

CROSS

Confidential Reporting on Structural Safety

Newsletter No 11, July 2008

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INTRODUCTION

In this edition there are examples which show the importance of inspection and maintenance on external structures. The failure of a culvert roof was prevented by timely inspection but the staircase in a multi-storey car park collapsed. There are comments on precast joint failures, the failure of a lifting bolt, and another case of a member that was found to be cracked after galvanising. A query about partition loads for timber construction is answered.

If attention is paid to these warnings potential collapses will be avoided. SCOSS/CROSS intends to develop a website to allow designers, contractors, and checkers, to search for issues relating to their field of work but this depends upon getting additional funding. In the meantime engineers can read the CROSS Newsletters, which are all on the web site, and contribute their own anecdotes and experiences.

Safeguards are in place to ensure the confidentiality of reporters by removing references that might identify a person, a firm, a project, a product, or other distinguishing feature. Reports can however be submitted with no identification except for the name of the reporter. This is to be sure of authenticity but after telephone confirmation names are not kept and the original documents are returned to reporters.

Reports may be sent on behalf of firms or organisations so that there is more openness and a wider distribution of lessons from which others may learn. The director of CROSS will always be pleased to discuss how a concern may be addressed.

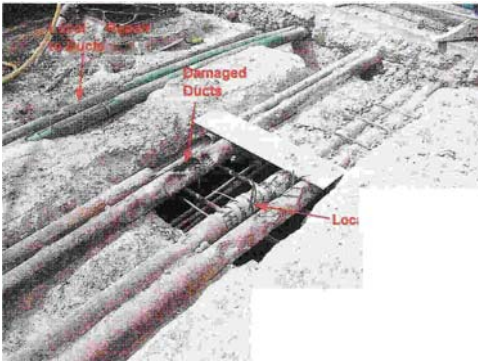
For the scheme to continue to thrive more reports are needed so if you have an experience that could be passed on please send a report by post or email or simply by telephone.

In the reports that follow the normal text is that of the reporter, whilst the italic comments in green are from the CROSS panel of experts.

CULVERT ROOF SLAB FAILURE

A culvert, which carries a river under a busy main road, has an internal span of 2.4m and headroom of 1.0m. The reinforced concrete roof slab was 300mm deep and had, from the time of its construction, four 120mm metal service ducts cast into it. Some years later two additional ducts were cut into a channel on the top of the slab. There had been a regime of inspections and key dates are:

- 1989 inspection satisfactory
- 1995 inspection found some damage due to the installation of new cable ducts which was repaired
- 2001 inspection generally satisfactory
- 2007 inspection found that a section of the roof had partially collapsed



Whilst demolishing the slab it became apparent that the only reinforcement was the longitudinally spanning tension bars. There was no transverse reinforcement and no reinforcement on the top of the slab. The bars were unevenly spaced, particularly where they had been grouped together so as to not clash with the original ducts. The presence of the newer ducts evidently impacted adversely upon the performance of the slab. The probable cause of the failure of the slab was that at some time the slab had cracked but as this was not visible it was not repaired. Over time and under loading, the cracks opened up allowing ingress of water causing corrosion to the reinforcement.

NEWS ITEMS

SCOTCROSS FINDINGS ON DANGERS FROM FALLING MASONRY PUBLISHED

The final report on risks from falling masonry in Scotland, carried out by SCOSS using its CROSS system (Confidential Reporting on Structural Safety), has been published by the Building Standards Division, Directorate for the Built Environment, of the Scottish Government

www.sbsa.gov.uk/pdfs/SCOTCROSS_REPORT.pdf.

It stems from a recommendation by the Construction Industry Council for Scotland in their 2003 report 'Risks to Public Safety from Falling Masonry and Other Materials'.

Information was obtained on materials and debris that fell from buildings, or was at risk of falling, from Scottish Local Authorities. They provided 1,275 reports over a two year period giving a wealth of data in a format devised by CROSS including age, type and size of building, type of ownership, use, material concerned, and other factors. Some examples were potentially serious, and illustrate the risks of personal injuries or deaths to passing members of the public. There were twelve reports, or 1% of the reported incidents, of pedestrians being struck by falling masonry or other debris. It was noticeable that the number of incidents increased in severe winter weather.

It is suggested that consideration should be given by Government and local authorities to have a system for recording falls, and incipient falls, of materials, which could be a valuable indicator of the resilience of buildings to climate change in addition to helping with safety issues. The use of CROSS is to be encouraged for reporting these and other concerns about structural safety.

Learning Points (from the reporter):

- The inspection regime was helpful in that problems were identified in 1995 and 2007 which allowed repairs to take place before a critical collapse in which a vehicle could have fallen into the culvert causing danger to both people and property.
- The damage on both occasions was only seen by an internal inspection of the structure, thus suggesting that inspections should always be as complete as possible.
- Damage can be done to a structure and not display itself, or affect a structure's serviceability for a substantial period of time.
- Any structure which is known to have been damaged must be monitored closely thereafter.
- The roof slab did not have a red-sand asphalt carpet over its top surface. If it had this might have alerted contractors that they were working over a structure and prevented damage to it.

CROSS comments: *The reporter mentions a red sand carpet but the most commonly used product is now a proprietary sprayed on protection system. What is also concerning is that the Utilities should have been issuing NRSWA notices to the Highway Authority. They should have then identified that the route included a structure and classified it as an Engineering Difficulty requiring additional caution and (sometimes) submission of method statements to the Highway Authority for approval. The extent of surveys is not always clear and here there are several points worth highlighting: good records must be kept, the relevance of defects must be understood, and the ownership of, and responsibility for, structural modifications must be clear. Those making alterations or repairs must be made aware of the potential structural consequences of their actions. It is important that access is available for inspection purposes. Utility companies should make their own inspections and assessments of aging infrastructure elements before disturbing them. (Report No 097)*

NEWS ITEMS

MORE ON CEILING COLLAPSES

Since the reports in the last Newsletter about ceiling collapses two Building Control officers have contacted CROSS regarding ceilings that have failed due to poor workmanship and/or inadequate fixings.

In the USA a ceiling collapsed recently in an apartment building. It is reported in the local press that the spacing of the fasteners used to apply the dry wall (plasterboard) to the joists was inadequate. Fortunately there were few people in the building at the time and nobody was injured. The building was closed and the apartments evacuated whilst investigations were carried out.

Also in the USA an inmate is claiming negligence after he suffered injuries when the ceiling in his jail cell collapsed. He was sleeping when a large portion of the ceiling collapsed and fell on top of him allegedly causing permanent injuries.

The ceiling of a hospital room collapsed on a patient in Bulgaria. The woman was injured severely but survived. Another patient who was lying on a nearby bed was slightly injured as pieces of concrete fell from a height of about 3m

CAR PARK STAIRCASE COLLAPSE AT CONSTRUCTION JOINT

The top flight of a staircase to a multi-storey concrete car park collapsed approximately 10 years after construction. The stair was constructed insitu and cast against the existing slab which had protruding continuity reinforcement. The failure occurred at the construction joint between the slab and the stair landing. An examination indicated that the failure was due to corrosion and consequent failure of the bars across the joint. The reporter believes there to be a number of issues contributing to this premature failure. The car park was of a split level type construction and the staircase went between two "half" levels. The stability of the car park was provided through moment frame action and the two split levels that the stair connected were separated in every other way by a movement joint. This meant that any relative movement of the two slabs due to seasonal thermal, shrinkage or other action, was restrained by the staircase alone. The weakest point of the stair was likely to have been the construction joint and it is likely that this would open and close due to the varying imposed movements.

The joint was provided with a rebate to be filled with sealant. Whilst this should have sealed the joint it was dependent on future maintenance. There was evidence from other areas of the same car park to suggest that, in some places, the sealant was either missing or not performing satisfactorily. Evidence from the failed stair indicated that the construction joint had been poorly prepared. This means that there would have been little aggregate interlock between the slab and stair concrete. Greater aggregate interlock would have made the water path more tortuous and provided a load transfer mechanisms across open cracks. Without aggregate interlock the only method of load transfer would have been dowel action in the reinforcement crossing the crack. The car park falls were such that the joint was placed at a low point, thus water tended to gather over the joint, leading to ponding and an increased flow of water through the joint. As this was the top floor of the car park de-icing salts were used during cold weather. Corrosion due to chlorides is often very local and pitting in nature, this means that significant section loss can occur without evidence of significant rust staining. Inspection of the failed staircase did not reveal such staining.

CROSS comments: *In addition to design issues the standards of construction and maintenance are important and with car parks these are more critical than with buildings generally due to the exposed and often harsh environment. The client should have been aware of the need for inspection and maintenance and with a modern structure this should be highlighted in the CDM Health and Safety file. The wisdom of a design detail that relies on the performance of a sealant for structural integrity must be questioned. However the most critical issue is whether the danger of tying together two large structures was appreciated, and if the stair had been supported by one only one of these structures there would probably not have been a collapse. Designers should take account of the durability requirements of car parks and there are three helpful publications. The Institution of Civil Engineers report 'Recommendations for the inspection, maintenance and management of car park structures' (www.ice.org.uk/downloads/Car_Parks.pdf), the Institution of Structural Engineers report 'Design recommendations for multi-storey and underground car parks' (www.istructe.org/publications/pubdetails.asp?pid=3&bhcp=1) and the planning portal from the Department of Communities and Local Government has a report 'Enhancing the whole life structural performance of multi-storey car parks' (www.planningportal.gov.uk/uploads/odpm/400000009277.pdf). (Report 106)*

PRECAST JOINT FAILURES

A reporter is interested in CROSS's evidence about joint failures in concrete. It seems to him that a failure generates immediate publicity in the technical press and has an impact on engineers practicing at the time. Some years later the same failure arises from similar circumstances but again with none of the lessons having been learnt. Whilst working for a large concrete component company in the early seventies he remembers a half joint failure on a precast staircase (this one was internal) for the same reasons described in Report 088 – Concrete half joint failure (Newsletter No 9) . The solution was to form a small pocket in part of the landing and stair flight nib which was then filled with insitu concrete on site. This allowed anyone to check that the reinforcement was in the correct place following casting. Such a solution is not, however, in current use by precast manufacturers. It seems to the reporter that there needs to be a formal link between the findings of failure investigations and those who draft standards to ensure that precautions necessary to prevent future failures are embedded into the latest codes of practice and standards. This would eliminate the need for those such as the reporter to rely on fading memories to pass on the dangers to the next generation of engineers

***CROSS comments:** An objective of SCOSS is to use CROSS reports to learn from the experiences of others particularly when there have been systemic failures. Codes of Practice cannot contain all the information needed for good design at the detail level. Indeed Eurocodes are much more about principles, and as they are introduced more emphasis will be placed on best practice documents, training and supervision. This will help to avoid the use of sensitive details such as poor half joints. (Report 107)*

REDUCED PARTITION LOADS ON PROPRIETARY JOISTS

A reporter believes that a number of proprietary joist manufacturers are using a reduced partition allowance for the engineered joist design. The load used is quoted in the code of practice for engineered wood products. Whilst carrying out structural checks on several designs the reporter noticed that the load allowance is less than he would normally have used. He is concerned that this may be missed by contractors commissioning the floor design without an engineering check on the assumptions that have been made and wondered if any one else has observed this too?

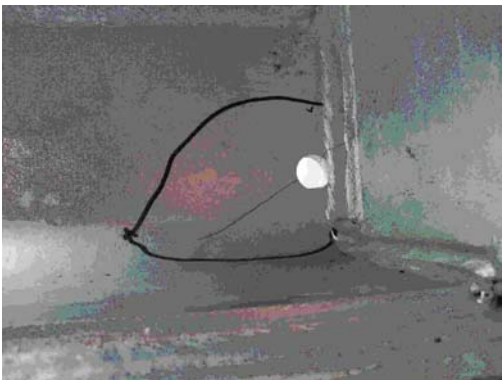
***CROSS comments:** It is assumed that the code of practice referred to is 'Engineered Wood Products - Code of Practice' by the UK Timber Frame Association (January 2007). This applies primarily to new residential buildings and structures, although it states that the principles can be applied to other classes of structure. The minimum load for non-load bearing partitions, applied to single occupancy domestic floors is given as the more onerous of 0.64kN/m line load or 0.22kN/m² udl. The weight of a timber stud partition with 12.5mm plasterboard both sides is given as 27kg/m² in TRADA Technology Timber Frame Housing: UK Structural recommendations. For a wall 2.4m high, this equates to around 0.64kN/m, as above. The document goes on to say that the floor designer is responsible for determining the partition loads on a floor. Where it is shown that the actual weight of partition exceeds the loads given, the actual weights should be used. It also states that reference should be made to BS 6399-1 or BS EN 1991-1-1 for partition loads for floors of other than single occupancy domestic dwellings. Where partitions are envisaged, but their location is not known, an allowance of 1/3 of the load/m run of the finished partition should be applied as a udl. This is consistent with the above. However, for office floors this udl should not be less than 1.0kN/m². The load to be applied thus depends upon the use of the building. (Report 108)*

LIFTING BOLT FAILURE

A major contractor reported an incident that had occurred in which a threaded eyebolt failed during an operation to lift a section of stonework into place. Although there were no injuries this was clearly a high potential incident. Investigation has revealed that the eyebolt was not marked with its Safe Working Load (SWL). Eyebolts are accessories for lifting under the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) and must be marked with their SWL. The eye had failed at a poor quality weld where it had been bent back on itself to form the loop of the eye. It had then opened out and fractured at the opposite end, releasing the load. The contractor's staff have been instructed to:

- ensure that all eyebolts are marked with their SWL
- ensure that the selection of any lifting accessory, including eyebolts, forms part of the lifting plan and must be undertaken by someone competent to select lifting equipment ie the appointed person/lifting co-coordinator or other suitably qualified engineer.

CROSS comments: *Lifting equipment used in conformity with LOLER should not exhibit this kind of problem so the use of un-rated components in a lifting rig must be avoided, as must the use of modified components. When possible lifting frames should be used under the control of a qualified rigger who would check the SWL before beginning operations. It may however be difficult to ascertain the weight of the component being lifted although this should be given by the manufacturer. The example illustrates the importance of knowing the source of material and equipment supplied. (Report 110)*



FOLLOW UP TO LIQUID METAL ASSISTED CRACKING (LMAC)

A reporter says that as a result of CROSS and SCOSS dissemination there is a wider awareness of the risk of liquid metal assisted cracking, and reports are being fed back following post galvanising inspection. CROSS welcomes more reports because the mechanisms that drive LMAC are still poorly understood and the industry needs to build up a better picture of the risk factors involved. A recent case involving cracking around holes in large structural components was detected immediately after galvanising as a result of the team being aware of the need for post galvanising inspection. Clearly the project risks are minimised by early detection before steelwork erection and this should be the norm.

CROSS comments: *This is another example of the value of passing on lessons that have been learnt. Guidance is available on the subject of LMAC (From the BCSA and Galvanisers' Association); SCOSS has also issued an Alert (www.scoss.org.uk/publications.asp) and has discussed the matter in its 15th Biennial Report. This issue is becoming more prevalent with the increasing size of galvanised components and the importance of post galvanisation inspection should be noted. (Report 105)*

DATES FOR THE PUBLICATION OF CROSS NEWSLETTERS

Issue No9	January 2008
Issue No 10	April 2008
Issue No 11	July 2008
Issue No 12	October 2008

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