THE INSTITUTION OF ENGINEERS, MALAYSIA

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POSITION PAPER FOR CONCRETE CODES OF PRACTICE IN LOCAL CONSTRUCTION INDUSTRY AFTER 2008

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ABBREVIATIONS

ACI	American Concrete Institute
ACMC	Asian Concrete Model Code
AS	Australian Standards
BS	British Standards
BSCP	British Standards Codes of Practice
BSI	British Standards Institution
CEC	Commission of European Communities (CEC)
CEN	Comite' European de Normalisation
CIDB	Construction Industry Development Board
CP	Code of Practice
DETR	Department of the Environment, Transport and Regions
DSM	Department of Standards Malaysia
EC	Eurocode
ENV	European Norm Pre-standard
IEM	The Institution of Engineers, Malaysia
JKR	Jabatan Kerja Raya (Public Works Dept.)
JPS	Jabatan Pengaliran dan Saliran (Drainage and Irrigation Dept.)
MS	Malaysian Standards
MSCP	Malaysian Standards Codes of Practice
NAD	National Application Documents
NZS	New Zealand Standards
PAM	Persatuan Arkitek Malaysia (Association of Architects, Malaysia)
SDC	Standards Development Committee
SIRIM	Standards Industrial Research Institution Malaysia
SWO	Standards Writing Organisation
UBBL	Uniform Building By-laws

POSITION PAPER FOR CONCRETE CODES OF PRACTICE IN LOCAL CONSTRUCTION INDUSTRY AFTER 2008

EXECUTIVE SUMMARY

BACKGROUND

The IEM Position Paper Committee was formed in July 2001 by the Civil and Structural Engineering Technical Division of The Institution of Engineers Malaysia, to study the impact of the withdrawal of the British Codes of Practice after year 2008 on the local construction industry.

This paper aims to provide a uniform, consistent and effective policies and procedures for recommending the necessary course of action in adopting the Eurocode EC2.

THE ISSUES AND CONCERNS

With the impending withdrawal of BS 8110 by year 2008, there will not be further maintenance, in the form of updates and amendments. This gives rise to the issues of what alternative code of practice will the local practicing engineers refer to.

If no action is taken, the local construction industry will face difficulty in competing against other countries in the globalised market due to non-recognition of standards.

The equivalent Malaysian standards MS 1195 : 1991 is a full adoption of BS 8110 : 1985, and its use is mandated in the local Uniform Building By-laws. Thus, the withdrawal of BS 8110 will have wide implications to the local construction engineering practices.

THE STUDY AND JUSTIFICATION

The committee has conducted an in-depth study of other codes of practices, besides BS 8110, such as ACI 318, AS 3600, NZS 3110, ACMC 2001, and ENV EC2. References may be made to literature review, referred books, published papers, written reports and other submitted works for details.

Malaysia has always used the British Standards as the main source of reference and since the British has decided to align with the European Union with the adoption of EC2, it would be prudent for Malaysia to follow suit. Besides gaining access to the latest technology in concrete engineering practices, local engineers would be able to get updates since the EC2 documents would have regular maintenance. Another advantage in adopting EC2 is its ready alignment with ISO, in terms of format and coverage. The design philosophies are in line with BS 8110.

EC2 has some unique features, such as National Annexes – formerly referred to as National Application Documents (NAD). This allows the incorporation of local parameters or items for special considerations, such as creep and shrinkage of concrete components especially in hot and humid Malaysian climates.

Many technical books and papers on EC2 are available for references, especially in the run up to the full adoption of EC2 in UK by 2008. This will ensure a smooth and easier transition, should a transitional period be required by local engineers, once the BS 8110 is withdrawn.

THE RECOMMENDATION

From the above study, IEM would recommend that EC2 be adopted as the concrete code of practice for the local construction industry after year 2008, when the BS 8110 is to be withdrawn by BSI. Although the study carried out only focused on concrete building structures, for coherence, the Committee recommends the adoption of EC2 in totality and the relevant parts of EC1.

It is also recommended that public forums, technical talks, and introductory seminars be conducted by IEM, as part of an awareness campaign to promote the adoption of EC2.

As part of the recommendations made, the committee also suggested that once the decision to adopt EC2 has been well-publicized and accepted, all local practicing engineers shall be re-trained in the use of EC2. IEM is also well poised to take the lead in conducting short courses in EC2 for the benefit of its many professional members. IEM may also initiate changes to the engineering course syllabus for local universities to educate engineering graduates in the design methods and approaches adopted in EC2.

The committee further recommends that the transitional period proposed by the UK practice to start implementing the standards in 2003 be adopted in Malaysia, with a view to full implementation by 2008.

1. INTRODUCTION

1.1 The Issues:

- The expected total withdrawal of BS 8110 after 2008 by BSI.

- Once withdrawn, there will not be further maintenance of BS 8110 – raising the issue of what concrete code of practice will local practising engineers refer to.

- The local construction industry will face difficulty in competition with other countries in a globalised market, due to non-recognition of standards used, if no action is taken.

- British Standards (including BS 8110) has been widely used and mandated in the Uniform Building By-laws (UBBL) in the form of MS 1195, thus its withdrawal has wide implications to local construction engineering practices.

- The lack of research culture locally and lag in independent development of local standards or codes of practices has not produced the necessary research data for further studies into local conditions in concrete usage.

1.2 Aim, Objectives and Scope of the Position Paper Committee

The aim of this Position Statement is to recommend the concrete code of practice to be adopted for local construction practices after 2008. In order to achieve the above aim, the committee has identified the following objectives and scope:

Objectives:

- To recommend a course of action which is deemed to be appropriate for the adoption of a concrete code of practice in place of BS 8110 after its expected withdrawal in 2008.

- To justify the recommended course of action in concrete code of practice adoption.

- To assist the Ministry of Science, Technology and Environment (as the decision-making authority) to make an informed decision

on the issue of adopting a new concrete code of practice, as the Malaysian Standards.

Scope:

- The study of the issue on adopting a suitable code of practice in the local construction industry is focused only on concrete code of practice.

- The committee is not in a position to recommend development of a wholly Malaysian Standard on concrete structures at this stage.

- BS 8110, as the current concrete code of practice is used as one of the main reference materials in conjunction with other similar documents on concrete usage, such as other national concrete codes of practice.

- The study made by the Position Paper Committee was done focusing only on concrete building structures.

- The function of the committee is mainly to examine and recommend policies on action plans, subject to approval by regulatory agencies or authorities.

1.3 The formation of the Position Paper Committee

- A committee was set up by the Technical Division of Civil & Structural Engineering, of the Institution of Engineers, Malaysia (IEM).

- It was chaired by Ir. M C Hee with invited members from the standards regulatory bodies, universities and practising engineers in the construction industry, to formulate a position paper on adopting a concrete code of practice after 2008.

- The list of committee members (past and present) is given in the Appendix.

- IEM will forward the recommendations made by the Position Paper Committee to higher authority for effective implementation.

2. BACKGROUND

2.1 Current Practices in the Development and Usage of the Malaysian Standard Code of Practice for Concrete

2.1.1 Development

The development of Malaysian Standard Codes of Practice (MSCP) is officially carried out by the Department of Standards Malaysia (DSM) under the authority of the Minister of Science, Technology and Environment. Operationally however, SIRIM Berhad (SIRIM) has been appointed by DSM to manage the work of the numerous Standard Development Committees (SDC) and Standard Writing Organisations (SWO). SIRIM has developed a well-defined system to manage the large network of SDCs and SWOs to produce high quality MSCP.

The rapid industrialisation of Malaysia and the globalisation movement has resulted in a surge in the demand for new national standards and put SIRIM's machinery under immense pressure. The shortage of funding, manpower and experts in the various fields, coupled with the demise of volunteerism has left SIRIM with no choice but to look more towards the adoption of International Standards. The MSCP for structural use of concrete, MS 1195:1991 was the product of the adoption of BS 8110:1985.

2.1.2 Usage

The By-Law 257 of the Uniform Building By-Laws (UBBL) under the Street, Drainage and Building Act 1974 stipulates that Malaysian Standard Specifications and MSCP are deemed to prevail over British Standard Specifications and BSCP respectively. Other than the By-Laws contained within the UBBL, there is currently no legislation in place to regulate the use of Codes of Practices in Malaysia.

Unfortunately, the Codes of Practice referred to in the UBBL are the out of date British Standard Codes of Practice (BSCP), for example BSCP 110 that has long been superseded by BS 8110. Both the UBBL and MS 1195 suffered from lack of maintenance, promotion and enforcement.

The actual practise by the professionals at large in Malaysia however is to refer to the latest revision of the BS 8110 rather than MS 1195. This is in part due to our past colonial link, ignorance, and resistance to change by the profession and reasons given in the previous paragraph.

Despite the presence of a large percentage of professionals having been educated in America, Australia, New Zealand and other countries and gained knowledge of the respective codes of practice, there was no effort to extract the best of each to develop the MSCP. Hence, BS 8110 has become the de facto national code of practice in Malaysia for concrete.

Of course, for structures outside the scope of the UBBL, the selection of the most appropriate Code of Practice for a project is still left to professional judgment.

2.2 Introduction of Eurocode in UK

In the summer of 1998, the Institution of Structural Engineers, UK hosted a meeting on the issues of the production and maintenance of structural design codes and the implementation of Eurocodes.

The meeting resulted in the formation of an Informal Codes Group consisting of senior engineers from various sectors of the industry. In December 1998, the group met the senior official of the Department of the Environment, Transport and Regions (DETR) and discussed on the concept of an independent review of codes of practice.

In September 1999, DETR suggested that the British Standards Institution (BSI) should facilitate a review. BSI announced the review in December 1999 and formed a Study Group in February 2000 to report to the Minister for Construction, The Presidents of the Institutions of Civil Engineers and of Structural Engineers, the Director of Standards and the Chairman of BSI.

In July 2000, the Study Group presented the report entitled, “Review of Structural Design Codes in Construction, Volume 1, Report of The Study Group on Structural Design Codes in Construction”.

2.3 Consequences on Withdrawal of BS 8110 by BSI, UK

By 2008, the withdrawal of the BS 8110 will have a major impact to the construction industry, during which it will be dealing with a set of documents, which are discontinued and outdated. Any major revamp or breakthrough in the research and development of concrete structures will be focused on the Eurocode EC2 document.

Although the existing BS 8110 is still adequate for at least another decade, those who persist in referring to BS 8110 will not receive

the benefit of continuous upgrading technology available to the newly adopted EC2.

There are two possible scenarios, which can be foreseen, in adapting to the withdrawal of BS 8110. They are:

- A fully Malaysian Code of Practice for Concrete Structures, to be drafted by local experts.
- Adopt the National Annexes, which are currently used in conjunction with EC2, as developed by UK.

The first scenario is the ideal choice for the development of a national code of practice, notwithstanding the mammoth task of producing such a document. This is likely to be beyond the capability of the local industry practitioners, at this stage. However, this could probably be realized in the future when local practitioners and researchers are ready and able to achieve major advancement in the research and development of concrete structures in the local context.

The obvious choice of scenario to be followed is to emulate the British, by adopting the National Annexes as developed by UK, to accompany the usage of EC2. Nevertheless, it is still a challenging option, as the National Annexes contains a set of unique parameters and recommendations which are used in conjunction with the usage of EC2, in order to suit local requirements.

In producing the National Annexes, there will be a need to draw upon inputs from various agencies and industry players, such as IEM, JKR, SIRIM, CIDB, PAM, DSM, JPS, local universities and specialists. It may be prudent for a working committee to be formed to tackle this issue with IEM taking the lead.

As funding for such a task is a primary concern, it will require deliberation from the various parties concerned, in order to secure the necessary resources.

2.4 Review of Courses of Action Adopted by IStructE and BSI

Development of code of practice is a continuous process. Even without the introduction of Eurocodes, the present BS codes are expected to undergo continuous amendments and changes due to the evolution of new knowledge through research, observations and experience of practicing engineers and researchers.

For decades, the British Standards adopted the CP 114, code of practice for the design of reinforced concrete structures; and BS 449, code for the design of steel. Both were the codes of practice produced by the British Standards Institution, and based on the working stress concept of design.

Subsequently CP 114 was replaced by CP 110 in 1972, the then code of practice which is based on the new concept of design called the limit state design (or ultimate strength theory). For the structural steel design, BS 449 was replaced by BS 5950 in 1985, which was also based on the limit state design concepts.

In 1985, a new code, BS 8110 was then introduced to replace CP 110. Since then, both codes BS 5950 and BS 8110 were subjected to various amendments so as to accommodate new findings from research and professional practices.

With the emergence of the European Union, the European Commission initiated a draft of the European design codes, called Eurocodes, for the design of building and civil engineering structures . The aim of EC is to establish a set of rules as an alternative to the differing rules, then in force in the various member states. The motivation was based on political or administrative consideration, as well as a technical desire, because Eurocodes will provide the means of demonstrating compliance with the essential requirement for structural stability in the Construction Products Directive.

Subsequently the British Standard Institution, indicated that no fund will be made available to maintain the existing standards, and any updating will be carried out on Eurocodes and National Application Document (NAD), a document that accompanied the use of Eurocodes in each particular European country.

3. LITERATURE REVIEW

3.1 Standards on Concrete Structures

3.1.1 British Standards on Structural Use of Concrete (BS 8110 - 1997)

References to British Standards were mainly focused on the usage of BS8110 – 1997, particularly on the provisions and scope for design. The immediate predecessor of BS8110 is the previous version, BS8110 – 1985 where the only major difference was the change of partial reinforcement safety factor from 1.15 to 1.05. Past versions of British Standards on concrete were published as

Code of Practices, namely CP114 – 1964, and CP110 – 1972. Notably, both these old and outdated versions are still listed as referenced documents in current Uniform Building By Laws (UBBL) Malaysia.

Other British Standards, which were briefly reviewed, include CP3: Chapter V (Part 2) -1972 Wind Loads, BS6399 Loadings for Buildings, and BS8007 – 1987 Design of liquid retaining structures. As other specialized structures such as bridges and marine structures are not within the scope of this Position Paper, BS5400 and BS6349 were not reviewed.

3.1.2 Australian Standards on Concrete Structures (AS 3600 -2001)

The Australian Standards on Concrete Structures was first published in 1934 as, AS CA2 Rules for Design, Fabrication and Erection of Concrete in Buildings. It was upgraded in 1974 to AS1480 and subsequent revision in 1988 to its previous form AS3600. The current version AS3600 – 2001 is currently under full revision. The standard covers reinforced, unreinforced and prestressed concrete design. Loads and load combinations are covered in AS1170 series, which are currently being revised in co-operation with New Zealand Standards to produced a joint standards on design actions, AS/NZS1170 – 2002.

3.1.3 New Zealand Standards (NZS 3101 : 1995 : Code of practice for the design of concrete structures)

First published as NZS3101P:1970 incorporating design requirements for reinforced and prestressed concrete this code has undergone regular updates before its current form.

Recognized as the most comprehensive seismic design standard in the world, NZS 3101 incorporates comprehensive design requirements for seismic loading, which have been derived from the excellent seismic research carried out in New Zealand by world-renowned experts like Robert Park, Thomas Paulay.

The code is mainly based on the strength (ultimate limit state) method of design with serviceability checks, which is mandatory for seismic design particularly with ductility and capacity design considerations.

Significant simplification can be obtained by the use of design and detailing provisions for members in structures of limited ductility subjected to earthquake loading. Only under special circumstances, does the code permits the structure to be designed as responding elastically to earthquakes, which considerably simplifies design

procedures by exempting the structure from the seismic requirements of the code.

With the exception of the provisions for seismic loading, ACI 318 Building code requirements for reinforced concrete, has been used with minor modification.

3.1.4 The Structural Use of Concrete 1987, Hong Kong

This document was drafted and issued by the Building and Lands Department Hong Kong, based on the various BSCP such as CP 114, CP 115, CP 116, CP 110 and BS 8110, although only those rules necessary for design and testing are included. Technical provisions for material quality and workmanship are still covered in the Building (Construction) Regulations which was issued in 1976.

In essence, this is a unified Code of Practice for concrete design, in which prestressed and precast concrete are included with provisions for reinforced concrete design.

3.1.5 Malaysian Standards on Structural Use of Concrete (MS 1195 - 1991)

Not much information is available on MS 1195 except that it is a full adoption of BS 8110 – 1985.

3.1.6 Asian Concrete Model Code (ACMC 2001)

This was a Japanese initiative in 1994, and is led by Japanese academics and researchers, with voluntary contributions from academics and practitioners from the Asia Pacific region. The current version of the code was published in 2001, for Level 1 and Level 2 documents, covering aspects of design, materials and construction, and maintenance. The main features are the 'three-level document structure' and the 'performance-based design concept'. It is envisaged that ACMC 2001 is still relatively new, and its acceptance by professionals in the region is uncertain at best in the short term. Nevertheless, the ACMC standard on maintenance of concrete structures has been adopted by the Vietnamese standards authority, as the preferred format in the drafting of their national standards.

3.1.7 ENV 1992 – Eurocode EC2: Design of Concrete Structures

In 1975 the Commision of European Communities (CEC) embarked on an action programme based on article 95 of the treaty of Rome to eliminate technical obstacles to trade and to harmonise technical specifications. This includes establishing a set of technical rules for the structural design of construction works. The Commission with the assistance of engineers and experts from member countries

developed the Eurocodes programme and published the first set of European structural codes in 1980s. In 1990 CEC transferred the development of the structural eurocodes to Comite' European de Normalisation (CEN), the European committee for standardisation.

At the current stage the standards are in pre-standard form and marked with ENV. They will be published in a full standard form (marked with EN) in stages. Eurocode 2 consists several different parts which covers specific types of structures such as bridges, liquid retaining structures, precast concrete and concrete foundations. Also includes under EC2 are parts which provides guidelines on structural fire design and the use of lightweight aggregate concrete. The full list of Eurocode 2 is shown in APPENDIX 1. Those items with DD in the table indicates that the documents are published together with their respective National Application Document (NAD) which will be explained later in this section.

The full standard of EN 1992- Part 1-1: Eurocode 2: General rules for buildings is expected to be published in 2003 and will be fully implemented in the United Kingdom in 2008. For the purpose of this position statement, it is proposed that the whole set of EC2 be recommended to be adopted in Malaysia. This is to ensure that a consistent design approach can eventually be applied to all types of concrete structures. It should be noted however that the present position statement committee has carried out an in depth study on EC2 Part 1: General rules for buildings only. Therefore, it is recommended that special committee should be established to carry out detailed studies on other parts of EC2. Refer to APPENDIX 2 for an outline format of the content in EC2.

3.1.8 ENV 1991 – Eurocode EC1, EN 206-1:2000 and National Application Document

EN 1991- Eurocode 1: Basis of design and actions on structures are the basic components of the standards that needs to be used together with EC 2. The table in APPENDIX 3 lists all parts under Eurocode 1. Except for parts on snow loads, all parts of Eurocode 1 should be adopted and used together with Eurocode 2.

Another document which needs to be adopted is ENV 206-1:2000: Specification, performance, production and conformity which provides guidelines on material properties.

Another feature of Eurocodes is National Annex or National Application Document (NAD). It contains information on parameters that are left open in the Eurocode for the national choice. The

parameters will allow member states to choose the level of safety, serviceability and durability applicable to their respective countries.

3.2 References

References were made to books, published technical papers, written reports and other relevant standards. More details of these can be found in APPENDIX 4.

4. DISCUSSION

4.1. Implications of Changes to Malaysia

- On adopting a new international standard in place of BS 8110, practicing engineers and academicians will have to re-learn new terms and different design approach or philosophy.
- All other supporting trades and skilled persons (such as material suppliers, draftspersons, quantity surveyors, and architects) will also have to adopt new mentality in terminology and standard practices.
- Approving authorities may have to re-organise standard practices and to re-train qualified engineers, to comprehend the acceptable level of submitted designs.
- Changes will have to be made to current national regulations (such as UBBL) to reflect the change in adopting another code of practice.
- Once on familiar ground, Malaysia will stand a better chance of competing globally in terms of standardization in engineering practices.
- Besides adopting an international code of practice, more research can be encouraged to develop National Annexes, which in time can be collated to form a Malaysian standard.
- Those affected countries such as Singapore and Hong Kong are on a "wait and see" mode, thus handing Malaysia the initiative to decide on a suitable code for adoption after 2008.

4.2. Justifications For Adopting EC2

- BSI has adopted EC2, so why should Malaysia not follow suit?. Besides gaining access to the latest technology in concrete engineering practices, local engineers would be able to get updates since the EC2 documents would have regular maintenance.
- Unique feature of National Annexes which allows incorporation of local conditions – such as creep and shrinkage in concrete, which are perennial problems in hot and humid climates.

- As Malaysia has limited research and development capability, and coupled with insufficient lag time to 2008, it is deemed advisable for Malaysia to adopt a suitable international standard in place of BS 8110 (i.e. EC2) – which are already adopted in some EU countries.
- It was suggested that to ensure a smooth transition, a code which is closest to BS 8110 be adopted (i.e. EC2) where literature and references are readily available and expanding in the market.
- Codes of practice which are aligned to ISO is very important – EC2 falls into this category, thus its adoption will put Malaysia in a favourable position to compete globally to export engineering skills and products worldwide.
- Other codes of practices are deemed unsuitable:
  (i) AS 3600 – a good quality standard, but not widely practiced worldwide, compliance to ISO is not confirmed, although Australian wind code is excellent and has been adopted as MS.
  (ii) ACI 318 – a high quality standard, but again commonly accepted in North America only, and many formulae are based on imperial units.
  (iii) ACMC 2001 – relatively new, and still under development, untried and untested as yet.
  (iv) NZS 3110 – similar situation to AS 3600, but seismic code is excellent, may be incorporated in MS.
  (v) Others – not considered in-depth.

5. RECOMMENDATIONS ON POLICIES AND PROCEDURES FOR CONCRETE CODES ADOPTION

IEM would like to recommend that the government through its relevant authorities and agencies should officially adopt the use of EC 2 and all other documents related to it (eg: EC 1) in Malaysia. EC 1 is a document which explains the basis of structural design. The official acceptance is considered vital and necessary so as to enable relevant authorities to enforce the use of Eurocodes among all the parties involved in the local construction practice such as the government bodies, consulting engineers, contractors, material suppliers etc. It is suggested that Malaysia should commence to use EC 2 once BS 8110 is officially withdrawn. Before that date the use of EC 2 should be encouraged in order to allow local engineers and authorities to familiarise with the principles and usage the new concrete code.

The acceptance should be gazetted and eventually should be incorporated into all legal documents such as UBBL. As the first step, SIRIM or

Department of Standard, Malaysia may need to apply for the right to use Eurocodes from British Standard Institution.

It should be noted that the process of shifting from BS 8110 to EC 2 will cause a massive impact to the construction industry in Malaysia. Apart from the need to train all local engineers with the new code of practice, the shifting will also involve various aspects pertaining to the practice of design and construction. A smooth and systematic transition should be carefully planned.

Another concern is that the content of the code itself, which may have provisions deemed unsuitable or irrelevant in Malaysian context. It may be the right time for Malaysia to adopt EC 2 as the basis to develop its own concrete design code. This aspect should be thoroughly studied as it may require significant research activities by local academics and practitioners.

In view of the issues raised above towards the adoption of EC 2 and other related documents, it is therefore appropriate to propose that a special committee be set up. The task of this committee is to formulate the implementation strategies of EC 2 and also to study on the possible effort to develop our own NAD or eventually to have our own code of practice.

IEM would like to recommend that the Government through its relevant authorities and agencies should officially accept the use of Eurocode EC2 and all other documents related to it (e.g. EC1) in Malaysian construction and concrete engineering practices by 2008. EC1 is a document which explains the basis of structural design. The official acceptance is considered vital and necessary so as to enable relevant authorities to enforce the use of Eurocodes among all the parties involved in the local construction practice such as the government bodies, consulting engineers, contractors, material suppliers, etc. It is suggested that Malaysia should commence to implement the usage of EC2 once BS8110 is officially withdrawn in 2006. Before that date, the use of EC2 should be encouraged in order to allow local engineers and authorities to familiarise with the principles and usage of the new concrete code.

IEM has the capability to take the lead in this task force with financial support from the Department of Standards Malaysia (DSM).

6. CONCLUSION

The Committee has conducted an in depth study of EC2 – Design of Concrete structures besides BS 8110 and other concrete codes of practice such as ACI 318, As 3600, NZS 3110 and ACMC 2001. In the Malaysian context, EC2 offers some unique features such as National Annexes,

formerly referred to as National Application Documents (NAD) which allows the incorporation of local parameters such as concrete creep and shrinkage values into the document.

EC2 is compliance to ISO format and thus its adoption will put Malaysia in a favourable to compete globally to export engineering skills and products worldwide. By culture and tradition, Malaysia has always follow the British codes of practice and since UK has adopted EC2, it would be prudent for Malaysia to follow suit. Many technical papers and books are available for reference especially in the run up to the full adoption of EC2 in UK by 2008, thus making the transition easier and smoother. The Committee recommends that EC2 be adopted as the concrete code of practice for the local construction industry after year 2008.

7. COMMITTEE MEMBERS

Ir. M C Hee	Chairman	IEM
Ir. Assoc. Prof. Dr. Wahid Omar	Deputy Chairman	UTM
Dr. Jeffrey Chiang	Secretary	IEM
Ir. Li Thang Fai	Member	IEM
Ir. Hooi Wing Chuen	Member	IEM
Ir. David Ng	Member	IEM
Ir. Tan Teck Eng	Member (resigned, Aug 2001)	IEM
Ir. CMM Aboobucker	Member	IEM
Ir. S P Lee	Member	Perunding Bersatu
Ir. Assoc. Prof. Dr. Mohd Saleh Jaafar	Member	UKM
Assoc. Prof. Dr. Muhd Zaimi Abd. Majid	Member	UTM
Ir. Andri Abdul Rahman	Member	ACEM
Dr. Kosai Aziz Al-Sanjery	Member	UNITEN
Ir. Lim Thiam Chai	Member (resigned, October 2002)	SSP
Mr. James Ng	Member	VSL
Ir. Rajinder Raj	Member (resigned, August 2002)	SIRIM
En. Aminudin Abd. Aziz	Member (resigned, August 2002)	SIRIM
Ir. Lim Ek Peng	Member	Hashim & Neh
Ir. Leow Kay Pin	Member (resigned, Oct 2001)	Master Builders
Mr. Low Son Heng	Member (joined, January 2003)	Master Builders

Appendix 1

ENV 1992 Design of concrete structures (EUROCODE 2)

DD ENV 1992-1-1:1992	General rules and rules for buildings
DD ENV 1992-1-2:1996	Structural fire design
DD ENV 1992-1-3:1996	Precast concrete elements and structure
DD ENV 1992-1-4:1996	Lightweight aggregate concrete
DD ENV 1992-1-5:1996	Structures with unbonded and prestressing tendons
DD ENV 1992-1-6:1996	Plain concrete structures
DD ENV 1992-2:2001	Concrete bridges
ENV 1992-3:1998	Concrete foundations
DD ENV 1992-4:2000	Liquid retaining and containment structures

Appendix 2

Format of Eurocode EC2

Chapter 1 – Introduction

Chapter 2 – Basis of Design

Chapter 3 – Materials Properties

Chapter 4 – Section and Member Design
- Section 1 – Design requirements
- Section 2 – Design data
- Section 3 – Ultimate limit state considerations
  - Sub-section 1 – Flexure, axial actions
  - Sub-section 2 – Shear actions
  - Sub-section 3 – Torsion
  - Sub-section 4 – Punching
  - Sub-section 5 – Buckling (sway)
- Section 4 – Serviceability limit state considerations
  - Sub-section 1 – Stress control
  - Sub-section 2 – Crack control
  - Sub-section 3 – Deformation (deflection) control

Chapter 5 – Detailing Provision
- Section 1 – Steel reinforcement
- Section 2 – Prestressing
- Section 3 – Structural members
- Section 4 – Limitations of damage due to accidental loads

Chapter 6 – Tolerances

Chapter 7 – Quality Control

Appendix 3

ENV 1991 Basis of design and actions on structures (EUROCODE 1)

DD ENV 1991-1:1996	Basis of design
DD ENV 1991-2-1:1996	Densities, selfweight and imposed loads
DD ENV 1991-2-2:1996	Actions on structures exposed to fire
DD ENV 1991-2-3:1996	Snowloads
DD ENV 1991-2-4:1997	Wind actions
ENV 1991-2-5:1997	Thermal actions
DD ENV 1991-2-6:2000	Actions during execution
ENV 1991-2-7:1998	Accidental actions due to impact & explosions
DD ENV 1991-3:2000	Traffic loads on bridges
DD ENV 1991-4:1996	Actions in silos and tanks
ENV 1991-5:1998	Actions induced by cranes and other machinery

Appendix 4

A4.1 Referred Books and Published Papers

A4.1.1 R.S. Narayanan, 'Concrete Structures: Eurocode EC2 and BS 8110 Compared'

This is a commendable effort by the author in producing a detailed and comprehensive comparison between EC2 and BS 8110 in terms of design philosophy and approach. It covers the basis or principles of design, analysis as well as design for both ultimate and serviceability limits states. Some of the design aspects covered include flexure, axial, shear torsion, punching shear and column action. Stress checks, crack control and deflection checks were also highlighted. Lastly, detailing and prestressed concrete design were also explained in detail.

Simple numerical design calculations were shown for both EC2 and BS 8110, but not on real life design structural calculations.

A4.1.2 Proceedings of ICE on Eurocode (Authors: R.S. Narayanan, H. Gulvanessian and R. Driscoll)

A series of papers were published by these authors which provide a detail introduction of Eurocode. It also describes the potential benefits they offer to civil engineers (in every EC member state) and set out the process and timetable for implementation.

The authors also highlighted the innovative approach in reliability and risk management and limit state design philosophy. The matter of loading combinations for all European structures was suggested to require further assessment. EC1 on actions on structures was also introduced as a document which covers all types of loads (or actions).

An introduction to EC2 on design of concrete structures was presented, in which it explained the principles of ultimate and serviceability limit state design and the requirements for shear, durability and fire resistance.

A4.1.3 IEM October 2001 Bulletin, 'BS 8110 Replaced by EC2: Are We Ready for It' (Author: Ir. Assoc. Prof. Dr. Wahid Omar, Zaiton Haron and Zainab Arman Ali)

In this paper, a comprehensive comparison between EC2 and BS 8110 was made and presented. Some of the major differences identified include, terminology and notation, content and layout, material properties, design for durability, ultimate and serviceability limit states in design, and detailing.

From the design parameters being compared, the author commented that some design formulas in EC2 are more complicated than those of BS 8110. Additionally, EC2 gives more detail guidance on shear design and imposes additional limits on serviceability limit state checks.

A4.2 Written Reports and Other Submitted Works

A4.2.1 'Review of Structural Design Codes in Construction', Vol. 1, prepared by The Study Group on Structural Design Codes in Construction, UK (2001).

A4.2.2 Status Report (Feb 2001) on Pre-Standard (ENV) and European Standard (EN)

A4.2.3 'Comparison of Design Section for Flexure – BS 8110, EC2 and AS 3600', prepared by Ir. MC Hee (2001)

A4.2.4 'Comparison BS8110 and AS3600 for Prestressed Concrete Design', prepared by Ir. MC Hee (2001)

A4.2.5 'Comparison BS 8110, AS 3600 and EC2 for Design Load Combinations', prepared by Ir. MC Hee (2001)

A4.2.6 'Design Section for Flexure Using NZS3101', prepared by Hooi WC (2001)

A4.2.7 'Proposed Outline of IEM Position Statement On Structural Codes With Special Reference to Eurocode', prepared by Assoc. Prof. Wahid Omar (2001)

A4.3 Other Standards

A4.3.1 MS 1553 : 2002 – 'Code of Practice on Wind Loading for Building Structure', published by SIRIM Berhad.