CROSS

Confidential Reporting on Structural Safety

Newsletter No 21, January 2011

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Reports sent to CROSS are de-identified, categorised, and sometimes edited for clarification, before being reviewed by the CROSS panel of experts. The panel makes comments that are intended to assist those who may be faced with similar issues. In the Newsletters the reports are shown in black text and the comments are shown below these in green italics. Reports and comments are also given on the web site data base.

Please click here for link to CROSS website

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INTRODUCTION

CROSS is very pleased to announce that the Highways Agency has implemented Confidential Safety Reporting in its procedures in Interim Advice Note 136/10 (see page 2). This relates to structures of any kind on the Highways Agency Motorways and Trunk Road Network and is an important step in the development of the scheme.

SCOSS has recently issued two alerts: the first is *Timber framed buildings in fire situations: the role of the designer* following a number of severe fires in timber framed buildings during construction. The second is: *Temporary structures: Saddlespan type tents* which highlights the need for adequate engineering input for specialised temporary structures.

In this issue are more reports on serious concerns that have been sent to CROSS and from which lessons can be learned by the engineering community. The first is the fall of part of a bridge due to the use of the wrong type of bolts and is another example of the importance of choosing the right fixings. The second is about the deflections caused by pouring concrete onto permanent metal decking which can affect the safety factors of primary and secondary beams and connections. There are then three reports on defects during construction which were caused by ignorance or negligence and were spotted by engineers on site. How many defects are not seen or are ignored and result in lowered levels of safety or serviceability?

Internet search engines offer a huge resource for finding out about any subject and when directed towards building collapses they find a daily catalogue of disasters often with a death toll attached. These are mainly from areas of the world where there are limited controls on building, many of the structures have not been properly designed or constructed, and defective materials may have been incorporated. Vigilance is required everywhere and ways of publicising concerns are a way of maintaining and bolstering standards.

CROSS needs reports all the time so that lessons can be learned and if you can contribute please do so.

FALL OF BRIDGE DECK SUPPORT DUE TO BOLT OVER-TIGHTENING (Report 216)

A 7 tonne steel frame designed to temporarily support part of a bridge deck during bearing refurbishments work fell from height as it was about to be lowered some 21m to the ground. An operative who was standing on the frame at the time of the dangerous occurrence suffered minor injuries, inflicted by his safety harness as it arrested his fall. The frame was supported on two air hoists, each of which was supported from a stub cantilever. The stub cantilevers were bolted to the web of a steel beam. It was the failure of this bolted connection that the investigation by the HSE and others identified as the principal cause of the accident.

The detailed investigation concluded that the principal cause of failure was the accidental over-tightening of the bolts using an impact wrench which damaged the threads. In testing carried out on behalf of the HSE, the damaging of the threads and eventual stripping of an M16 Gr 8.8 bolt was repeated, using an impact wrench. It is noteworthy that the impact wrench in question has a quoted bolt range of M16 to M22. The torque graph from the impact wrench manual indicates that the appropriate torque for an M16 bolt can be achieved in less than a second. It was also noted that although the design considered the bolt to be a non-preloaded bolt, operator experience was solely relied upon

Interim Advice Note 136/10 from the Highways Agency - Structural Safety Reporting

1. Background

Interim Advice Note 136/10 provides guidance on structural safety reporting relating to highways structures on the Highways Agency Motorways and Trunk Road Network. See:

http://www.standardsforhighways.co.uk/ians/pdfs/ian136.pdf

The collation and dissemination of information relating to matters of structural concern is a vital element of achieving safe structures. The Highways Agency, therefore, in partnership with the Standing Committee on Structural Safety (SCOSS) and their Confidential Reporting on Structural Safety scheme (CROSS), is interested in events where there have been failures, collapses or any concerns about any part of the construction process, on all of the Agency's construction sites. The Agency is also interested in reports relating to near misses, or observations relating to collapses where these have not been uncovered through formal investigation.

Reports are treated in complete confidence and all identifying features and names are removed before the data is reviewed by an independent panel of experts and comments are added. Comments are non-judgmental, and aim to help others learn from the reported event. CROSS will analyse the data and SCOSS will then use its influence with Industry, Institutions, and Government to effect changes where this is seen to bring sustainable benefit by improving structural safety. CROSS publishes quarterly Newsletters and maintains a data base of reports on www.cross-structural-safety.org, whilst SCOSS publishes a range of reports, topic papers and alerts on matters of concern. Further information about SCOSS/CROSS is provided in Annex B.

2. Action

Structural Safety events related to any Highways Agency schemes or contracts must be reported via the Agency's www.standardsforhighways.co.uk website.using the "Feedback" button. Guidance on what and how to report is provided in Annex A; the reporting procedure is described in Annex D.

Reports do not have to be about current activities so long as they are relevant. Whenever an incident occurs, or a concern is felt, then it can be reported. Structural Safety Reporting is not a substitute for internal (Health & Safety, or other) reporting processes, though can be used in parallel. This scheme does not apply to Occupational Health and Safety issues.

The reports can be submitted by anyone within the Highways Agency and its Supply Chain, involved in the building and civil engineering professions, including Structural and Civil Engineers. Reports will also be welcome from others, who have an interest in structural safety.

to achieve the correct torque. For design, the correct torque settings for safety critical connections should be stated clearly on the drawings. Furthermore, the HSE says that critical connection designs should be checked by an external consultant and that critical connections must use HSFG bolts with load indicating washers or TCBs (tension control bolts).

CROSS comments: *The report states that this was a grade 8.8 bolt that failed. Such bolts should not be torqued because control is difficult and indeed they are not designed for this action. If pre-loading is required, the correct bolt to use is an HSFG bolt which has a heavier head and appropriate thread with a heavy nut to assure against thread stripping failure. The report also states that the connection was through a beam web. That suggests the bolt grip length was very short and as such, any over torquing would have imposed a high plastic strain on very short length. Additionally, the torque tension relationship in bolts is very unreliable since the amount of friction within threads is uncertain. If there is too much friction, then over torquing can cause serious damage. It appears that there was a failure to follow recommended procedures and there was a lack of experience. Good site control together with the proper use of HSFG bolts should prevent such occurrences.*

PERMANENT FORMWORK FOR SLABS (Report 215)

The advantage of permanent formwork to slabs is that it can remove the need for temporary falsework and formwork. However, designers of structural frames usually leave the specification of the sheeting to the contractor and do not specify what propping is required when the concrete is placed. In turn, the people responsible for procurement within the contractor go out for quotes to specialist suppliers of the sheeting. The suppliers typically do not know the deflections of the steel frame under dead load so assume zero deflection and specify sheets over one, two or three spans. There is no feedback to the designer of the proposed sheeting and the designer does not usually check that the sheeting is adequate when deflections of the structure are taken into account.

Typically, the structural steel will deflect by 40-70 mm under the dead load of the concrete, resulting in an increase the depth of the concrete slab. The consequences of this include the following:

- Permanent formwork could be excessively loaded (e.g. a slab with a nominal thickness of 130 mm would become 195mm thick and increase loading by 50%).
- Increased stress induced in steel beams before composite action is achieved (possibly close to permissible stress even before live load is applied).
- Deflection of steel beams becomes a permanent feature of the structure, limiting space available for services.

The ideal procurement method for permanent formwork is well defined (e.g. Composite slabs and beams using steel decking: Best Practice for design and construction. SCI Publication P300) but this is not followed in practice and the method does not work well within the UK construction industry. There are several potential solutions:

- Follow the sequence detailed in publication P300
- The consulting engineer should specify sheeting based on his knowledge of the structure.
- Suppliers of permanent formwork should take deflection into account when specifying the sheeting.

With pressure to keep fees and prices low there is a real risk of this issue not being adequately addressed by either consultants or contractors.

Interim Advice Note 136/10 from the Highways Agency - Structural Safety Reporting (cont.)

3. Implementation

This IAN should be disseminated across all of the HA Supply Chain. It should be used with immediate effect on all HA schemes and contracts.

4. Contact details

If you have questions regarding this document, please contact: Vladislava Flanagan Palan:

Standards_Feedback&Enquiries@highways.gsi.gov.uk

CROSS comments: *This report echoes a recurring theme and illustrates one of the most significant problems within the industry, i.e. the apportionment of tasks according to commercial expediency, rather than according to appropriate risk management. There have been many reports of excessive concrete depth due to deflection of support structures. Such deflection causes at least two problems: firstly the cost of the extra concrete and secondly a safety issue in that the extra weight of concrete carried has to be subtracted from the system's capacity to carry live load. The issue becomes particularly acute for long span (composite) floors and beams since the absolute value of system sag can then be large in comparison with the nominal slab depth thus increasing dead load significantly. There is often uncertainty over whether slabs should be put into nominal depth or to level: if the latter there is this risk of 'ponding' and excessive concrete thickness. Overall, one designer should be in charge of the whole process and there should be a site presence so that there is no divided responsibility for assigning overall structural capacity.*

Designers may be able to limit risks by considering the following issues and communicating their intent on drawings:

- *being satisfied that a reasonable permanent formwork solution exists*
- *saying whether steel beam design relies on composite action with the slab*
- *saying whether propping is required*
- *providing the deflection criteria*
- *indicating whether slabs are to be laid to level or to a constant thickness*
- *showing anticipated deflections so that propping the beams, or the beams and decking, or pre-cambering the beams, can be considered.*

It is however perfectly practical to pour to a given thickness using screed rails. This may not fit with modern laser leveling techniques but does avoid the problems described. It is then a specification and co-ordination issue as the following trades will need to deal with the deflection which becomes a tolerance issue. This solution avoids the additional weight and additional material use. At any stage in the design process the designer should be satisfied that the design at that stage of development can be safely (and economically) built, and that information needed by those who follow is provided.

NEED FOR LICENSED BUILDERS (Report 214)

Certain building operation should only be carried out by licensed qualified builders says a reporter. He believes that the creation of a basement below an existing building is far too complicated and dangerous for the incompetent operatives that abound in this industry. He says that he cannot call them tradesmen - they don't know a trade. The photograph shows inadequate propping of a house and illustrates what happens when incompetent builders are let loose on a basement excavation. This is two weeks after building control staff served dangerous structure notices on the builder, for undermining the foundations whilst digging the basement.

CROSS comments: *Extending accommodation by extending basements is becoming common and in sophisticated cases even double basements may be added. The panel is aware of many instances of local collapse and indeed of complete building collapse*

NEWS REPORTS

River Crane bridge failure (report 223)

During the evening of Saturday 14 November 2009, the foundations of a Victorian bridge carrying the railway over the River Crane in West London failed without warning, causing part of the bridge to subside. A total of 21 trains crossed the failing bridge between the first report and closure of the line. There was no derailment and no injuries occurred. The immediate cause was that the east abutment was undermined by scour caused principally by an obstruction of the watercourse which channeled the flow towards the abutment, increasing its velocity and making it more likely that scour would occur. Network Rail was unaware of the obstruction and the vulnerability of the abutment to undermining by. The underlying factors were that the verification role performed by the examining engineer was wholly dependent on the completeness of the bridge examiner's report. For visual examination reports where bridge examiners propose no action, the low level of information required in the report may mean that the examining engineer's review can add no value. Neither Network Rail, nor the Environment Agency who inspected the river periodically knowledge about the condition of the foundations of the bridge or the safety risk presented by an obstruction.Amongst the recommendations are:

There should be a mandatory process for the routine inspection of bridges spanning watercourses and of the watercourses.

To increase the probability of debris in the water being reported and removed prior to structural damage occurring. Network Rail should provide means by which members of the public can report obstructions or other defects.

The role of the examining engineer should be modified so that they have a more effective role including the use of photographs to identify obstructions to watercourses which might affect scour.

The above is taken from a report by the Rail Accident Investigation Branch www.raib.gov.uk.

Comments: This failure suggests the need for bridge assessors to pay special attention to modes of failure that might be catastrophic and scour is one of them. Structural engineers strive to assure that a potential failure may be indicated by deformation well before collapse. Unfortunately scour of bridge foundations offers opportunities for instant failure. A similar incident occurred in 2009 when a Cumbria bridge collapse under flooding and a life was lost. The same year there was a major failure of the Malahide Viaduct in Ireland which collapsed just after the passage of a train due to scour weakened foundations.

where this work has not been carried out properly. Not only is there damage but deaths and injuries have resulted from improper basement construction. Older properties are particularly at risk since they often have shallow foundations (or no proper foundations), the brickwork bonding may be poor, and the mortar may be weak. There can be no guarantee that the foundation level is uniform so leading to a requirement for underpinning. Design issues are carrying vertical load, resisting lateral pressure (for basement wall stability and bending) and assuring that the stability of adjacent property is not jeopardised.

Clients should use competent people but too often the cheapest option is chosen. The DCLG Competent Persons Scheme aims to reduce these risks by giving "notified" organisations under The Building Regulations the powers to provide a building control function for some types of building activity or refurbishment work. Basement work however requires building regulation approval and in many cases the intervention of building control, sometimes by the serving of dangerous building notices, has prevented collapse. Building control cannot control the qualifications or experience of those carrying out the work and indeed they cannot require detailed plans of the work. The applicant often uses a building notice procedure which does not require the deposit of plans.

DEFECT ON SITE DELIBERATELY COVERED UP (Report 217)

A reporter says that supervision of construction has declined over the last 15 to 20 years and believes that the Eurocodes could provide a basis for change. He wants to share an experience he had whilst working for a contractor as an assistant site engineer of evidence of the risks associated with the reliance on self-certification of construction.

The site level had to be raised which allowed reinforced concrete pile caps and ground beams to be constructed above ground level. At one end the formwork was struck within a couple of days and fill immediately placed to form the founding layer for the ground slab. During the compaction of the fill, which was done by a subcontractor, part of the ground beam was damaged by a roller. A section of foundation approximately 1.0 m long was broken off, exposing the reinforcement on the internal face of the footing. The reporter brought this to the attention of the Site Engineer, Agent and Project Manager separately and was assured that it would be repaired. The repair was never carried out and the fill was brought up to finished level to hide the problem. The damage cannot be seen on the finished structure and the area of damage was not bearing any significant load. The reporter anticipates that the only consequence is a reduction in the durability of the finished structure.

This problem was the direct responsibility of a subcontractor whose senior staff were aware of the issue. It was not rectified because of the time it would have taken to resolve which would have delayed completion and affected the contractor's profit. This commercial pressure motivated the contractor to hide the problem and has left a less durable structure. This same commercial pressure exists on all contractors and the reporter contends that independent supervision is the most effective mechanism to ensure that structures are constructed to specification.

CROSS comments: *This shows a dereliction of construction standards. Durability is still a safety issue if the design life of the building is compromised and covering up faults before they are found is a serious matter. The report reminds us that the quality of a design is only as good as the quality of execution. All building professionals will be aware that things happen on site that were often not envisaged at the design stage, and safety is assured by periodic inspection – this is especially true in conversion work. Incidents of this type described need a multi-facetted approach: competency, fair tendering, sensible*

What should be reported?

- concerns which may require industry or regulatory action
- lessons learned which will help others
- near misses and near hits
- trends in failure

Benefits

- unique source of information
- better quality of design and construction
- possible reductions in deaths and injuries
- lower costs to the industry
- improved reliability

Supporters

- Association for Consultancy and Engineering
- Bridge Users Forum
- British Parking Association
- Communities and Local Government
- Construction Industry Council
- Department of the Environment
- Health & Safety Executive
- Highways Agency
- Institution of Civil Engineers
- Institution of Structural Engineers
- Local Authority Building Control
- Scottish Building Standards Agency
- UK Bridges Board

timescales, and targeted supervision on critical elements or stages. As another example one member of the CROSS panel recalls visiting a site and spotting that the plant room flat slab (300mm thick) had actually been cast using the drawings of the floor below (200mm thick) such that the top rebar had 125mm cover!

RISKS IN NOTCHING TIMBER STUDS (Report 209)

During the construction of a block for student accommodation a reporter found a couple of locations on an external 4th floor wall where the load-bearing studs had been notched well past permissible depths. The site was on a coastal location so subject to strong wind loading which caused the reporter's firm considerable concern as there was only 35mm depth of the stud left. It had not been shown on any drawing how & where joists could be notched. Whilst the firm believes this practice is not widespread it is, in his opinion, imperative that the structural engineer designing any timber works should specify the zones in which drilling and notching can take place, and the maximum sizes for these notches. Also the contactor should make all subcontractors especially the electricians and plumbers aware of these requirements.

CROSS comments: *This is not an isolated case and highlights the need for designers to anticipate and consider the full demands of construction. This form of construction will require some form of 'notching' or other means of passing through the wall structure. The structural engineer should recognise this at the design phase and consider the consequences. Notes on drawings to maximum depths of cut-out, or prohibited zones of cut-out is one way of proceeding. Other common examples are the weakening of block work walls by excess chasing out for services, the weakening of timber floors by excessive notching to carry services such as central heating pipes, and the cutting of 'unauthorised' holes in concrete and steel members. Design codes and recommendations such as the NHBC Standards give notching and drilling limitations for this type of work. Part P competent electricians should also be aware of the structural effects of notching structural timber as part of their training for registration into a competent persons scheme. However because timber frames are often procured as a system there are usually no full structural drawings as such. As usual it must be said that no changes should be made without the approval of the designer.*

ROLE OF APPROVED INSPECTORS (Report 205)

A reporter's firm is involved in a partially built project, worth £6m, where there is defective work and the builder has gone into liquidation. The project is 2-3 storey building in the health care sector and has load-bearing masonry walls and floors spans of up to 9m. The reporter and the client have sought the information that they would normally expect be lodged with the Approved Inspector concerning the structural design. The Approved Inspector has told the reporter that he did not get any information except foundation drawings, a ground investigation report and architectural drawings and in his opinion this would be: "all they would expect on a project of this nature". On the basis of these drawings and the site investigation the Approved Inspector has not commented on the works done even though there are numerous defects in design and workmanship that may lead to demolition.

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To register for CROSS Newsletters go to the website (www.cross-structural-safety.org) and on the right hand side of every page there is a 'Register' box. Enter your name and email address and click the 'Register' button. An email will be returned to your address confirming that you are on the list of subscribers.

FEEDBACK

With the 'Feedback' facility you can send comments on any aspect of CROSS or of the site or on anything to do with structural safety, and also read the input from others. More feedback is wanted.

REPORTING

Use either the 'How to report' button on the top of the website www.cross-structural-safety.org or the similarly labelled button on the right hand side to send on-line or off-line reports. It is simple, confidential, and could be important. Click here to go directly to the reporting page

HOW TO REPORT

Please visit the web site
www.cross-structural-safety.org
for more information, or email
Alastair Soane, CROSS Director, at
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The reporter wants to know if it would it be normal for an Approved Inspector to accept this state of affairs -or would he be correct to assume that the Approved Inspector is there to help achieve Building Regulation compliance, in which case this has not been done. Is there a scope of duties that an Approved Inspector, or indeed a local authority, should comply with? The reporter believes that local authorities are exempt from negligence claims and wants to know if this applies to Approved Inspectors? The reporter further wonders if there any simple guide for clients, perhaps from the LABC, that could be used by construction professionals to help a client understand what he needs to consider. He thinks that improving the knowledge of design teams in this regard could be a quick win in improving standards and improving the position of Local Authority Building Control. Finally, he asks whether, in the case of a dispute between a consulting engineer and an Approved Inspector is there a way of getting the local authority involved.

CROSS comments: *The responsibility for compliance with Building Regulations rests with the owner/developer. An Approved Inspector has an obligation under the Regulations to ensure within the limits of professional skill and care that the work complies with the building regulations. This does not mean that there is a guarantee of compliance as that responsibility rests with the person carrying out the work and, by its very nature, the process of Building Control is a spot checking process. In the case of Approved Inspectors there is a contract in place with the client, which may be limited to the liabilities in the Building Act and Regulations, or a wider range of liabilities related to performance. Approved Inspectors are liable to negligence claims under contract if they do not perform to the agreed scope of service. Unlike a local authority there is no requirement in statute for an Approved Inspector to check plans and the client should request a plan's certificate if they wish to have documentation of an independent design check. Inspection on site is costly for the building control provider and the number and type of inspections is a matter between a building control provider and the client. Competition between building control providers is driving prices down and that reflects in lower levels of inspections by building control bodies.*

If the owner/developer engages an Approved Inspector, and the builder does not satisfy the requirements of the Approved Inspector then the Approved Inspector can ask the Local Authority to take over the inspection. In such instance, the Local Authority can then apply to the courts with the purpose of enforcing the Building Regulations.

DATES FOR THE PUBLICATION OF CROSS NEWSLETTERS

Issue No 22	**April 2011**
Issue No 23	**July 2011**
Issue No 24	**October 2011**