STATISTICAL LOAD MODELLING FOR THE ASSESSMENT OF SHORT- TO MEDIUM-LENGTH HIGHWAY BRIDGES

Bridge loading consists of normal (HA – BD37/01, LM1 – EC 1.3) or abnormal (HB – BD37/01, LM3 – EC 1.3) loads. In the assessment of existing bridges, abnormal loads can be controlled by weight restrictions and permit-based systems (such as EIRSPAN). However, normal loading – normally governed by illegally overloaded trucks – cannot be so readily determined or controlled. Practitioners involved in assessing bridges are well aware of the conservative nature of the normal (HA-type) loads that they are assessing the bridges for (BD21/01). This is so, as any design or assessment code will cover a large geographical region and road class range, and as such will apply to the worst loading regime in that region/class. Thus, the loads to which a 30 m bridge in a remote rural area is actually subjected to will not be the same as those of a similar bridge in a heavily trafficked urban site. The key to solving this problem is to measure the actual traffic loading at the site for a period – normally using a form of Weigh-In-Motion (WIM). The use of WIM is generally undetectable by the road-user and thus yields unbiased data. Such measurement is expensive and two-week measurement periods are usual.

Detailed statistical modelling of the characteristics of the traffic at the site (such as gross vehicle weight, axle weights, number of axles, axle-spacings, truck-type proportions, average hourly flow rate, speed, headways for different flowrates etc.) can be carried out and used to simulate up to about 5 years of truck traffic (cars are not critical). This simulated traffic is then passed over the influence lines of the load effect and bridge of interest, yielding load effect data: normal ranges of computing power still render the simulation of traffic for the full return period prohibitive. Results such as the maximum mid-span bending moment per day caused by 2-truck meeting events are then available for the simulation period.

Further statistical analysis is performed on the load effects induced by the generated traffic. Different forms of loading events constitute different forms of statistical mechanisms, that is, two average trucks meeting on a bridge will tend to be more critical than a heavily overloaded single truck, for example. It is the combination of these differing mechanisms, in such a way as to yield a characteristic load effect with an average probability of occurrence of once in the design return period, that has been of great interest in recent work. Further, assessing the variation of the characteristic load effect arrived at through the above process has led to questions about the adequacy of statements such as 10% chance of exceedance in 100 years or 1 exceedance in 1000 years.

Further work will establish simpler models that may be more suitable for use on a day-to-day basis. The same statistical methods may also be used to examine the effect of changes to the truck population such as new forms of trucks. It is hoped that designers and assessors will become more aware of the powerful tool that statistics offers in reducing the cost of repair and rehabilitation of bridge stocks, not only in Ireland but across the world.

Colin Caprani and Prof. Eugene O'Brien,

UCD Civil Engineering

STUDENT PRIZE EVENING

On 11th October the Branch held an evening meeting at which the nominees from each college for the student prize presented their work. Those who presented were:

- Maire Greene & Donal Gannon, *Three-Dimensional Flexibility Model Using Pattern Recognition*, National University of Ireland, Galway;
- Emma Sheils, *A Finite Element Analysis of the Old and New Tacoma Narrows Bridge*, Trinity College, Dublin;
- Cathal Dullea, *Precast Concrete Floor Slab Design*, Cork Institute of Technology;
- Louise Lynch, *Understanding Finite Element Analysis*, Dublin Institute of Technology, Bolton St.;
- James Flahavan & Donnchadh Campell, *An Investigation into Compressive Membrane Action Using Finite Element Analysis*, University College Dublin.

The judges – Brian Mahony, Sara Devitt and Tom McKenna – were very impressed by the standard of work presented, and found it difficult to determine the winner of the Overall Branch Student Prize. However, Emma Sheils of Trinity College Dublin particularly impressed the judges with her work on the complexity of modelling suspension bridges for dynamic analyses and she wins the prize this year. The others receive both a scroll from the Institution and a small gift from the Branch, in recognition of their achievement and work in nomination and presentation.

CHARTERED MEMBER EXAMINATION PREPARATION COURSE

The date for the next C.M. examination is Friday 21st April 2006 and a preparation course for engineers planning to sit the exam will be held in the Dublin Institute of Technology, Bolton Street, Dublin 1, between 6.30pm – 9.30pm on Monday 6th, 13th, 20th, and 27th of February 2006.
The course covers the examination format, examiners' expectations, design concepts and short cut analysis. Participants will be grouped and assigned a past paper question each week. A presentation of the solution will be presented by each group on the following week in order to facilitate open discussion by course participants and guest presenters.

The course fee will be €150 which will include hard copies of all previous past papers. Further information may be obtained from Joe Ryan at 01-2832967 or Ms Una Cribbin at 01-4023635.

Joe Ryan, Hanley Pepper

COMMITTEE 2005-2006 SESSION

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BRANCH MEMBER EXCELS

Peter Brunner of O'Connor Sutton Cronin has won a prize for achieving the highest standard in the 2005 Part 3 Examination to become a Chartered Member of the Institution. The 7 hour exam is known as one of the toughest test of engineering competence.

Peter won the AE Wynn prize for the best solution to the concrete question, and joins only two other Branch members to have won similar prizes. Michael Carew and Eddie Fallon, both well known to Graduates of DIT Bolton St. over many years, won the Graham Wood prize for excellence in 1964 and 1975-6 respectively.

Peter said of said of his achievement: 'I am absolutely delighted to win this prize, especially as it is such a highly esteemed exam. I am now a Chartered Structural Engineer, and have laid the best foundation on which to build my career!' The Branch committee congratulates Peter and wishes him every success in his future career.

Designing for Safety in Construction Under the Safety, Health and Welfare at Work (Construction) Regulations 2001

The introduction in the guidelines to the regulations deals with the duties laid on designers to 'take account of the general principals of prevention as specified in the first schedule of the Principal Regulations'. We do not concern ourselves with duties of the Project supervisor Design Stage; that is a separate issue.

In considering that safety should be an integral part of the design process we are enjoined to:

- Seek to identify the key construction hazards and risks
- Design out these risks
- Mitigate the risks by combating these at source
- Facilitate lower order protective measures

The designer must consider the safety and health of persons maintaining the place of work. Hazards must be identified, but the guidelines state that there is no statutory duty to carry out formal risk assessment of health and safety issues. Further, the degree of risk assessment must be proportionate to the nature of the project.

The guidelines go on to outline an assessment matrix method of evaluating risk and develops it where there is more than one member of a design team and the necessary co-operation required. It accepts that designers who are normally thought of as designers have expertise in designing buildings/structures to be safe and suitable for its intended purposes. They do not necessarily have the expertise in regard to the building means, methods and procedures or experience of construction methods designing buildings/structures nor can they control the resources or management of the work. The guidelines accept that a designer could not hope to identify all possible hazards but can identify as many as possible and try to mitigate them.

The next point is the method of communicating the assessment of hazard and risk. It is suggested that they should keep records of the hazards they have identified and hope that this quantifies the associated risks. But the guidelines do not prescribe how designers should record their considerations and suggests that each practice should have its own approach. They then suggest a format. Further on, they state that designers should record only key information and decisions and should avoid unnecessary bureaucracy.

All this is contradictory in my view. If the regulations are to be taken seriously then the work should be done properly. I suggest that the guidelines are either somewhat disingenuous or reveal a lack of knowledge of the entire building process.

Tom McKenna, The McKenna Pearce Practice

The final part of this article will be in the next newsletter

NMA OFFICES, BAGGOT COURT

Travelling along Baggot Street towards St. Stephen's Green, between Fitzwilliam Street and Pembroke Street, one will see a narrow archway on the southside of the road. Travelling through this seemingly narrow brick alley-way, one will be opened up to the recently completed jewel of Baggot Court. Where once stood a dull office building and surface carpark, now stands a mixed development of distinguished and elegant beauty.

NMA Architects were both the clients and the architects for this project, with their Dublin office residing in the existing building on site. The project involved a compete refurbishment of the existing building, including an additional floor, and a new build section on the existing carpark extent of the site. The development would consist of four luxury apartments and a state-of-the-art office building.

With NMA currently working out of the existing building, it was envisaged that the project would be seperated into two distinct construction phases. This would allow the new-build section to be constructed as Phase 1, being the four apartments. Following completion of Phase 1, NMA would temporarily move their offices into the apartments to allow Phase 2, the refurbishment of the existing building, to be unhindered by a working office. Most importantly, though, was that this phased work allowed NMA's practice to remain operational and onsite which reduced loss of man-hours to a minimum.

The newbuild structure consisted of 3 levels of precast wideslab floors supported on masonry, with the load path being transferred at first floor by RC beams to RC columns, founded on pad footings, to suit the ground floor carpark layout. Due to the obvious restrictions of the site, with the overall site area being 570m^2, the ground floor layout and level was designed to suit a mechanical carparking lift that would double the amount of spaces available.

The architect's design of the façade resulted in there being large glazed areas and a number of projections along the perimeter that would be clad in iroko timber. These projections required detailed structural steel frames that were attached to the conrete superstructure.

Access to the apartments is by the feature staircase. The staircase consists of individual structural steel plates with an iroko timber plank for the steps. 10mm diameter bars were welded to the plate under the timber plank to act of dampeners, to resist the horizontal movement and subsequent vibration of the steps as they were travelled upon. There is a reinforced concrete spine wall in the middle of the staircase, from which each steps cantilevers. The stairs are enveloped by a three storey steel frame with full-height glazed curtain walling. This steel frame and the landings of the stairs are tied back into the lift shaft walls for stability.

On completion of Phase 1, NMA relocated their office into the recently constructed apartments. Phase 2 commenced with the stripping of the existing building. Subsequently, the roof and mezanine were removed from the existing building. The gable of the existing building adjacent to the new apartments (west facing) was removed in order to construct a façade of glazing. The stability of the building was maintained using a two storey steel frame along the gable line. This glazed gable also allowed for an interaction between the two buildings, being a link bridge at second floor and a terrace at first floor.

The existing upper floors in the existing building were concrete slabs supported on an arrangement of steel beams. A new staircase was introduced within the existing structure and to incorporate it in the location proposed by the architects it was necessary to sawcut the slab and install additional secondary trimming steel beams.

An overall structural capacity of the existing building was established as an additional floor was being introduced. The dead load from the additional floor was kept minimal by using steel beams and timber joists. New columns were erected in locations above existing concrete columns so new foundations were required in few locations.

The architect wished for the additional floor to be the feature of their new office. They introduced a new roof profile that is ellyptically shaped. This curve was constructed using CHS steel sections at 3.5m centers rolled to suit the proposed outline. The hoizontal force exerted at second floor level was resisted by the CHS being connected to a new steel beam spanning the full width of the building, hence turning the force into an axial force in the beam. This beam was then connected to a band beam on either facadeline. Stuctural Kalzip decking was used for the roof finish and spanned from CHS to CHS.

Dave Clarke
Barrett Mahony
Consulting Engineers

The Institution of
Structural Engineers
Republic of Ireland Branch

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Edited by Colin Caprani: colin.caprani@ucd.ie

MESSAGE FROM THE CHAIRMAN

Little did I think that one day I would be Chairman of the Institution of Structural Engineers, Republic of Ireland Branch, when I qualified from DIT Bolton Street in 1979. I am extremely delighted and proud to be chairman and really look forward to working with our superb committee over the next two years.

Reflecting back on my career, I remember that one of the ultimate challenges for any structural engineer was to pass the ISE Part 3 exam, which I did (second time around) in 1986. I guess it's still the same for young engineers but nowadays they have the benefit of the ACEI/ISE scheme design training programme along with the ISE Part 3 exam preparation programme. Another great advantage for Chartered EI members is that they can skip the "hard work" interview and portfolio bit and jump straight into the exam. This important link with EI reflects the great work undertaken by Keith Eaton, Chief Executive, ISE and Paddy Purcell of EI.

While these programmes help, the challenge for young engineers still remains the same. On that note great credit must be given to Peter Brunner, O'Connor Sutton Cronin Consulting Engineers for coming first in the concrete question in this year's paper, well done.

Back to my career; after a short spell with Jennings and O'Donovan, Sligo (my home town) I was fortunate enough to join Ove Arup and Partners (now Arup Consulting Engineers) in 1980 and this September I saw the completion of my "first" 25 years there. Like many engineers my age I have lived through very changing times, the recession in the 80s, the boom times in the 90s and the growth and staff demands of this decade. But I enjoy the challenges within our business, the people we work for, the people we work with, the incredible growth within our country, and the unification of worldwide skills within our business. It's very exciting times for engineers and I believe it will only get better.

Irish engineers are already at the cutting edge of many significant international projects. Recently I've had the opportunity to travel to a number of countries through business and fund raising cycling trips with the National Council for the Blind and before that, the Beaumont Foundation. The place that took me completely by surprise was China, because the scale of the work there is astronomical. Perhaps the upcoming Olympics in Beijing and Quingdao is generating a significant amount of this work, but it appears to be happening everywhere. While I was there I met a number of Irish Engineers who are leading a number of very significant projects.

During my 16 years on the ISE committee I have enjoyed working with a number of past chairman - James Daly, Brian Hendrick, Prof. Simon Perry, Ian Roberts, Colin Short, Tom McKenna and our immediate past chairman Joe Kindregan. Working with Joe was a real pleasure. Being in 3rd level education (Head of Civil Engineering, DIT Bolton Street), Joe has actively promoted the ISE in secondary and other third level colleges through engineering awareness workshops and Student competitions. Joe, like many of us, recognised the need to promote engineering at secondary school level so that more engineers will come through our system. On behalf of myself, our committee and our members I want to say a very big thank you to Joe for a job well done.

During the next two years I hope to continue the good work our committee does on an ongoing basis. In addition I am in the process of organising a number of national and international speakers to make presentations to our members.

Finally I would like to extend a very warm welcome to the recently appointed President of the ISE, Mr Michael Dickson. Only today I read Michael's presidential Inaugural address and noted that not only was he one of the founding members of Buro Happold but that he also spent some time in Arup in London – so he has to be one of the best!

Declan Monaghan, Chairman