LETTER TO THE EDITOR:

Dear Sir,

Re. Paper by Dhakal, Khare and Mander "Economic Payback of Improved Detailing for Concrete Buildings with Precast Hollow-Core Floors" in NZSEE Bulletin Volume 39, No 2, June 2006, pp106-119.

In relation to the above paper, readers need to be aware of the serious limitations on the applicability and precision of the results presented, noting in particular the following:

1. The tests on hollowcore floors which form the basis of the analysis consist of one test for each of the three details that are the subject of the analysis.

2. These details apply to 300mm deep hollowcore units spanning past an intermediate column. This represents a small proportion of all hollowcore placed to date in New Zealand. Thus the analyses should not be regarded as in any way representative of the whole situation in New Zealand.

3. The Matthews test was done on an assembly that did not meet the requirements of the standard in that the tie-back to the intermediate column was inadequate. The effect of this omission is unknown, but it is highly likely to have been detrimental to the overall performance of the floor/frame assembly. This would affect the values used for drift in Table 2.

4. The financial analysis is based on the numbers given in Table 2 (for drift capacity), Figure 2 (for drift demand) and Table 5 (relating Damage State to Damage (or Loss) Ratio). The results derived are thus totally dependent on the numbers in these Tables and Figure, each of which is subject to wide margins of uncertainty. Using these values in combination compounds the uncertainties.

5. The degree to which changes in the numbers used can affect results may be seen by comparing Figures 3 (b) and 3(c). For example, the boundary between DS3 and DS4 is at 20% CDF in (b) and 4% in (c). The only difference between the two examples is in the % drift shown for DS4. Interpretation of the results presented in the paper should be made with this sensitivity in mind.

6. The figures relating drift to damage state given in Table 2 are open to considerable debate and should not be used by engineers as other than values used in this financial analysis. They should not be used to make engineering design decisions. There is an urgent need for a paper that looks at drift limits suitable for the assessment of existing floors and for the design of new floors to achieve the required level of safety.

7. The paper title refers to economic payback. This is somewhat puzzling when the key issue is one of safety, and in any case, the difference in cost of the various different details is negligible. The detailed analysis of the cost of damage, without any reference to the cost of injury or loss of life, seems to overlook the safety aspect.

8. There is a strong focus on Expected Annual Loss (EAL). For a building owner such values are of little or no use. Most owners are not interested in the damage from frequent small earthquakes, but in the worst damage they may suffer in the event of a major (design) earthquake. They want to insure their building for this value, or at least base there insurance on such an assessment.

NZSEE should push for the development of practical criteria and guidelines that will assist designers in the assessment of the safety of existing hollowcore installations, development of practical remedial measures and the development of design criteria and detailing requirements for hollowcore floors in new buildings.

Yours faithfully

David Hopkins

AUTHORS' RESPONSE TO COMMENTS ON:

Dhakal, Khare and Mander "Economic Payback of Improved Detailing for Concrete Buildings with Precast Hollow-Core Floors", Bulletin of the NZSEE, Vol. 39, No. 2, June 2006.

1. The tests on hollowcore floors which form the basis of the analysis consist of one test for each of the three details that are the subject of the analysis.

➔ The financial analysis starts from the published and well-accepted results of the well-known tests at Canterbury [6, 7, 8]. It should be noted that the results of these experiments and other tests in Auckland, although few in number, have formed the basis of amendments and changes to NZS3101. Although the authors would like to refrain from commenting on the authenticity of the reported test results, they are aware that the results from these super-assemblage experiments have been confirmed by supplemental test results [18, 19]. The loss estimation that follows uses the observed limit state values as expected (median) response. These values are, of course, subjected to inherent epistemic and aleatoric uncertainties. This approach is a standard practice, first adopted in the nuclear industry in the 1970s and 1980s [15].

2. These details apply to 300mm deep hollowcore units spanning past an intermediate column. This represents a small proportion of all hollowcore placed to date in New Zealand. Thus the analyses should not be regarded as in any way representative of the whole situation in New Zealand.

➔ Although the authors tend to agree with this comment; the results, as mentioned above, do have a measure of general applicability. Specifically, the failure process of the tested specimens was particularly governed by the performance of the connection between the floors and the beams seating the hollow core units. This dictated the drift values for the onset of damage states DS2, DS3 and DS5 in Table 2. This observation, as confirmed by other works [18, 19], indicates that the thickness of the hollow core and other details are unlikely to influence these drift values by a significant extent. It should be noted that the financial analysis framework published by the authors [5, 20] and applied in this paper for buildings can be easily applied for any other case. It is admitted that if other tests were conducted, the entries in column 2 of Table 2 might change slightly. However, it is considered that this is covered by accounting for the uncertainties in the form of $ß_C$ and $ß_U$ in Equation 3.

3. The Matthews test was done on an assembly that did not meet the requirements of the standard in that the tie-back to the intermediate column was inadequate. The effect of this omission is unknown, but it is highly likely to have been detrimental to the overall performance of the floor/frame assembly. This would affect the values used for drift in Table 2.

➔ As mentioned clearly in the paper, the objective of the paper is to apply the probabilistic financial risk analysis framework to compare the three different detailing relevant to the old and new New-Zealand Standards. The paper assumes that the tested specimen represented the standard practice in New Zealand because the authors think that it would not have prompted Amendment 3 of NZS3101:1995 if it did not meet the requirement of the standard. Otherwise, the authors think that the first half of this comment would have been raised when the code was being amended based on the results of this test.

For the second part of the comment related to Table 2, DS4, for which the drift level was 1.9%, was the only damage state likely to be influenced by the intermediate column and frame members (beams) running parallel to the precast floor units. Had this detail not been present, the onset of DS4 may have been delayed to 2.5% drift [18]. On the other hand, with other relatively common non-compliant construction practices such as negative seating, the onset of DS4 was found to be 1.75% [19]. The authors considered all this information in terms of diversity of construction practice and felt that the results of DS4 of 1.9% was a representative value to adopt for the 50^{th} percentile. Regardless of the values chosen for the median of DS4 in Table 2, they do not have much influence on the EAL outcomes as values used for DS2 and DS3.

4. The financial analysis is based on the numbers given in Table 2 (for drift capacity), Figure 2 (for drift demand) and Table 5 (relating Damage State to Damage (or Loss) Ratio). The results derived are thus totally dependent on the numbers in these Tables and Figure, each of which is subject to wide margins of uncertainty. Using these values in combination compounds the uncertainties.

➔ Yes, the financial analysis does depend on the values given in Figure 2 and Tables 2 and 5. The limitations of the study originating from these assumptions have been clearly explained in the last paragraph of *Conclusions*. The drift capacity values in Table 2 are obtained from the test results and NZ standards; and the drift demand in Figure 2 is the outcome of the extensive PhD research by Matthews. To avoid putting blind faith on the result of one test, the analysis takes into account the uncertainties in these parameters, and the resulting compound uncertainty has been estimated using Equation (3). The loss ratio values in Table 5 are logical approximations, whose rationale is clearly explained in *Section 5.1*. While the loss ratio values of DS1, DS4 and DS5 are obviously 0, 1, and 1, respectively, the remaining two values are approximated as the mean of the logical range. While changing these values within the range will make slight changes to the EAL values for the three cases, it should be emphasized that the relative standing of the three floor-frame connection details will not change providing consistent values of the loss ratios are used throughout the comparative analyses.

5. The degree to which changes in the numbers used can affect results may be seen by comparing Figures 3 (b) and 3 (c). For example, the boundary between DS3 and DS4 is at 20% CDF in (b) and 4% in (c). The only difference between the two examples is in the % drift shown for DS4. Interpretation of the results presented in the paper should be made with this sensitivity in mind.

➔ Undoubtedly the drifts corresponding to different damage states influence the fragility curves shown in Figure 3. This is one of the main points this paper is trying to demonstrate. It clearly shows that the profession needs to improve the quality of design details so that the structure can sustain large drifts with less damage. It is expected that the probability of exceeding a given level of damage (DS3 in this case) during an earthquake (MCE in this case) will be higher for a relatively poorly detailed structure. The reported difference in the exceedance probability of 4% vs. 20% is because the damage state DS4 starts at a drift of 4.0% and 2.25% in these two cases. As pointed out by the discusser, this is the ONLY difference but not to be forgotten that it is also a VERY SIGNIFICANT difference; and this difference will remain of the same order regardless of how many different sets of tests might be conducted.

6. The figures relating drift to damage state given in Table 2 are open to considerable debate and should not be used by engineers as other than values used in this financial analysis. They should not be used to make engineering design decisions. There is an urgent need

for a paper that looks at drift limits suitable for the assessment of existing floors and for the design of new floors to achieve the required level of safety.

➔ Again, the drift values in Table 2 are from the experimental observations. Engineers should always make decisions based on values that have a reliable origin (such as an experiment). The authors agree with the discusser that drift limit values for different damage states for different floor designs should certainly be published as soon as possible only if these values have been found through comprehensive research, and are different from and more convincing that the experimental values found by Matthews, Lindsay and MacPherson. It is doubtful that the values would change significantly. However, as more test results are accumulated, the confidence in those results is improved.

7. The paper title refers to economic payback. This is somewhat puzzling when the key issue is one of safety, and in any case, the difference in cost of the various different details is negligible. The detailed analysis of the cost of damage, without any reference to the cost of injury or loss of life, seems to overlook the safety aspect.

➔ The authors are disappointed that perhaps they have been unable to clearly convey their message of loss estimation – this is more than just safety. The issue may be of safety to designers, but for other stakeholders (users/owners/insurers) of the building, safety is a vague, fuzzy or immeasurable notion. They will understand better if the safety of a building with an improved detail is expressed in terms of how much less they need to spend in repairing likely structural damage with these improved construction details. The latter part of this comment relates to the cost of injury or loss of life is a good one. Although it is inferred in the current form of the paper that the financial analysis covers only the structural damage, the authors think adding the following sentences will make this more explicit: The total loss comprises of the so-called 3 D's; damage, downtime and death – all of which can be evaluated in terms of dollars. The total damage is also contributed by structural damage and non-structural damage. This paper only deals with the structural damage; and research to apply the financial risk assessment framework to account for other forms of losses is presently underway at the University of Canterbury. However, it is obvious that more severe structural damage will also lead to a higher probability of (and more severe) non-structural damage, a longer downtime and a larger number of deaths (note that the interrelationship will not be linear). Hence, the relative standing of the total losses of the three systems is likely to be of the same order, although the relative magnitude may change.

8. There is a strong focus on Expected Annual Loss (EAL). For a building owner such values are of little or no use. Most owners are not interested in the damage from frequent small earthquakes, but in the worst damage they may suffer in the event of a major (design) earthquake. They want to insure their building for this value, or at least base there insurance on such an assessment.

➔ The authors strongly disagree with this comment. All non-engineer owners will be more interested in a proportional or representative dollar loss value rather than other measures such as inter-storey drift or ductility. They would certainly like to know the likely loss of their buildings in case of earthquakes of different magnitude (or different probability of occurrence). It is possible to obtain these scenario losses from Figure 6 or Table 7. EAL is the total risk which is the integration of the likely losses due to all probable earthquakes in one year. EAL, once clearly explained to lay people is a more useful concept than knowing the meaning of inter-storey drift, ductility, and the concept of 10% in 50 years.

NZSEE should push for the development of practical criteria and guidelines that will assist designers in the assessment of the safety of existing hollowcore installations, development of practical remedial measures and the development of design criteria and detailing requirements for hollowcore floors in new buildings.

➔ The authors also think that there is scattered information on the seismic behaviour of hollow core floor systems. This information coupled with the fire performance of hollow core systems needs to be gathered and design and detailing guidelines should be formed to help designers. Thus, establishment of a study group by NZSEE and other stakeholders would be a welcome way forward.

References:

18. Bull, D. K., and Matthews, J. G., 2003, "Proof of Concept Tests for Hollow Core Floor Unit Connections." Precast NZ Research Report 2003-1 (www.precastnz.org.nz).

19. Liew, H. Y., 2004, "Performance of Hollow Core Floor Seating Connection Details." ME Thesis, University of Canterbury.

20. Dhakal, R. P., and Mander, J. B., 2006, "Financial Risk Assessment Methodology for Natural Hazards." Bulletin of the NZSEE, Vol. **39**, No. 2, pp. 91-105.

GENERAL INFORMATION

NZSEE HOME PAGE ON THE INTERNET

The Society's home page address is:
http://www.nzsee.org.nz

COMING CONFERENCES AND SYMPOSIA

September 2006
September 3-8, 2006
1st European Conference on Earthquake and Seismology, Geneva, Switzerland. For details see www.ecees.org

March 2007
March 30- April 1, 2007
NZSEE Annual Conference & AGM, Palmerston North.

June 2007
June 27-27, 2007
Ninth Canadian Conference on Earthquake Engineering, Ottawa, Canada. For details and how to submit an abstract, see www.9ccee.ca .

December 2007
December 4-6, 2007
Pacific Conference on Earthquake Engineering, Singapore. Organised by Nanyang Technical University, Singapore (NTU). See Society website for details.

October 2008
October 12-17, 2008
14th World Conference on Earthquake Engineering, Beijing, China. Details on http://www.14wcee.org

STRONG MOTION RECORDINGS

Processed strong-motion records from the GNS network can be downloaded from the GeoNet webpage www.geonet.org.nz. Proceed via "Data centre" and "Strong motion data" to ftp.geonet.org.nz/strong/processed. The data includes the following

- raw files from digital instruments,
- unfiltered acceleration time-histories
- filtered time-histories for acceleration, velocity and displacement, and
- acceleration, velocity and displacement response spectra.

All are in ASCII (text) format and are accompanied by plots in postscript format. The recording period covered is from 1966 to present, but be aware that earthquake parameters in records from the most recent 12-month period are not final and may be changed in the future.

Records from the period 1966 to 1999 are also available from the COSMOS site (www.cosmos-eq.org).

For further information about the data, bulk supply of records, or to provide feedback, contact Jim Cousins at j.cousins@gns.cri.nz.

PEOPLE

New Members.

The following persons and a corporation have recently been admitted as members of the Society:

Belleri, Andrea	**Brescia, Italy**
Hand, David	**Dunedin**
Gibbs, Michael	**Auckland**
Grant, Gordon	**Havelock North**
Langbein, Andrew	**Auckland**
Uma, S R (Dr)	**Christchurch**

Life Members.
Obituary: David Leicester Steven (1942-2006)

It is with sadness that we record the death of Leicester Steven on July 14th, 2006.

Leicester was born in Christchurch in 1924 and educated at Elmwood Primary and Christ's College before studying Engineering at Canterbury University College (now the University of Canterbury). His study was interrupted at age 20 by service in the navy but he returned to complete his degree in 1947, in spite of a shortage of what he termed "good lecturers" during the war years. He undertook postgraduate study in the United States in 1954.

Leicester was involved in a host of public health engineering projects throughout New Zealand during his professional career. He began work with the Timaru City Council and joined the Christchurch Drainage Board after returning from his postgraduate studies. He established his own consultancy practice in 1962 and his firm's work won awards for engineering excellence and environmental value.

Leicester was appointed to the Board of the Earthquake Commission (EQC) in 1982. Through his leadership, he positioned EQC at the forefront of research support, including investigations of overseas disasters and using their lessons to improve New Zealand's preparation. He championed the Commission's extensive planning and preparation for handling the many thousands of claims a large natural disaster would bring, sparking his active interest in disaster management for the remainder of his life.

The EQC recognised Leicester's 15 year contribution to their Board by establishing the Leicester Steven EQC Lectureship in Earthquake Engineering at his alma mater, Canterbury University, on his retirement from the board in 1998.

Leicester, a fellow and later life member of the NZSEE, forged and fostered the close association of the Society with EQC. He persuaded the board to agree to funding support because he saw the need for and value of a journal of international academic standard that could showcase NZ earthquake engineering research.

Leicester was the inaugural recipient of the NZSEE President's Special Award in 1998. This was awarded to recognise his consistent championing of the Society's objectives and interests as a Board member of the Earthquake Commission. His professional service was also recognised by his election as fellow of IPENZ, the Institute of Civil Engineers (UK) and the Institute of Directors (UK).

Leicester is survived by his wife, Rachel, 7 children and 20 grandchildren. He will also be greatly missed by many colleagues, including David Wilkie who described him perfectly as the "true professional who, above all, made work fun".

B.L.D. and D.M.

OTTO GLOGAU AWARD NOMINATIONS

The Society is seeking nominations from members for the 2007 Otto Glogau award. This award is presented to the authors of the best paper published over the last 3 years up to 30 June 2006. Only 1 author has to be a member of NZSEE. Nominations, including a copy of the paper, should be sent to The Administrative Secretary, PO Box 2193 Wellington 6140, or email secretary@nzsee.org.nz by **1 November 2006**.

2006/2007 MANAGEMENT COMMITTEE

Administrative Secretary NZSEE
Mr Derek Wilshere
PO Box 41 069
Eastbourne
Wellington 6340
NEW ZEALAND
Email: derek.wilshere@xtra.co.nz

President
Prof. Michael Pender
University of Auckland
Dept of Civil &Environmental Engineering
P Bag 92 019
Auckland
Fax: (09) 373 7462
Email: m.pender@auckland.ac.nz

Immediate Past President
Dr Mark Stirling
Inst. Geological & Nuclear Sciences
P O Box 30 368
Lower Hutt
Fax: (04) 566 6168
Email: m.stirling@gns.cri.nz

Mr Graeme Beattie
BRANZ,
Private Bag 50 908
Porirua
Fax: (04) 235 6070
Email: graemebeattie@branz.co.nz

Mr P. Brabhaharan
Opus International Consulting
PO Box 12 003
Wellington
Fax:
Email: p.brabhaharan@opus.co.nz

Mr Hans Brounts
Ministry of Emergency Management
PO Box 5010
Wellington
Fax: (04) 473 7369
Email: hans.brounts@dia.govt.nz

Dr. Hugh Cowan,
Inst. Geological & Nuclear Sciences
P O Box 30 368
Lower Hutt
Fax: (04) 566 6168
Email: h.cowan@gns.cri.nz

Dr. Bruce Deam
Dept. of Civil Engineering
University of Canterbury
Private Bag 4800
Christchurch
Fax: (03) 364 2758
Email: b.deam@civil.canterbury.ac.nz

Mr. Warwick Kellaway
121 Maeroa Rd
Hamilton
Fax: (07) 846 1175
Email: jwk@slingshot.co.nz

Bulletin Editor
Mr. Les Megget
Dept. of Civil & Environmental Engineering
University of Auckland
Private Bag 92 019
Auckland
Fax: (09) 373 7462
Email: l.megget@auckland.ac.nz

Dr Stefano Pampanin
University of Canterbury
Dept of Civil Engineering
Private Bag 4800
Christchurch
Fax: (03) 364 2758
Email: stefano.pampanin@canterbury.ac.nz

Technical Development Manager
Dr. Graham Rowe
1 Flint Way
Northland,
Wellington
Phone: (04) 4757189
Fax: (04) 4757189
Email: ghr@orcon.net.nz

Dr Dean Saunders
Beca Carter Hollings & Ferner Ltd
P O Box 3942
Wellington
Phone: (04) 473 7551W
Fax: (04) 496 2536
Email: dean.saunders@beca.com