

CROSS

Confidential Reporting on Structural Safety

Newsletter No 19, July 2010

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INTRODUCTION

BP oil rig disaster – lessons to be learned for the construction industry

The dominant issue on safety is of course the disaster in the Gulf of Mexico which has transcended the technical press to become a matter of international concern. It is an extreme example of a low probability incident which has enormous consequences. It is likely to change the way in which such operations are conducted in the future, it will change safety regimes, and it will influence the practice of risk analysis in all engineering disciplines. This is a defining event. The Tay Bridge disaster and other bridge collapses are reminders of the way in which bridge design has changed, Ronan Point changed thinking on robustness, the football stand disasters in the 1960s changed for ever the design of stadia. To learn from past events and to keep that information for future generations of engineers is vital. To pick up precursors of major events and then use proper reporting schemes to generate alerts is a valuable aid to safety. The Swiss Cheese model which is often used to illustrate risk shows that there are usually several influences which coincide to transform a hazard into a failure. It is when deficiencies in Plant, Processes and People coincide that failure occurs. Indeed the application of these three Ps to risk analysis is a SCOSS mantra.

Influence of CROSS

A primary objective of CROSS is to use data from reports to influence change and a good example is the effect of a report in Newsletter No 18 on unstable concrete blocks. The issue of inferior concrete blocks has been discussed in the relevant BSI Product Standards technical committee and the aggregate block industry has been made aware of the situation. The issue is usually the use of furnace bottom ash as the aggregate (whether of quality assured nature or not) and the limit to proportion of ash used in concrete block mixes. At the moment the BS EN for aggregate masonry units does not limit proportion.

SPLIT RESPONSIBILITIES ON TEMPORARY BRACING OF STEELWORK (Report 204)

The report below has been sent to CROSS by an engineer who wants to illustrate potential problems due to devolved responsibilities on site.

A project is supported by numerous steel columns which start at ground floor level. Because of various site constraints, several columns are kinked at upper floor levels; the resulting horizontal forces are taken back to a substantial concrete core through the floor beams or slabs. The second floor slab is post tensioned concrete and the contractor decided to erect the steel first and install the second floor slab later, when the steelwork and concrete subcontractors would not interfere with each other.

The steelwork subcontractor installed temporary bracing to two columns which kinked at second floor level. In the permanent structure these columns are unbraced from second floor to fifth floor. The steelwork subcontractor identified (correctly) that without the second floor in place there would have been a problem with major axis bending due to the kink, and a problem with minor axis buckling because the column was unrestrained over five floors. The main contractor removed the temporary bracing (because "it was in the way") shortly after the column was connected to the fifth floor steelwork. He was surprised to be told that the bracing was still required - he believed the column was properly restrained when it was connected at top and bottom. He claims that the engineer

NEWS REPORT

Network Rail bridge collapse (Report 187)



A train carrying kerosene, gas oil and diesel, came off the rails south of Stewarton on 27 January 2009. Six of the 10 wagons came off the rails during the incident and some caught fire. Power lines were also brought down and the nearby A735 was closed. It took the emergency services several hours to bring the fire under control. The resultant leakage of fuel contaminated local waterways, causing harm to wildlife. The Rail Accident Investigation Branch said corrosion in the bridge's girders meant it could not support heavy loads and criticised Network Rail's maintenance regime for the bridge saying corrosion went unidentified.

The report states: "The immediate cause of the derailment was the collapse of the bridge that followed the catastrophic structural failure of its east and centre main girders. Heavy corrosion had so significantly weakened these main girders that they were no longer able to carry the loading from trains that were permitted to run over the bridge." It further states that "no arrangements had been made to inspect the hidden parts of the east and centre main girders" where the heavy corrosion had occurred. Corroded parts of the bridge were "not fully repaired" when the bridge was waterproofed in 1987. The report also states that the bridge superstructure was not re-painted when the waterproofing work was done, or afterwards. The operator of Britain's rail infrastructure is also urged to improve its "methods and processes for the examination of hidden critical parts of structures" and its management of the information used for making decisions about the structural safety of its bridges.

Network Rail said that since the crash it had carried out inspections on 575 bridges of similar design throughout the UK - 129 of which were in Scotland. No bridges have been found in a condition similar to that of the bridge at Stewarton. "As a result of this incident, we have reviewed the way we examine bridges of a similar style." "We have made changes to our inspection procedures so that bridge inspectors are required to expose hidden critical elements of the bridge during examination."

should have identified a "hold point" (either on a sequence drawing or a health and safety note) - "column should be restrained at second floor if construction proceeds above second floor before permanent second floor structure is in place" - or similar.

The engineer's drawings clearly showed the kink points in plan and section, and identified the horizontal forces applied, in the permanent structure, by the kink to the second floor slab. The engineer believed that he should not have to tell a competent contractor that a kinked column needs temporary restraint at the kink; nor should he have to point out that a column designed to be unbraced over three floors needs extra restraint if it is erected unbraced over five floors. The problem appears to be that the main contractor has no in-house temporary works engineer. The contractor's staff rely on subcontractors or call in an engineer if they decide it is necessary - but because the decision is made by the site agent (and the site agent is not an engineer) they do not always get it right. There are "scope gaps" between the subcontractors and nobody to co-ordinate them. In this case the main contractor decided to remove some temporary bracing without understanding the consequences. The problem was picked up by the consulting engineer's REs and the steelwork subcontractor but there was a potential for a serious problem.

CROSS comments: *This report raises issues which go to the heart of the construction process. The Report of the Advisory Committee on Falsework, June 1975, states: "...at each stage of the design and construction of Falsework a check or inspection should be made by a competent person. A senior designer must countersign the plans: an inspector must sign off the construction. We therefore believe that it is essential that one individual in the construction organisation be given the duty of ensuring that all procedures and checks have been carried out.we describe this person as the Temporary Works Co-ordinator." The message has been repeated many times since then.*

BS 5950 has two particularly relevant clauses:

Clause 2.1.1.2---one engineer needs to be clearly identified with responsibility for overall stability and they need to "ensure compatibility" of parts by others contributing to overall stability even if designed by others.

Clause 2.4.2.3---where resistance to horizontal forces is provided by something other than a steel frame the steel design needs to "clearly indicate the need" and "state the forces acting on it".

The need for temporary bracing therefore needs to be identified by the engineer if they are aware that the sequence of works requires it. Instability introduced by a change in the contractors' method of construction is however out of the engineer's hands if he is unaware of the change. It is not uncommon to find issues such as this when the structure is part complete and not fully restrained. Some contractors may not have the expertise to identify such problems, especially when the structure is unusual, and some designers may not be sufficiently conversant with erection processes so that potential problems may not be identified. There are lessons to be learned from this report.

- 1. It should always be assumed that steelwork is potentially unstable during erection and a method statement, which is agreed between all involved parties, should describe the erection sequence so that a competent and responsible engineer can check that the frame is stable in all stages up to completion.*
- 2. Site visits by the designer during construction are to be encouraged so that any changes are identified.*

Further information can be found in BS 5975 Code of Practice for temporary works procedures and the permissible stress design of falsework. Finally, the report raises an issue which has been of concern to SCOSS for some time: that on many sites there is an absence of competent structural engineers in the key decision making process.

NEWS REPORT

Network Rail bridge collapse (continued)

CROSS Comments: *Having an independent review of procedures at periodic intervals is a beneficial 'insurance policy'. A fresh pair of eyes may identify shortcomings that those who are close to the activities may not identify. The benefits of independent reviews are set out in a SCOSS Topic Paper (www.scoss.org.uk/publications.asp) 'Independent review through Peer Assist'. However it is interesting to note that inspection procedures have apparently been changed to allow study of hidden parts. With this type of structure there is a very open arrangement of main and cross beams and should not be hard to thoroughly inspect on a routine basis. All structures degrade with time and their continuing safety is dependent on an inspection regime that identifies corrosion before it progresses too far.*

There have been several serious failures consequent on degradation that could not be inspected. A key part of a proper design process should be to ensure that potentially vulnerable and important structures can be inspected especially when the consequences of degradation may be catastrophic.

Cases of degradation leading to severe incidents were identified by Dr Allan Mann (Learning from failures at the interface, Civil Engineering, Nov 2008). These include leaks in a drainage pipeline at a UK government laboratory that enable a Foot and Mouth virus to escape in 2007, and a leak in a gas pipeline that resulted in the fatal Stockline Plastics factory explosion in Glasgow in 2004.

DANGEROUS MODIFICATION TO A COLUMN (Report 169)

A reporter was requested to visit a warehouse to inspect work carried out to a column that was constantly being hit by a fork truck. The Client had commissioned a 'design & build' contractor to remove the lower section of the column and support the higher section out of the path of the forklift with a cantilever. The Client was concerned that the work 'did not look right'. The photographs show the work that was carried out. The reporter spoke to the builder who confirmed that no calculations or detailed drawings had been prepared for the scheme. The new posts were merely resin anchored to the floor slab of the warehouse and covered with 200mm of unreinforced concrete. The bolt holes did not line through and some bolts were at an angle between members. Welds were of varying quality and all work was carried out on site, i.e. no shop fabrication. The most worrying fact was that there was no temporary propping to the column despite the works not being complete according to the builder. It was also learnt that Building Control were not informed of the proposed column removal. The reporter advised the Client to have temporary props installed immediately.



CROSS comments: *Building owners must be mindful of their responsibilities in ensuring that the work they are commissioning is undertaken by competent persons and that the necessary approvals are in place. It appears here that the Client has not appointed a competent contractor and/or designer who complied with CDM regulations. However a lay client cannot be expected to know this, which is why contractors are obligated to inform them, and some "design and build" contractors appear to be reluctant to use engineers except when a building control officer asks for calculations. Unauthorised work can be reported to a local authorities building control section and the authority may be able to prosecute the builder for failure to give notice particularly if the builder is known to them as a repeat offender.*

The wider picture is that performing unauthorised alterations and performing alterations where the full consequences have not been appreciated is a generic cause of failure and sometimes catastrophic failure. No work of any obviously structural nature should ever be designed other than by a competent designer (preferably a chartered engineer) and no work like this should be carried out other than by a competent contractor and the final work quality ought to be verified by the designer.

The difficulty is how to control the activities of unsuitable contractors. Should there be a carrot or stick? Comments to Feedback on the CROSS website www.cross-structural-safety.org will be welcome.

NEWS REPORT

£7,000 fine after worker crushed in building collapse

Fines totalling £7,000 have been issued after part of an office block that was under construction collapsed, seriously injuring a worker. The Health and Safety Executive (HSE) prosecuted the building's designer and the principal contractor. A Magistrates' Court heard that emergency services, including a county Fire and Rescue Service's major incident unit, were called to the scene in 2008. The HSE investigation found that a concrete block pillar, used to support the first and second floors, had been resting on the ground floor instead of going down into the foundations.



Part of the collapsed office block

The investigating HSE Inspector said:

“One of the workers' legs was badly broken after the rubble fell on him, but the consequences could have been much worse. This was a basic error which should have been spotted by both the building's designer and the principal contractor. It is common sense that the pillar supporting the floors should have gone into the foundations, and not just rested on the floor below. It is vital that companies learn lessons from this to prevent similar incidents happening in the future.”

The principal of the design company pleaded guilty to breaching Section 3(2) of the Health and Safety at Work Act 1974. The builder pleaded guilty to breaching Section 3(1) of the Act. Both charges related to the safety of workers being put at risk. The principal of the design company was fined £4,000 and ordered to pay £12,000 towards the cost of the prosecution and the builder was fined £3,000 with costs of £12,000.

RETAINING WALL CONCERNS AND THE STANCE OF A LOCAL AUTHORITY (Report 189)

A reporter was asked by a Client to assess a retaining wall built on their boundary by a neighbour who had erected a new dwelling. Of reinforced concrete block work construction the wall is about 2.75m high at its highest point and retained the Client's land. On the other side of the wall is an access road to the neighbour's new dwelling. From a visual inspection the wall appeared sound. However, a review of the calculations and a typical section, gave serious concern for its strength. From the layout of the calculations it was reasonably obvious that they could not apply to the structure in question. The reporter contacted the Engineer named on the calculations to ask him if he could deal with the Section 167 issues. It was then established that the Engineer had not designed the retaining wall or overseen its construction. He did not know that his calculations had been put into an Agreement for the Works. The calculations were for a garage wall with concrete floor over (to support part of the new dwelling) and part ground retaining.

The reporter's firm then informed their Client that the retaining wall was substantially under strength, and therefore an unsafe structure requiring action to make it safe as soon as possible. The firm took the view that they had done their duty in so far as they had advised of a severe health and safety risk and recommended a course of rectification. However, they believed that they should also inform the relevant authority and consequently wrote to the Local Authority. They suggested that an Engineer's calculations had been fraudulently used and issued, giving cause for concern as to the integrity of the construction as a whole. The firm's recommendation was that the LA takes action under Section 77 of the Building Act. The LA's reply was, paraphrased: “our officer has visited the site and upon inspection there was no visible change in the walls condition (from a previous visit) and therefore we are taking no action at this time.”

They ask, through CROSS, what more can the firm do about this clear and present danger?

CROSS comments: *It is very difficult when professional advice on safety is not taken up and there have been, as previously reported, a number of recent collapses of boundary walls and retaining walls sometimes with fatal results (eg Newsletter No 15 July 2009 – Deadly Retaining Wall) and the matter is important. Boundary walls may however not come within the jurisdiction of Building Control unless they are deemed to be dangerous structures and this is the subject of the following comment published in Feedback on the CROSS website:*

“Report 166 [Newsletter No 17] concerning the collapse of a freestanding boundary wall misses the main problem with these walls, which is that they are not covered by Building Regulations (unless they form part of a building), so their construction is unregulated. Therefore local authority building control officers have no authority to do anything about the design or condition of such a wall unless someone reports it as a dangerous structure (by which time it is usually too late).”

A further step can be taken by explaining again these concerns in writing (possibly in a registered letter) to the head of Building Control with copies to the Highways Authority and HSE. The local authority has powers under the Building Act to take action and below is a paragraph taken from a typical council web site:

“Local Authorities are given discretionary powers to deal with Dangerous Structures by Sections 77 and 78 of the Building Act 1984.

The Council will take action where deemed appropriate to ensure public safety, either to require the owner to make the structure safe, or in an emergency, to take action then recover costs from the owner. Emergency action might be to remove the danger, perhaps

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

by demolition or partial demolition, or to provide barriers around the dangerous structure (www.hastings.gov.uk/dangerous_structures)”.

If there is still no satisfactory response then as a citizen, the reporter can complain about the action, or inaction, of a local authority to the Local Authority Ombudsman who has powers to investigate (www.lgo.org.uk/). Mention made in the letter to the Local Authority that recourse might be made to the Ombudsman could have a salutary effect. It should be noted that the authority can only take legal action when the building or structure is in such a condition as to be dangerous, they can not take action on the basis that the structure is likely to become dangerous in the future. If the authority shares the concern of the engineer they could write to the owner of the wall advising them of the authority's concern and advising that if the condition of the wall deteriorates the authority may instigate proceedings against them as the owners.

UNDERMINING SHALLOW FOUNDATIONS (Report 196)

A reporter's firm has come across several similar problems when constructing extensions to older properties. The problem is a tendency for existing shallow footings to be exposed and possibly undermined during the process of reducing levels for the proposed new floor. This appears to occur more regularly on sites underlain with clay soil where a suspended floor is proposed for the extension. In such a situation the reduced level for the slab may be more than 500mm below existing ground level which in many instances will expose shallow foundations. Such exposures and undermining can occur along significant foundation lengths (corresponding to the full extension width) with obvious dangers.

CROSS comments: *Undermining existing foundations is a problem frequently encountered, and there are numerous examples of resultant substantial failures. The situation is predictable in older buildings and the designers should arrange for hand dug trial pits to determine the level of existing construction as part of the hazard elimination and risk reduction measures. Excavation on a 'hit and miss' principle may well be necessary, coupled with site visits at an early stage. This problem can also be addressed by employing competent builders and Building Control bodies can assist by providing advice at the start of the project with local knowledge of construction, and if there are doubts about the competence of the builder. CROSS is aware of incidents where foundations have been undermined leading to gross collapse of the wall overhead and death of those involved in the excavation.*

UNSUITABLE UNDERPINNING (Report 175)

A reporter received an appointment from an Adjoining Owners Party Wall Surveyor to comment upon proposed basement and other works to an adjacent site. The consulting engineer for this site proposed to underpin the party wall to depth of 3.8 metres using 325 mm thick mass concrete. A simple glance at the details showed that there was insufficient vertical load to maintain stability under lateral load from the retained height of soil. The drawings showed no requirement for temporary works and the site was so restricted that propping would have been impractical unless the ground and basement floors were designed to be built in a properly thought out sequence. The Consultant designing the scheme demonstrated little understanding of the stability issues for the underpinning and (according to the reporter) was swayed by the architect into specifying the proposal to save space in the proposed basement. Following several months of deadlock (the Party wall Award was not forthcoming until the reporter was satisfied with proposals) the scheme was radically revised and the stability issues were properly addressed but the reporter is concerned at an apparent lack of understanding regarding stability of underpinning and the designer/contractor interface so far as responsibility for safety is concerned.

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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 dir_cross@btinternet.com

When reading this Newsletter online [click here](#) to go straight to the reporting page.

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CROSS comments: *The party wall surveyor was correct to call in an engineer because if the original scheme had progressed, a major collapse would have been likely with possible loss of life. The report highlights a lack of competency and failure to understand the processes of structural design (i.e. risk management) as well as the obligation on the designer to demonstrate how a scheme is to be safely constructed. Small projects can exhibit substantial risks. General comments are the same as for Undermining Shallow Foundations (report 196) in this Newsletter.*

SCAFFOLD COLLAPSE AND SLIPPING CLIPS (Report 152)

This photograph has been sent in by a reporter and shows a scaffold that collapsed onto a parking area. Luckily, he says, only 11 vehicles were damaged, and no people were injured. The scaffolder's sign board apparently vanished fairly quickly thereafter. The reporter notes that front to back diagonals and horizontals are offset by half a bay and that the horizontal members are held with putlog clips only. The diagonals and some verticals were wrapped in polythene before the clips were put in place which then appear to have slipped.



CROSS comments: *In a similar case a scaffolding company failed to take sufficient care to protect public when working in a city centre after a pole fell and gashed the leg of a pedestrian. The company was fined a total of £4,000 and ordered to pay costs after pleading guilty to breaches of the Work at Height Regulations 2005 and the Management of Health and Safety at Work Regulations 1999. The scaffolding had been erected on a pavement that had not been closed or restricted, allowing pedestrians to pass by it. Scaffolding should comply with BS EN12811-1, by following the National Access & Scaffolding Confederation, Technical Guidance, TG20:08, Volumes 1 and 2. This case is a reminder of the need to:*

- Appoint competent scaffolders
- Ensure that scaffolds are designed and built to industry standards, for example TG20
- Inspect scaffolds properly
- Plan and supervise their use

DATES FOR THE PUBLICATION OF CROSS NEWSLETTERS

Issue No 20	October 2010
Issue No 21	January 2011
Issue No 22	April 2011
Issue No 23	July 2011