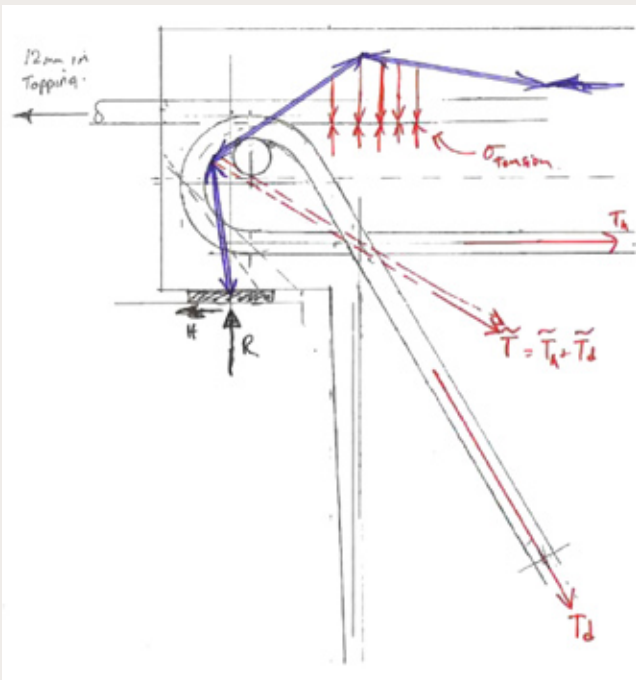


Issue 4 • September 2008

Welcome to the fourth edition of SESOC NEWS. For general information regarding the NZ Structural Engineering Society (SESOC) and for committee contact details refer www.sesoc.org.nz

In this issue



Notional strut and tie model for "Pigtail" flange supported double tee.

Double Tee Flange Supports under Review

The SESOC Management committee has spent much time recently debating flange-hung precast double tee floor units.

Hollow-core Floor Changes in NZS3101 A2

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Structural Engineering Society of New Zealand

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Double Tee Flange Supports under Review

The SESOC Management committee has spent much time recently debating flange-hung precast double tee floor units. This follows the parallel debate and subsequent amendments to NZS 3101:2006 relating to seismic performance of precast hollow-core floors.

The industry currently has a number of ways of detailing flange-hung tees, and the current debate has focussed on the loop bar or 'pigtail' hanger, as it is commonly known. This detail has been used extensively in New Zealand for approximately 35 years and has performed well under gravity loading. However some designers and precasters have recently abandoned it, citing manufacturing and safety concerns in particular with seismic loads.

Many questions have been tabled, and historic testing appears to provide only partial answers. Further testing and research is at present underway to clarify some of the technical questions which have been debated. However, the SESOC committee is of the opinion that cost effective support details exist which are believed to offer greater robustness and are also more readily analysed using traditional techniques.

Therefore, it is recommended that until further research demonstrates otherwise, designers and precast manufacturers should avoid pigtail hangers and instead specify flange supports that utilise a length of steel flat bar or RHS projecting from the top of each web. This is typically anchored back into the double tee web by deformed reinforcing bars welded to the steel flat or RHS. These details can be more readily justified by standard calculations and should have improved capability to cope with seating variations and movements, for example under seismic loading. It is recommended that designers specify these support details on both drawings and specifications.

In general, more communication and coordination is needed now than in the past between the building structure designer and the precast floor designer. Building designers should include in their specifications full performance parameters for precast flooring, including not only gravity loads, but also other effects such as creep and shrinkage, thermal effects, horizontal and vertical seismic loads and relative movements between the floor units and surrounding structure. This should clarify the full design criteria for the precast flooring as well as the scope of design responsibility for both parties.

Background:

A SESOC subcommittee has reviewed typical pigtail flange support details and has reported as follows:

- The detailing of typical pigtail hangers is non-compliant with NZS3101:2006 and NZS 3109:1997 in a number of ways, including:
 - The bend diameters of the pigtail bars are often too small considering the tension in the bars.
 - The pigtails are often smooth bars which are not adequately anchored by either development length or by hooks.
 - The large diameter round bar that is passed through the eye of the pigtail bars is frequently welded to the bends of the pigtails. Welding to bends is forbidden in NZS 3109.
 - The shear stress in the double tee flange often exceeds the shear strength that can be relied on for concrete under NZS 3101 and yet shear steel is typically not provided into the insitu topping. In any case it would be difficult to anchor shear steel, except perhaps headed stud type anchors because the flange and topping are invariably shallow.
- There is currently a lack of agreement about a valid analytical method for determining the strength of the pigtail hanger. Many pigtail designs appear to rely on concrete tensile strength, which is not reliable. The strength of the typical pigtail hanger has also been shown by calculation to be very sensitive to the precise placement of the reinforcement. Factors that must be considered in rational design calculations include the following:
 - It cannot be assumed that reinforcement will achieve its yield stress at the ultimate limit state as this assumption ignores the possibility of shear (diagonal tension) failure or bond failure.
 - Equilibrium must be maintained
 - Compatibility requirements must be satisfied

- A valid alternative approach to compliance with NZS 3101 would be to justify pigtail hangers by load testing. However for the results of tests to be relied upon for design nowadays the following points must be addressed:
 - Testing should now be carried out in accordance with NZS 1170.0:2002 Appendix B which takes account of, amongst other things, variability of material properties and fabrication tolerances.
 - Load testing should generally only be carried out to help establish a rational design method. Testing to cover all the different sizes and configurations and to allow for all the other factors which may influence strength would be extensive and impractical.
 - The subcommittee is aware that previous testing has been carried out however the results have not yet been widely circulated.
 - Load tests to date have not included horizontal or twisting components of load which would reflect elongation or displacement incompatibility effects resulting from earthquake loading, or shrinkage and creep. Vertical seismic loads may also be significant for some floors and should be considered when reporting test results.
 - Further testing is now underway or proposed, which may address some of the above issues but results are not yet available.

It is expected that a more detailed technical paper will soon be made available on the SESOC website as a draft for members to review and comment on. As mentioned above further testing is under way and the results of that testing will be communicated to members when available.

In the meantime, as a precautionary measure the subcommittee recommends as follows:

1. Designers should avoid pigtail hangers, and should not accept pigtails as an alternative solution for flange hung double tee units.
2. Designers should consider alternative details to the pigtail that have already been developed. Typically these use a length of steel flat bar or RHS projecting from the top of each web. This is anchored back into the double tee web by deformed reinforcing bars welded to the steel flat or RHS. These details can be justified by standard calculations and should have improved capability to cope with seating variations and movements.
3. Designers using load test data alone as verification of performance of elements should not accept the results unless the testing adequately addresses the full range of imposed loads or displacements that the units may be subjected to, and allows for the statistical variation in material strengths and properties. Load testing and the use of test data for design should now comply with NZS 1170.0:2002 Appendix B. Load testing should generally be used to verify a rational design method.
4. Irrespective of the flange support detail used, the supporting ledge needs to be capable of taking the concentrated loads from the double tee webs. The resulting bearing stresses can be high. Engineering design of the flange and the supporting ledge as a corbel is needed. It may be necessary for example to incorporate steel bearing plates in the double tee flange and/or steel angles tied back into the supporting beam. For steel supporting beams, web stiffeners may be needed because of the extra local bending in the beam flange.

The obvious next question is what, if anything do we need to do with respect to existing building stock? The subcommittee postulated that unlike hollow-core, if the concrete flange should crack then, providing the seating is adequate, the ductile steel of the pigtail itself should still cross the potential failure plane and prevent the floor unit from dropping. This will need further study, and is intended to be covered in the more comprehensive technical paper that is planned.



[Contents](#)

Hollow-core Floor Changes in NZS3101 A2

Amendment 2 to NZS3101:2006 has now been published and members should be aware that in Clause C18.6.7 of that Amendment there is now only one detail that is considered best practice for seating hollow-core floors. That detail is similar to the one tested by MacPherson at Canterbury University and incorporates Grade 300 plain round reinforcing bars in grouted cells and low friction bearing strips.

There still appears to be some confusion in the marketplace, amongst both designers and precast manufacturers about the applicability of that seating detail. For example some understand that the detail recommended in C18.6.7 is relevant only for ductile frame buildings in high seismic zone

areas like Wellington. That is not the case. The detail is considered best practice for all new hollow-core construction throughout New Zealand, irrespective of the seismic zone or building type. It is also noted in the Standard that research into precast flooring systems is ongoing and further improved details may be developed as more research data becomes available.

Refer to NZS3101 A2 for full details of the above and many other changes. It is planned to provide a summary list of other changes in a future SESOC newsletter.



Structural Documentation Guidelines Updated

SESOC has been working closely with IPENZ, ACENZ and the New Zealand Construction Industry Council (NZCIC) to update the NZCIC Design Documentation Guidelines – Structural to reflect current good practice. Changes proposed by SESOC have been published in draft form and placed for a short while on the NZCIC web site for consultation purposes prior to being approved and superseding the previous version.

Changes include the recommendation that detailed design documentation should be included with all building consent submissions, together with a design features report that explains the structural systems and load paths, design standards used and key design assumptions. Also, significant changes or clarifications to structural work in relation to the initial building consent documentation should be submitted to the Building Consent Authority and if necessary and amended building consent obtained to cover those changes.

Both the current version www.nzcic.co.nz/design/ddg-structural.pdf and the proposed update www.nzcic.co.nz/design/ddg-structural-proposed-08.pdf can be found on the NZCIC website. Changes have been marked with an asterisk for easy reference. Comments can be sent to dir-eng@ipenz.org.nz



Producer Statements – Guidelines in Progress

Despite having no legal status under the Building Act, producer statements are supported and accepted by many individuals and Building Consent Authorities (BCAs). There is however some variability in the way Producer Statements are viewed and used. A draft document entitled “Guidelines to the Use & Acceptance of Producer Statements in the New Zealand Building Industry” has been prepared by Adam Thornton of Dunning Thornton Consultants Ltd in consultation with IPENZ, ACENZ, main BCAs and other building professionals. This document will provide the starting point for the publication by the Department of Building and Housing of formal guidelines expected to be available by the end of the year.

In the interim SESOC is concerned that Producer Statements be used appropriately and so offers the following advice:

- (a) Producer Statements should be issued for specific projects and unique sites.
This does not preclude the issue of a generic PS1 statement for repetitive transportable structures constructed at a factory site. In this case, at the time a building consent is required for construction to proceed, the final location may not be known and hence the generic PS1. Some time may then elapse before the structure is purchased and transported to a specific location. However in such cases an additional unique PS1 should be requested by the BCA and provided by the designer for the structure in its final location.
- (b) Producer Statements submitted to BCAs should be the signed original and not a copy. The person signing the producer statement should be a CPEng registered engineer who is responsible for the work covered by the producer statement.
- (c) The design engineer should, as a matter of good practice, submit with the consent application the level of construction monitoring that he or she requires to verify on reasonable grounds that the design is constructed in accordance with the design documents.
- (d) Where a BCA requires a PS4 for monitoring of construction the designer should be notified of this directly by the BCA at the time the building consent is issued. The consent application may be lodged by others, not necessarily the engineer, and if the BCA conditions are not communicated to the engineer then the required inspections may not be done, or done to a different standard. This could create an issue for the Code Compliance Certificate.



IStructE News

Graham Owens will take over from Sarah Buck as president of the Institution of Structural Engineers (IStructE) on 1st January 2009. Graham is a former director of the Steel Construction Institute and will be known to many of you as co-author of the seminal SCI text the Steel Designers' Manual. We understand Graham is planning a president's visit to New Zealand in 2009 and look forward to welcoming him to the Southern Hemisphere.

This year is the IStructE centenary and has been marked by a series of high profile events and publications. The centenary conference was held in Hong Kong in January this year. The conference proceedings which contain an array of fascinating papers are available to IStructE members and can be downloaded from the IStructE website www.istructe.org

The centenary edition of The Structural Engineer journal was published on 21st July, with a message from President Sarah Buck. Sarah urges structural engineers to 'attract, support and enthuse' future generations of engineers. This edition of the journal is an excellent resource which celebrates 100 years of structural engineering and serves both as a record of past achievements and a catalyst to inspire young engineers to meet future challenges.

Volume 86 Number 19 of The Structural Engineer contains a paper co-authored by John Butterworth, Charles Clifton and Greg MacRae outlining the development of steel frame joints in New Zealand with specific attention to Flange Bolted Joints and Sliding Hinge Joints.

The Institution also recently announced the short listed entries for the 2008 IStructE Structural Awards. An achievement for New Zealand is the inclusion of The University of Auckland Business School (structural engineering by Beca) in the shortlist for the Education and Healthcare category.

Finally, the Institution has been very supportive of the SESOC / IStructE jointly organized seminar programme which kicked off in June with Barry Davidson's 'Fundamentals of Seismic Design' Seminar. The second in this series 'Fundamentals of Earthquake Resistant Concrete Structures' is currently underway. The Institution has promoted the event in their newsletter and The Structural Engineer.



[Contents](#)

SESOC Bridge Group Formed

At our recent Management Committee meeting, member Rudolf Kotze asked if SESOC would support a new bridge engineering technical group. The mission of the Bridge Group is to promote the profession and interests of bridge engineering within New Zealand and to provide peer support to our colleagues in the field.

There was general agreement in the Management Committee that SESOC would welcome the opportunity to work with and support this group. The Bridge Group will be based initially in Wellington but the objective is to extend beyond Wellington once the viability there has been confirmed.

If you have an interest in highway, railway or port structures then this is the forum for you. Constructors, consultants, designers, product suppliers and asset managers are all encouraged to attend meetings of this newly formed group. For further information contact Rudolph.Kotze@nzta.govt.nz The inaugural meeting is scheduled for 25 September 2008 at 5.30pm, Lecture Theatre 1, School of Architecture, Vivian Street, Wellington.

The 7th Austroads Bridge Conference is to be held in Auckland 26 - 29th May 2009 and so the formation of a New Zealand group is considered timely. Austroads is the association of Australian and New Zealand road transport and traffic authorities. This conference will lead up to the 50th anniversary of the Auckland Harbour Bridge on 30th May 2009. The conference website is www.austroads2009.co.nz



[Contents](#)