The Institution of Structural Engineers
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Structural Engineering for Conservation

Ian Hume

What is Conservation Engineering?

Conservation Engineering is structural engineering in the field of conservation. It includes the structural engineering aspects of repair, refurbishment, rehabilitation, and renovation but goes further than these terms suggest. It is actively involved with the conservation of both the hidden and visible structure of listed buildings, scheduled ancient monuments and buildings within conservation areas. It is not always looking for the cheapest option although conservation need not always be the more expensive option.

Conservation philosophy

When a building or structure is listed everything within the curtilage (usually the boundary) of that building is deemed to be listed. A building is not usually listed for one particular feature but is listed as a whole, all parts being considered important.

Whilst it is easy to understand that the exterior appearance of a building is of historic and aesthetic importance it is often not appreciated that the hidden structure is also considered to be important. Floor joists and beams for example, cannot be destroyed without listed building consent being given.

The best alternative from the conservationist viewpoint is the original building in its original location and in its original condition serving its original purpose. Many buildings fall into this category but many more change their use and their condition demands repairs; listed building consent may well be needed for such repairs. Conservation engineers have to temper their philosophy of conserving as found and of minimum intervention with their responsibility for the safety and structural integrity of the building and of its users.

There are perhaps five “principles of conservation”:

1. Conserve as found,
2. Minimum intervention,
3. Like for like repairs
4. Repairs should be reversible,
5. Repairs should be sympathetic.

It will be appreciated that these cannot all apply in all cases.

Conservation engineering techniques.

The first test of suitability for any technique proposed for the consolidation of historic fabric is "it tried and tested"? Tried and tested techniques are preferable to new methods that may have an unforeseen detrimental effect on the building at some time in the future. A further test for suitability is whether or not the technique is reversible; can it be taken out at a later date without significant damage?

Other questions regarding suitability include

Are the repairs really required or will the building survive without them?

Does the proposed work improve the overall structural stability of the building?

What damage will be caused if these repairs are carried out?

Will the repairs be seen?

If they are seen, are they to blend in with the existing fabric or are they to contrast whilst still being in harmony?

Will future historians be able to date the repairs?

If there is a need to mix materials, what effects might this have?

Will the building lose its inherent flexibility which enables it to cope with climatic changes without distress?

Do the proposed methods meet the axioms "minimum intervention" and "conserve as found"?

The art of conservation engineering

Structural engineering for conservation is an art as well as a science. It takes little effort to design a major and intrusive scheme to deal with a perceived problem. It takes considerable expertise and experience to evolve a scheme that improves the condition of the structure which is unobtrusive and sympathetic to the historic fabric but which ensures that it has a sound future.

Experience and expertise are also needed to decide whether a building which is distorted actually has a current problem or if the distortion is a result of movements which took place a long time ago and which are not likely to recur.

It takes experience and an understanding of traditional buildings to carry out sympathetic repairs to historic fabric, not just ability with numbers.

It is not at all easy to decide to do nothing to the structure but very easy to advise demolition.

Load testing and structural monitoring

Load testing can be of great help in determining the structural adequacy of something that defies proof by calculation and it gives a deeper insight into the understanding of how old buildings work. Structural monitoring is sometimes carried out to help in the diagnosis of problems but more often it is done to prove beyond doubt that fractured buildings showing signs of distress are in fact stable. Structural monitoring can be complex and expensive but a great deal of use can be made of straightforward and inexpensive techniques and it is these more simple methods which are underused but which have considerable potential.

The involvement of the engineer

It is important that sympathetically minded engineers become involved at a very early stage. The future of many listed buildings relies on the amount of damage caused by proposed works. All too often the layout of a listed building is replanned without a proper understanding of its construction and structural condition thus condemning it to unwarranted disfigurement.

Conclusion

It is in the area of the safety of the building that conservation engineers most often finds themselves in the centre of the argument. The owners and their engineers may consider that buildings are dangerous and should be demolished forthwith whilst the purist conservationist wishes to retain everything than can possibly be retained. However it is of no use whatever retaining a building or structure that is dangerous but very often a building is by no means as dangerous as it at first appears.

The philosophy of conservative repairs to buildings can be considered as being on a sliding scale of desirability.

1. do nothing
2. add extra members in similar material
3. add extra members in foreign materials
4. traditional repairs
5. insert new materials into the existing materials
6. replacing isolated members
7. replacing whole elements of the building
8. facadism
9. facsimile structures.

However, life is rarely simple and many cases will be a combination of two or more of these levels of desirability.

Introduction to Eurocode 2

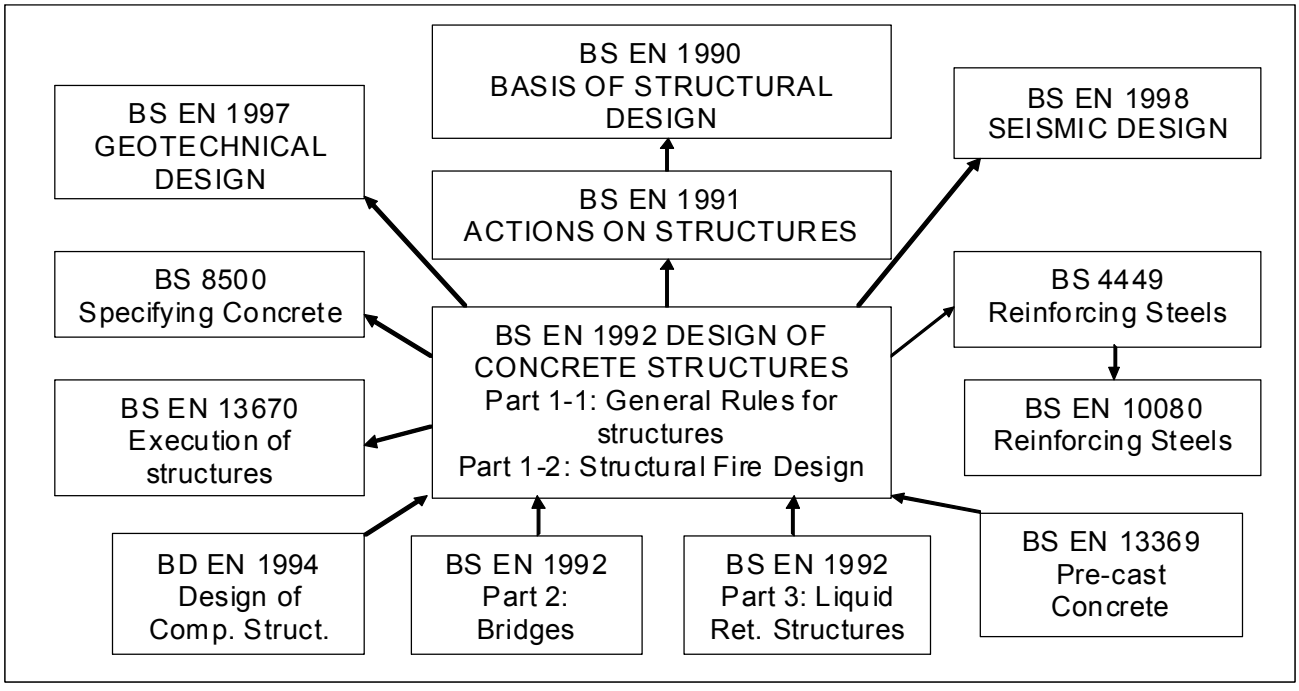
Andy Hallum

Speaker: Owen Brooker (The Concrete Centre)
Date: 18th October 2005
Eurocode development began in 1975. Some thirty years on they are now being published for use. There are 10 Euro Standards containing rules for designs and construction, which will be used in 28 European countries. The Eurocodes include the main text as well as the National Annex (NA). The main text contains Principles (P), which comprises of general statements, definition, requirements and analytical models for which no alternatives are permitted. The NA provides the Nationally Determined Parameters (NDPs), which take into consideration safety, economy and durability.
The 10 Eurocodes are:

- BS EN 1990 (EC0): Basis of structural design
- BS EN 1991 (EC1): Actions on Structures
- BS EN 1992 (EC2): Design of concrete structures
- BS EN 1993 (EC3): Design of steel structures
- BS EN 1994 (EC4): Design of composite steel and concrete structures
- BS EN 1995 (EC5): Design of timber structures
- BS EN 1996 (EC6): Design of masonry structures
- BS EN 1997 (EC7): Pyrotechnical design
- BS EN 1998 (EC8): Design of structures for earthquake resistance
- BS EN 1999 (EC9): Design of aluminium structures

EC0 and EC1 are the basis of all structural design as they include the information to derive the loading and reactions. One the main differences between Eurocodes and British Standard is the factors used when calculating the ultimate limit state (ULS). In the Eurocode, the ULS can be derived to be $1.25G_k + 1.5Q_k$ providing the permanent actions are less than 4.5 times the variable actions. There are now 3 ways to calculate the serviceability limit state depending on the type and duration of live load acting on the structures. Another main difference is the bulk density of reinforced concrete has been increased to 25 kN/m^3. The UK NA proposes to keep the loads the same as in BS 6399.
EC2 provides information for the design of concrete structures and has 4 parts, covering the common design rules for building and civil engineering structures, fire design, bridges and liquid retaining structures. The design is based on characteristic cylinder strength as opposed to characteristic cube strength. The EC now includes higher strength of concrete, although they require different design equations to standard concrete classes. Mild steel bars are no longer to be used, as the minimum characteristic yield strength is now 400MPa, with the UK NA adopting a maximum of 600MPa. The notation of steel reinforcement is also to change under the new Eurocode. EC2 allows the engineer to derive the design equations from the rectangular concrete stress block and by selecting the appropriate stress – strain diagrams. The deflection can now be calculated by 2 methods: direct calculation and limit span to depth ratios. The method for the design of column due to axial loading is more complex and will probably require computer analysis.
Throughout the next 12 months, the remaining Eurocodes are to be published, and will co-exist with British Standard until 2010, although it is proposed to withdraw BS8110 in Jan 2008. Many of the British Standards are to be updated throughout 2006 to accommodate the Eurocodes. The introduction of the Eurocodes will present some challenges. For example, the Eurocodes use a comma (,) as a decimal marker and do not contain derived formulae. These will create a steep learning curve along with new symbols and terminology. However, Eurocode 2 is considered to be less restrictive, more extensive and ultimately produces more economic solutions than current codes.

Figure 1: Eurocode 2 Relationships (Courtesy of The Concrete Centre)



The Clifford Evans Award (Papers)

Jeff Venus

November 01 2005 Trevithick Building, Cardiff University was the second year of presentations for the annual papers competition held to celebrate the life of Clifford Evans. Although many will have known Clifford or at least be aware of his standing in the local, national and indeed international engineering communities, by way of a reminder he was a former President of the Institution of Structural Engineers (the only Welsh president of The Institution of Structural Engineers) and founding partner of Wallace Evans (which later became part of Hyder Consulting).

Three papers were given on the evening:

- A249 The Swale Crossing – by Gareth Davies of Cass Hayward LLP.
- Research undertaken at Cardiff University into the Development and Constitutive Behaviour of a High-Performance Fibre-Reinforced Cementitious Composite (HPFRCC) CARDIFRC – by Dr Sharon Benson of Parsons Brinkerhoff
- The Behaviour of the Reinforced Concrete Deck during the Launch of Bishop's Bridge Road – by Tim Nuttall also of Cass Hayward LLP.

All three papers were to a high standard as were those in the first year of the competition. However, the judges on the evening felt that Tim Nuttall presented the best paper with Gareth and Sharon taking joint second prizes. They are all to be congratulated on their efforts as are those that submitted papers for consideration, but were not successful on this occasion.

The first prize winner received a cheque for £600 and the two runners up each received cheques for £200. Prize money was provided by Hyder Consulting who we are grateful to for sponsoring this annual papers competition.

Each winner of the competition was invited as a guest to the Branch Annual Dinner held on 25 November 2005 in the Marriott Hotel, Cardiff. Formal awards were given on the evening of the Dinner by Michael Dickson CBE the President of The Institution of Structural Engineers.

We are running the competition again this year, possibly for the last time as this will mark the end of the three year sponsorship agreed with Hyder Consulting. Details of the competition and the rules of entry are appended and will appear in the Wales Branch website and The Institution of Structural Engineers journal.
Be part of this unique experience and submit expressions of interest to me at jeff.venus@channelconsulting.org by the 29 August 2006. Remember that this may be your last opportunity to take part if further funding does not become available. So, if you are under the age of 35, and wish to raise your profile and get some valuable presenting experience and the kudos of winning, start tapping on that keyboard.

Useful Web Addresses

Chris Usher

Institution of Structural Engineers (also, follow links) www.istructe.org.uk
Institution of Civil Engineers (also, follow links) www.ice.co.uk
Welsh Assembly Government www.wales.gov.uk
Building Research Establishment Environmental Assessment Method www.breeam.org
BRE EcoHomes www.breeam.org/ecohomes
Budgeting for sustainable procurement. Department for the Environment/Building Research Establishment. www.bre.co.uk/sustainableprocurement
Clear Skies. Department for the Environment/Building Research Establishment advice on grants and funding for renewable energy projects. www.clear-skies.org
Construction Industry Research and Information Association (CIRIA) Directory of businesses receiving grading and selling recycled products. Site is searchable by product and area. www.ciria.org/recycling
Department of Trade and Industry www.dti.gov.uk/energy
Construction Industry Research and Information Association (CIRIA) www.ciria.org.uk
European Environment Portal www.europa.eu.int/comm/environment
Waste and Resource Action Programme (WRAP) www.wrap.org.uk
Recycled Products (including Construction) www.recycledproducts.org.uk
Recycled Aggregates (including certified) Directory www.aggregain.org.uk
The Carbon Trust (including free site surveys and toolkit for energy conservation) www.thecarbontrust.co.uk
British Wind Energy Association www.bwea.com

Hong Kong Building Environmental Assessment Method www.hk-beam.org.hk
Sponge. A network of constructing professionals promoting sustainable development. www.spongenet.org
Elephant and Castle, London, Website www.into.org.uk/elephantandcastle
Association for Environment Conscious Building www.aecb.net
Sustainable building resource (Directory of resources) www.iris.ba.cnr.it
International Initiative for a Sustainable Built Environment (Promoting Energy and Environmental Performance in Buildings) www.greenbuilding.ca
Renewable Power Association www.r-p-a.org.uk
Green Building Press www.newbuilder.co.uk
Centre for Alternative Technology www.cat.org.uk
Leadership in Energy and Environmental Design (USA equivalent of BREEAM)www.usgbc.org

The Clifford Evans Award (Rules)

Jeff Venus

The Clifford Evans Award is a papers competition open to all UK corporate and non-corporate members of the Institution of Structural Engineers and the Institution of Civil Engineers, who are under the age of 35 on the 10th October, in the year of the competition.

The topics of the competition are restricted to those which were of both interest and contributed to by Clifford Evans. They can include any combination from :-

a Reinforced concrete.
b Pre-stressed concrete.
c Port / Marine works.
d Sports facilities.
e Contract Law.

Papers can include project or research work, but they must be linked to Wales in some way i.e. they must be designed, constructed or researched here in Wales.

Entrants wishing to participate must firstly express interest by the 30 August and then submit a maximum of a 1000 word synopsis to Jeff Venus of the Wales Branch by 29 September in the year of the competition.
The synopsis will be judged and if successful short listed by the nominated Clifford Evans Award Panel. Candidates will be notified if they have reached the shortlist by 16th October in the year of the competition.
Three candidates shall be short listed for a maximum, twenty-minute presentation, to take place in Cardiff during mid November. The exact date of the presentation is to be notified in late October in the year of the competition.
The presentation, based on the synopsis, shall be presented to the membership and the Clifford Evans Award Panel.
The presentation will be judged and scored by each member of the Panel, with the maximum accumulative score providing the winner of the Clifford Evans Award.
The scoring Matrix for the evening used by the Clifford Evans Award Panel will be as follows

	MAX SCORE
TECHNICAL CONTENT	
Accuracy and Clarity of Technical Content	25
Relevance (dependant on no. of topics)	10
Newness of Content	15
	50
PRESENTATION STYLE	
Degree of interest to Structural Engineering	20
Confidence of Delivery	10
Clarity	10
Competence in appropriate use of Aids	10
	50

The winner of the Clifford Evans Award will be notified on the evening of the presentation, with a formal presentation taking place at the IStructE Wales Branch Annual Dinner in November. The winner will receive a certificate and a cheque in the amount of £600 from Hyder Consulting at the Annual Dinner. The other two contestants will each receive a certificate and a cheque for £200. The Clifford Evans Award Panel decision will be final.
Any candidate wishing to enter this years competition should contact Mr. Jeff Venus, Channel Consulting Limited, 5 Kelston Place, Whitchurch, Cardiff CF14 2AP Tel/Fax; 029-2021-4909
E-mail: jeff.venus@channelconsulting.org with expressions of interest before 30 August 2006.

Top Civil/Structural Engineering Courses at Glamorgan

Civil Engineering staff at the Faculty of Advanced Technology, University of Glamorgan, recently received official conformation from the Joint Board of Moderators (JBM) that the BSc Civil Engineering and BSc Civil Engineering with International Studies awards have been re-accredited as fully satisfying the academic base for an Incorporated Engineer under the provisions of the UK Standard for Professional Engineering Comptence (UK-SPEC).

The JBM represents the Institution of Civil Engineers (ICE), the Institution of Structural Engineers (IStructE), the Institution of Highways and Transportation (IHT), and the Institute of Highway Incorporated Engineers (IHIE). A JBM panel made an accreditation visit to the University on 23-24 March this year.

In addition, the three masters programmes, i.e.,

PgDip/MSc in Civil and Structural Engineering; PgDip/MSc in Civil Engineering and Environmental Management; PgDip/MSc in Civil Engineering for International Development,

have also been approved by the ICE, IStructE and IHT as meeting the requirements for Further Learning for a Chartered Engineer (CEng) under the provisions of UK-SPEC.

The University is a strong provider of civil engineering higher education in Wales, UK and internationally, and is particularly experienced the provision for part-time courses. It started the HNC and then BSc programmes in the late 1950s and the MSc awards in the 1979. Many of its estimated 9500 strong graduates are actively engaged in the civil engineering and construction industry or related professional fields, with an appreciable number of company directors, CEOs, principal engineers, professors and government employees in Wales, the UK and across the world.

“The JBM accreditation and approval is excellent news for our students,” says Head of Division of Civil Engineering, Dr David Tann, “the undergraduate students will be reassured that they are studying on a course that has the highest standard, well thought of by experts and accredited for IEng status. For the first time, studying the PgDip/MSc civil engineering awards at the University will enable those who aspire to become chartered engineers to fulfil the EC[uk] Further Learning requirements.”

For further information of all civil/structural engineering courses at the University of Glamorgan, please contact Dr David Tann (01443 482164, email: dbtann@glam.ac.uk) or call Freephone 0800 716925.