanics Society

(4) Australian Institute of Building Surveyors

(5) Cement Concrete and Aggregates Australia

(6) Concrete Masonry Association of Australia

(7) Construction Industry Advisory Council

(8) Engineers Australia

(9) Foundations and Footings Society of Australia

(10) Housing Industry Association

(11) Master Builders Australia

(12) National Timber Development Council

(13) Plastics and Chemicals Industries Association

(14) Steel Reinforcement Institute of Australia

(15) Think Brick Australia

(16) University of Newcastle

(17) University of South Australia

The diversity of the interested parties being represented meets the charter 'to represent the broadest possible spectrum of stakeholder interests', but does not necessarily have influence over the personnel being nominated in terms of qualifications, expertise, currency of research or industry practice, etc. Indeed, without in any way casting aspersions on the example Committee cited above, it is readily apparent that whilst there are numerous 'industry sector interest groups' represented, it is not apparent whether their nominees are representing current 'state–of–the–art' products and practices, or leading–edge technology and practices that may arise from within each sectoral interest.

Is the 'industry sector interest group' nominating an employee whose regular responsibilities involve commercial, promotional or technical support, or seeking interested, available and qualified personnel from within its sector? If the latter, what selection criteria are adopted? The nominees of its major corporate supporters, from its semi–retired members, or driven individuals with particular pet interests?

OUTCOME OF STANDARD DEVELOPMENT PROCESS

Australian Standards are published documents that set out specifications and procedures with the aim of ensuring that products, services and systems are safe, reliable and consistently perform the way they were intended to. They establish a common language which defines quality and safety criteria acceptable to a broad range of interested parties.

All Australian Standards are expected to deliver a net benefit to the Australian community, taking into consideration:

- public health and safety;
- social and community impact;
- environmental impact;
- competition; and
- economic impact.[7]

These are an appropriate set of expectations to strive for in terms of net benefit to the community at large. However, it is submitted that Standards should not introduce or engender provisions that have implicit or explicit negative impacts on the status quo of the above listed community considerations. Nor are, nor should, Standards be a channel for back–door social engineering.

In essence, by documenting norms in a common language, Standards enable the community and industry to seek and contract for goods and services on a level playing field. They specify minimum acceptable requirements pertaining to the majority of transactions that were anticipated in conceiving and scoping the particular Standard. The minimum acceptable requirements may address safety, quality and reliability, with implications for environmental impact and public health and safety considerations. The ability to contract for goods and services on a level playing field of minimum acceptable requirements is good for competition within the marketplace, with implications for society at large through the ensuing economic benefits.

However, establishing such norms as the basis for putting out to tender and contracting for goods and services, also sets the technical basis for which these goods or services are priced and the commercial terms of offer.

The upside of Standards is that the common forms of transaction for normal goods or services do not require a critical evaluation of the specific circumstances in order to establish alternate applications or project specific requirements or basis of design. This efficiency streamlines the process of scoping the goods and services sought and being offered, enables proceduralisation and standardisation of their delivery and removes uncertainty in the technical requirements for delivery and acceptance criteria.

The downside can arise on the infrequent occasions when the Standards, or particular elements of a Standard, may not be adequate or appropriate for the circumstances in question. If not recognized and accepted upfront by either the client or the engineer, the request for tender may be an inadequate or unsound basis upon which to price and apply regular terms of offer. Thereafter, once the scope and commercial terms of contract are agreed, the momentum of the works will overwhelm the unnatural tendency to query the adequacy or applicability of the industry accepted Standard which is applied in most regularly contracted goods or services.

Professionals generally accept that appropriate procedures have been applied in the drafting, review and adoption of a Standard, so that it represents the 'state–of–the–art'.

On what informed or qualified basis would the regular practitioner be aware of the specific basis of each provision of the Standards, background research and deliberations of the Technical Committee and its individual members? In the authors' view, it is commercially impractical and contrary to the professional objective of Standards for a user to review the project specific circumstances to assess the applicability and adequacy of each and every provision of a contractually specified Standard.

STATUTORY SIGNIFICANCE OF CODES AND STANDARDS

As issued by Standards Australia, a private non–government organization, Australian Standards have no intrinsic statutory significance. Certain individual Standards achieve statutory force when they are incorporated into legislation. Many Standards are never incorporated into legislation, and thus have no statutory significance.

Typically Standards are incorporated indirectly via subordinate legislation, as illustrated by the following Victorian example in the context of domestic housing.

The *Building Act 1993* (Vic) lists as one of its main purposes: 'to regulate building work and building standards'. The *Building Act* empowers the Governor in Counsel to make Regulations in respect of, inter alia: 'building permits, occupancy permits and temporary approvals, including the duration of permits and approvals and the matters to be complied with by the relevant building surveyor before a permit or approval can be issued'.[8]

The Building Regulations 1996 (Vic) includes amongst its objectives: 'provide for matters relating to the accreditation of building products, construction methods, designs, components and systems connected with building work'.[9]

The Building Code of Australia (BCA) is incorporated in the *Building Act 1993* (Vic) via the Building Regulations 1996 (Vic): 'The BCA is adopted by and forms part of the Regulations as modified by this Part'.[10]

The BCA adopts a number of Australian Standards by listing specific editions in Table 1.4.1, including the following examples relevant to design:

- AS1170 Structural Design Actions
- AS1657–1992 Fixed Platforms, Walkways, Stairways and Ladders—Design, Construction and Installation (SAA Code for Fixed Platforms Walkways, Stairways and Ladders)
- AS2870–1996 and 2011 Residential slabs and footings
- AS3600–2009 Concrete Structures
- AS4055–2006 Wind Loads for Housing
- AS4100–1998 Steel Structures.

When an engineering failure is investigated by a government body, it will first seek to verify that the design, operation or equipment complies with the prevailing Australian Standard, or another recognised international Standard, if there is no appropriate Australian Standard. Notices of failure to comply and rectification, fines, shut–down notices, or progression to litigation, often result from an identified failure to meet recognised Standards. In the authors' experience in litigation, the prevailing Standard is frequently used as the fundamental measuring stick of engineering adequacy. Often this is done on the advice of inspectors or practitioners, who may have little

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knowledge as to the background and basis of development of the Standards they are citing, the operating paradigm for which they were conceived, or indeed the suitability of all the code provisions to the circumstances to which they are being applied.

In these circumstances, Standards are implicitly assumed as embodying the 'state–of–the–art', where non–compliance is, prime facie, a fundamental breach of the duty of care by the professional practitioner.

CONTRACTUAL SIGNIFICANCE OF CODES AND STANDARDS

Many contracts specify that particular applicable Codes and Standards form part of the contract.

For example the Federation Internationale des Ingenieurs–Conseils Conditions of Contract for Plant and Design Build and Conditions of Contract for EPC/Turnkey Projects (FIDIC Silver Book) provides as follows:

5.3 Contractor's Undertaking

The contractor undertakes that the design, the contractor's Documents, the execution and the completed works will be in accordance with:

…

the documents forming the contract

…'

5.4 Technical Standards and Regulations

The design, the contractor's documents, the execution and the completed works shall comply with the Country's technical standards, building, construction and environmental Laws, Laws applicable to the product being produced from the works, and other standards specified in the Employer's Requirements, applicable to the works, or defined by the applicable laws.'

…

'Employer's Requirements' means the document entitled employer's requirements, as included in the contract, and any additions and modifications to such document in accordance with the contract. Such document specifies the purpose, scope and/or design and/or other technical criteria, for the works.

In addition to these overarching requirements in the FIDIC General Conditions, it is common for employers to specifically nominate an extensive list of Standards and Codes of Practice in the Particular Conditions that the designer is required to comply with. In these circumstances, compliance with Standards is a contractual obligation, in addition to obligations that might arise from a duty of care.

DUTY OF CARE IN DESIGN

COMMON LAW

There are many judicial statements on the standard of the common law duty of care that a professional person must comply with, e.g.

Where you get a situation which involves the use of some special skill or competence … the test is the standard of the ordinary skilled man exercising and professing to have that special skill. A man need not possess the highest expert skill … it is sufficient if he exercises the ordinary skill of the ordinary competent man exercising that particular art.[11]

And in somewhat more detail:

… a professional man should command the corpus of knowledge which forms part of the professional equipment of the ordinary member of the profession. He should not lag behind other assiduous and intelligent members of his profession in knowledge of new advances, discoveries and developments in his field. He should have such awareness as an ordinarily competent practitioner would have of the deficiencies in his knowledge and the limitations in his skills. He should be alert to the hazards and risks inherent in any profession or task he undertakes to the extent that other ordinarily competent members of his profession would be alert. He must bring to any professional task he undertakes no less expertise, skill and care than other ordinarily competent professional would bring, but need bring no more. The standard is that of the reasonably average. The law does not require of a professional man that he be a paragon, combining the properties of polymath and prophet.[12]

The message in these statements to designers is clear: be up to date with the knowledge of the profession in your area of expertise, and know your limitations!

STATUTORY MODIFICATION OF THE COMMON LAW

The Parliaments of the Australian States and Territories have legislated significant statutory modifications to the common law of negligence since the turn of the century. Some of these statutory modifications are directly applicable to an engineer's duty of care.

For example, the *Wrongs Act 1958* (Vic) contains the following relevant sections:

59 Standard of Care for Professionals

(1) A professional is not negligent in providing a professional service if it is established that the professional acted in a manner that (at the time the service was provided) was widely accepted in Australia by a significant number of respected practitioners in the field (peer professional opinion) as

competent professional practice in the circumstances.

(2) However, peer professional opinion cannot be relied on for the purposes of this section if the Court determines that the opinion is unreasonable.

(3) The fact that there are differing peer professional opinions widely accepted in Australia by a significant number of respected practitioners in the field concerning a matter does not prevent any one or more (or all) of those opinions being relied on for the purposes of this section.

(4) Peer professional opinion does not have to be universally accepted to be considered widely accepted.

(5) If, under this section, a Court determines peer professional opinion to be unreasonable, it must specify in writing the reasons for that determination.

60 Duty to Warn of Risk

Section 59 does not apply to a liability arising in connection with the giving of (or the failure to give) a warning or other information in respect of a risk or other matter to a person if the giving of the warning or information is associated with the provision by a professional of a professional service.

Section 60 thus contains an important carve–out from the 'peer professional opinion standard'—it does not apply in relation to the duty to warn of a risk. That duty is somewhat unhelpfully articulated as follows:

50 Duty to Warn of Risk — Reasonable Care

A person (the defendant) who owes a duty of care to another person (the plaintiff) to give a warning or other information to the plaintiff in respect of a risk or other matter, satisfies that duty of care if the defendant takes reasonable care in giving that warning or other information.

Arguably, this is a subjective standard that does not provide the same measure of predictability that section 59 provides in relation to the 'peer professional opinion standard'.

There are three potential sources for requiring a duty of care in design:

(1) an implied or express term in the designer's contract of engagement that the design will be prepared with reasonable skill, care and diligence;

(2) a tortious duty of care under the common law that is generally co–extensive with the contractual obligation to exercise due care in preparing the design; and

(3) statutory provisions on duty of care that codify and perhaps limit common law rules.

IS THERE AN OBLIGATION FOR AN ENGINEER TO COMPLY WITH A CODE OR STANDARD?

It is suggested that there are three possible sources of such an obligation:

(1) a mandatory statutory requirement, such as incorporation of a Standard in legislation, e.g. the *Building Act* cites Building Regulations, which cites BCA which cites Standards;

(2) a mandatory express provision of the contract to comply with a Standard, e.g. FIDIC Silver Book; and/or

(3) a duty of care arising from either or both a contractual or tortuous duty to exercise reasonable skill, care and diligence in carrying out engineering.

The statutory or contractual obligations to comply are known and unexceptional.

However the issue of compliance arising from an engineer's duty of care is less clear. It is contended that in most cases compliance satisfies the 'peer professional opinion standard'. Arguably, a Standard documents the 'state–of–the–art' of the ordinarily competent professional, whereby:

• it is the product of a formal, structured process;

• the Technical Committee responsible is deemed competent in the relevant fields;

• a broad and disparate spectrum of interested parties are represented on the Technical Committee;

• the published Standard is the result of consensus between the Technical Committee members;

• a broad range of community interests are considered in establishing the appropriate balance between conflicting requirements; and

• amendments can be made, and communicated to the profession, if there are advances in the 'state–of–the–art' or deficiencies or errors in the Standard identified after publication.

It should be borne in mind that Standards prescribe minimum requirements. Hence, any non–compliance with minimum specified criteria would need to satisfy the 'reasonable professional' test:

Would the non–compliance be 'widely accepted in Australia by a significant number of respected practitioners in the field (peer professional opinion) as competent professional practice in the circumstance?

An engineer's conscious decision not to follow the requirements of a Standard may create additional risks for their client. This is equally applicable to a conscious decision to substantially exceed a

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Standard's minimum requirements just as it is not to achieve them.

There are cases in which an engineer has been found to be negligent in preparing a costly design that substantially exceeded a Standard's requirements. Thus, there are risks and potential consequences if a Standard is not complied with. A prudent engineer electing not to comply with a Standard would therefore be well advised to warn their client of the risks and ensure that the client acquiesced in the decision.

It should also be noted that the provisions of Standards and Codes of Practice are not suited to 'mix and match' clauses from different documents. Like a contract, a Standard needs to be construed as a whole document in which the individual provisions are integrated into an overarching conceptual framework.

For example, the limit state design of steel structures in accordance with AS4100 Steel Structures Code needs to be carried out for loads derived from AS1170 Structural Design Actions. It could be quite unsafe to design a structure to AS4100 for loads derived from a Standard that was based on inconsistent assumptions in respect of partial factors for material strength.

IS COMPLIANCE WITH A CODE OR STANDARD SUFFICIENT?

The authors' proposition is as follows: in respect of conventional infrastructure, a Standard represents the 'state–of–the–art' endorsed by the profession, and compliance with it is consistent with acting 'in a manner that (at the time the service was provided) was widely accepted in Australia by a significant number of respected practitioners in the field (peer professional opinion) as competent professional practice in the circumstances'.

In other words, compliance with a Standard in the design of conventional infrastructure is an exercise of 'the ordinary skill of the ordinary competent man exercising that particular art'. It is not suggested that this proposition would be valid in respect of major hazard facilities, or structures involving new or untested concepts.

Highly skilled practitioners, or academics specializing in a particular field, may consider that the provisions of a Standard are inadequate, or are not 'state of the art' in the context of 'leading edge'. The authors suggest that that does not immediately translate to the 'state–of–the–art' of the ordinarily competent practitioner.

Standards are living documents, regularly updated either by specific amendments to particular provisions (which can occur when a significant deficiency becomes known), or by a general revision to incorporate advances in the 'state of the art'. A major revision of a Standard may require the profession to undertake retraining to adopt new approaches. The profession usually accepts such revised Standards as an evolution of the 'state of the art' of the ordinarily competent practitioner. However, before a Standard is formally revised and re–issued, there may have been a number of draft revisions in progress at various times, and circulated for comment. Such draft revisions typically receive wide exposure in the technical community as part of the transparent and consensual process of Standard preparation, but they are by no measure adopted prior to the 'official' revision.

Do the provisions of a draft revised Standard issued for review immediately translate to the 'state–of–the–art' of the ordinarily competent practitioner? The authors submit that it does not;

by their nature 'draft' revisions are circulated for comment and review, and the finally adopted provisions in the revised Standard may bear little relation to the draft provisions, or the inclusion of subtle changes in a draft may significantly alter its interpretation and application to particular circumstances.

The situation may be different if it was universally accepted in the profession that certain provisions of a Standard were deficient. In that case, the ordinarily competent practitioner would be aware of the deficiencies, and in the exercise of her/his duty of care, would make appropriate provision in the design (Note: A clear distinction is made between the profession adopting Amendments or Warning Notices pertaining to an existing Code or Standard, as opposed to observing the provisions of an incomplete or unadopted Draft version of a Code of Standard that has been distributed for comment).

However if the inadequacy of certain provisions of a Standard was controversial, section 59(3) of the *Wrongs Act 1958* (Vic) (or equivalent in other States) could provide a defence supporting compliance: 'The fact that there are differing peer professional opinions widely accepted in Australia by a significant number of respected practitioners in the field concerning a matter does not prevent any one or more (or all) of those opinions being relied on for the purposes of this section'.

A CASE STUDY

BHP COAL PTY LTD & ORS V O&K ORENSTEIN & KOPPEL AG

Some of the issues discussed above in relation to an engineer's duty of care in respect of compliance with Standards and Codes were highlighted in *BHP Coal Pty Ltd & Ors v O&K Orenstein & Koppel AG*[13] (*Goonyella* case).

This case concerned the total collapse of a Bucket Wheel Excavator (BWE) at the Goonyella mine in Central Queensland.

Design, supply and installation of the BWE took place between 1978 and 1981. In November/December 1984 grounding of the bucket wheel due to misoperation of the BWE caused buckling damage to the rear tower flanges. The owner arranged for an engineer from O&K (the designer and supplier of the BWE) to inspect the damage and prepare an on–site emergency repair proposal. The repair of the buckling and addition of eight stiffeners was executed by a third party under the supervision of an O&K supervisor, primarily there for stabilisation of the balanced machine before and after the repair works.

Sometime after the repair was completed, fatigue cracks in the steel columns started to propagate from the repair welds at the ends of the added stiffeners.

Between 1985 and 1999 TKEA carried out bi–annual inspections of the BWE structure, with the final inspection in March 1999. In March 2000 the BWE collapsed. There was a Mine Warden's Court Inquiry into the collapse in 2002, and in 2003 BHP initiated legal proceedings against O&K and TKEA.

The court hearing occupied a total of 120 sitting days between April 2007 and February 2008.

In his judgment, McMurdo J found that, in respect of the design of the repair stiffeners, O&K had breached its duty of care and had engaged in misleading or deceptive conduct in breach of the *Trade Practices Act*. He also found that, in respect of the inspection of the BWE after the repair work had been completed, TKEA had breached its contract, breached its duty of care and had engaged in misleading or deceptive conduct in breach of the *Trade Practices Act*. The misleading and deceptive conduct ruling will not be discussed further herein, as it is not germane to the theme of this paper, which is covered by the other part of the ruling.

The negligence case against O&K ultimately hinged on the judge's findings in respect of detailed aspects of the design of the welding of the repair strengthening stiffeners, the location of the fatigue cracks that ultimately propagated sufficient to cause complete collapse of the BWE. The upper stiffener terminations terminated in an area with bending stresses higher than further up the tower. The design of these upper stiffener terminations was awkward and increased the local stress.

The judge found that if the engineer had made proper fatigue stress calculations he would have identified that the upper stiffener terminations were in a critical spot. Further, if the engineer had identified the problems caused by the chosen details, he could without problems have extended the stiffeners to the end of the tower or designed a better detail that would not have been as susceptible to fatigue.

The contract for construction of the BWE required it to be constructed according to the operative German Standard specific to BWEs at the time, BG60. This was still the operative standard for BWEs used by O&K in 1984, although a draft revision had been circulated for discussion within the drafting Committee in 1984. ISO 5049 was an alternative international standard applicable to mining machinery (including BWEs, though this was not its predominant area of focus) that resulted in lower fatigue strengths of welded joints than BG60.

The welded detail of the upper stiffener termination implemented (FI) had adequate fatigue strength according to BG60, but not according to ISO 5049. ISO 5049 was developed for application to the design of bulk–ore handling machinery, such as stackers, reclaimers, bucket–wheel reclaimers and ship loaders, where the load duty handling excavated material in stockyards and the like, is more consistent than bucket–wheel excavators digging hard material directly from the earth.

As such, the fatigue load duty provisions of ISO 5049 was aligned to a more uniform load duty spectrum, which was not the case for fatigue load duty provisions in the design codes that were mostly in use of BWEs (including BG60 and its successor BG86).

McMurdo J considered the following issues relevant to his conclusion that BG60 was unreliable as a standard with which to design the FI welded detail. [The authors' comments on these issues are in square brackets.]

- BG60 was 'being challenged by some and officially reviewed' in 1984 and was replaced by BG86 in 1986. [It should be noted that the fatigue provisions of the 1984 Draft were more onerous than BG60 and were not adopted in the final Standard BG86. The welded repair details complied with the requirements of BG60 and BG86 but would have failed the 1984 Draft.]
- BG60 did not take dynamic loads into account, although this was not necessarily a prevalent professional opinion in 1984. [BG60 did not include a specific dynamic load factor on the statically determined loads in its load case combinations, as did BG86, but BG86 was actually calibrated against BG60 to produce similar design outcomes.]
- O&K knew that ISO 5049 specified lower allowable fatigue stresses; 'ISO 5049 should have alerted an engineer to the risk of using only BG60'. [Although ISO 5049 includes BWEs in its scope, it was not in general use by the industry for the design of BWEs as was BG60, where there are significant differences in load duties between the two codes. Also ISO 5049's fatigue S–N curve for the FI category was significantly more conservative than BG60 and BG86.]

McMurdo J expressed his findings on this Standard issue as follows:

... But I do not accept that a reasonable engineer would have been obliged to give up a long–standing code (BG60), if otherwise considered to be reliable merely because some engineers, however eminent, were publishing an opinion suggesting otherwise ...[14]

... I am not satisfied that such an engineer would have thought that BG60 overstated the fatigue strength of an FI detail ...

However, any reasonable engineer in his position should have doubted the reliability of BG60. After all there was a review of BG60 which had been put in place by the relevant West German authority. The review committee had been constituted, made up of leading engineers from the major manufacturers and academics. … All of that amounted to more than a professional opinion being ventilated occasionally in published journals or seminars. … In the midst of that review the reasonable engineer in [the designer's] position could not have said to himself at the same time that BG60 was reliable.

... Because BG60 was unreliable, that margin for error should not have been accepted as reasonable ...[15]

COMMENTS ON PRACTICAL DESIGN ENGINEERING ASPECTS OF JUDGMENT

Merely because a Standard is under review by an eminent Committee, which as part of its remit is to update/modernise the code, with respect it does not follow that 'a reasonable engineer should have doubted the reliability of BG60'. The ultimate 'official' revision, BG86, was in fact calibrated to BG60 because that had been found to produce reliable designs that had adequate fatigue service lives.

If no notices of warning or amendments to the Standard had been issued, even during the Standard review phase, what if any basis was there for the conclusion that 'a reasonable engineer should have doubted the reliability of BG60'? Indeed many Standards are subject to regular periodic review (with draft revisions in the public domain)—does this automatically oblige the design engineer to consider the current, unamended version as suspect and potentially 'unreliable'?

What would have been the legal standing of the design engineer in adopting the provisions of an interim draft Standard that was still subject to considerable deliberation by the Committee? In the case of the fatigue provisions of the 1984 Draft, these were ultimately rejected by the Committee in the final issue of BG86. Arguably, design of an entire machine to the 1984 draft provisions would have ultimately proved to have been unnecessarily conservative and added unwarranted cost.

Design Codes are intended to be inherently conservative in their provisions, as they are intended to apply to the majority of applicable systems for which they have been developed.

Factors of safety are applied to and allowable stresses are used in conjunction with conservatively compounded design loads. In the case of fatigue, the design load combinations are used in conjunction with lower bound S–N curves used for design purposes.

When in design is it appropriate to apply even more conservative factors of safety over and above accepted and current codified values in Standards? Such additional conservatism has commercial and feasibility implications for the client to whom the engineer owes a duty of care. Thus, if there was no valid basis to conclude that 'BG60 was unreliable', why then should the codified 'margin for error.. not have been accepted as reasonable. …'?

Even if there was some concern as to the adequacy of the codified factors of safety, what would be an acceptable technical basis for employing higher values? (e.g. +5%, +10%, +25% ...?

If the Standard is unreliable but you can't put your finger on it, what is a 'reasonable' fix?). If a designer arbitrarily adopted, say an additional 10% margin for safety, to cover some unquantifiable reservations, and then the structure still failed at some time in the future, would the Court view this as the prudent act of a reasonable engineer, or an ill–fated guess in the absence of a more technically supported engineering design decision.

At the heart of engineering design codes, there is an intent to provide inherent conservatism, not to sail close to the wind and thereby court regular failure. This enables engineers to make safe design decisions with a degree of comfort that they do not in most circumstances need to question the basis and applicability of the codes they are relying upon. The professional training of engineers, whilst not eliminating the prospect of codes being limited, or occasionally in error, is largely skewed towards engineers practicising their profession by following the provisions of the many codes that apply to their sector. Most engineers are 'code practitioners' not 'code questioners'. If codes have required constant questioning, then the engineering profession has over the years progressively amended and improved the deficient elements of such codes. This has involved drawing on the expertise and experience from other countries with similar codes, and this has reduced the instances where codes need to questioned. The profession would have a fundamental problem were there a Court implied requirement that on all occasions the 'code practitioners' should become 'code questioners'.

CONCLUSION

The genesis of Standards, the common law and relevant statutory provisions suggest that engineers should generally be able to rely on current relevant Standards and Codes of Practice when designing conventional infrastructure.

It would be chaotic for the majority of the engineering profession undertaking design on a daily basis if they were not able to rely upon current Codes and Standards. There is neither the time nor the fees for designers to undertake a critical review of the provisions of design Codes and Standards for conventional and well understood infrastructure for which they have been written.

If in hindsight Courts judge that the conservatism in design Codes and Standards is inadequate, this brings into question the 'professional consensus' underlying their development and status within the engineering profession and as the basis of construction contracts. It provides no guidance to the practicing professional as to what is an acceptable degree of conservatism.

The judgment in the *Goonyella* case contains some surprising and salutory warnings for practicing engineers:

- There may be an obligation to question, monitor and understand the reliability of current codes in light of 'potential' amendments.
- There may be an obligation to consider other Standards than those specified in the contract, and if more conservative apply such provisions.

REFERENCES

1. New Dictionary of Civil Engineering (2005)

2. Ibid

3. Standards Australia website: www.standards.org.au

4. Ibid

5. Ibid

6. Ibid

7. Ibid

8. Section 261(1)(a)

9. R101

10. Building Regulations 1996 (Vic) R109

11. *Bolam v Friern Hospital Management Committee* [1957] 1 WR 582 HL, 586 per McNair J

12. *Eckersley v Binnie & Partners* (1988) 18 Con LR 1

13. [2008] QSC 141

14. Ibid [157]

15. Ibid [160]–[162]

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