

Newsletter No 9, January 2008

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INTRODUCTION

This issue contains five reports on collapses: two involving demolition, two concerning free standing masonry walls, and one of a concrete joint. There were several fatalities and a serious injury. The reasons for failure were poor engineering judgement, or indeed none at all. There are fortunately only a few fatalities, certainly in the UK, as a direct consequence of bad engineering. However there are a significant number of failures and near misses on structures where there should have been proper engineering input but there was not. There is also a report about concerns over very lightweight steel frames. Reports to CROSS usually come from engineers who are well qualified and have come across failures in the course of an investigation or as a result of being called in to a collapse. The objective of SCOSS (Standing Committee on Structural Safety) is to raise awareness so that their knowledge is passed on, particularly to those are in a position to influence behaviour amongst designers, checkers, and contractors.

Submitted reports are edited to remove identification and sometimes to give clarification but the views of reporters are not changed. They are logged and categorised to provide data for analysis and are then reviewed by a voluntary panel of experts who, in turn, provide the comments that are given in the Newsletters. There have recently been two important additions to the panel: the chief designer from a major contractor, and the chief building surveyor from a major city. They join the seven existing members who are from SCOSS, from firms of consulting engineers, and the Health & Safety Executive. All are appointed on the basis of their personal expertise and do not represent either their organisations or any commercial interests.

CECA (Civil Engineering Contractors Association) is now circulating these Newsletters to its members and reports from them will be much appreciated as they will add to the value of the scheme.

Reports are presented in normal text below, whilst comments from the panel are shown in green italics.

DEMOLITION RISKS

A reporter has written about the collapse of a 'flat slab' building that occurred overseas whilst the top floor of the building was being demolished onto the next floor down. He says that this process was being undertaken by three tracked vehicles operating on the floor. The collapse was a classic "pancaking" of the slabs as they effectively slid down the supporting concrete columns. Several employees were killed in the accident and a number of serious defects were identified.

1. Cover to Reinforcement According to the reporter engineers familiar with the design of flat slab construction will know that CP114 (which was the relevant design document when the building was constructed) and other Codes and Standards, allocate flat slab design bending moments between column and middle "strips". Heavy concentrations of shear occur around column heads and these are often strengthened by thickening the slab locally. The design must ensure that sufficient of the column strip steel located over the column area is correctly located. Investigation of the construction, after the collapse of this building, showed that top reinforcement was not located where it should have been but had been placed closer to the geometrical neutral axis than was originally intended in the design.

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NEWS

Consultation on the Future of Building Control

Communities and Local Government are soon to publish a consultation paper on the Future of Building Control. There will be a 3 month period for consultation and architects, builders, engineers, surveyors, and others in the construction industry are encouraged to participate. It is intended that there will be a major review of many aspects of Building Control and responses to the consultation will help to shape the nature and extent of these. Publication will be on <http://www.communities.gov.uk/planningandbuilding/> and responses can be made by individuals and organisations.

2. Temporary Propping To cater for the potential additional load of machines and debris, says the reporter, the three floors immediately below any floor that was being demolished were provided with temporary screw jack propping. The reporter says that it will be appreciated that it is extremely difficult to assess the contribution which such propping makes at any individual floor level, because each floor can deflect either during the propping operation and/or during the demolition stage. An individual floor may have substantially more or less load imposed upon it. A secondary consideration was that the props were designed to be tied at mid height position to add to their load carrying capacity and also to have some cross bracing. It was thought highly probable that no such intermediate tying was used, or, if it was, then only on an ad-hoc and casual basis. Essential cross bracing was thought to have been omitted.

3. Loads and vibration from demolition machinery and from debris The assessment of the building loads and the proposed temporary propping arrangement before demolition did not take into account the fact that heavy tracked vehicles not only imposed static loads, but dynamic loads. There was also no specified maximum height of demolition material which could be allowed to accumulate. Stock piling of broken concrete occurred to considerable heights and heavy machines ran onto and over these stockpiles. Demolition machinery was supposed to be restricted to machines of not greater than 20 tonnes. In fact, one machine was over 30 tonnes.

So, says the reporter, 'what do we learn from this?'

- Never assume that because a building has been standing for 30 years that it must be OK!
- Never assume that a building has been constructed in accordance with the original drawings and specification.
- Temporary propping - indeed any propping - should commence from a firm, solid and static base unless the risks of not doing so are assessed.
- Machinery can result in both static and dynamic loading.
- There may be risks because nobody has explained to the operatives doing the job, why it should be done in a particular way.

CROSS comments: *This example clearly demonstrates the need to design for demolition with the same thoroughness as one would design for construction. It also illustrates the need (and requirement) to take an holistic look at the existing structure in order to eliminate all foreseeable hazards and reduce associated risks, so far as is reasonably practicable. The 'designer' i.e. the person specifying the demolition must be satisfied there is a safe way to demolish the structure, and provide adequate information for the contractor. The current state of the structure must be assessed allowing for deterioration, not the state of the structure as built. A contractor undertaking such work must have the requisite competence and the requirements of CDM regulations apply. It appears that punching shear failure may have been involved, and there have been other examples of the failure of flat slab car parks and similar buildings. Shear failures often give no early indication of impending failure, so demolition, or indeed alteration, of flat slab structures demands care. (Report 096)*

A FURTHER DEMOLITION COLLAPSE

Another report is of an incident that occurred recently in a UK city when a floor suffered a structural collapse during the demolition of a reinforced concrete building. Three small excavators fell down at least one floor and one of the site personnel was injured and three others were rescued. The cause has still to be ascertained.



The collapsed floor

CROSS comments: *The comments made above apply here also. However, it is not known in this instance whether the collapse was due to a shortfall in the design, or in the manner of demolition adopted. It can be seen from the picture that one column protrudes through the floor slab which may indicate shear failure around the column head. Both reports reinforce the fact, which is backed by HSE statistics, that demolition risks are amongst the highest in construction activities. A review of proposed demolition procedures by a structural engineer should always be carried out. Notice should also be given to the local authority whenever demolition is planned. (Report 090)*

SERIOUS INJURY FROM FREE STANDING WALL COLLAPSE

A reporter wants to raise important structural points about free standing walls especially those that are planned and built by untrained people. He says that in the back garden of a house stood a 100 mm brick wall, built of Flettons in cement mortar, about 2.5m long, and just under 1.0m high. There was a patio behind it about 200mm high, and in front of it grass. It was therefore nominally retaining some ground, certainly enough for it to have plenty of water going into the bottom two or three courses. It had no restraint, neither by a cross wall at either end, nor were there any piers. It was some years old. Examination of photographs (the wall has disappeared) indicates that there was a certain amount of damp at the base and it seems likely to the reporter that there would have been minor thermal and moisture movements here, and possibly freeze/thaw effects, which caused the lowest exposed mortar course just above the grass to loose its bond.

Late one evening, says the reporter, three young people returned home. Two sat on chairs on the patio, a young lady perched herself on the wall. It rocked, she fell backwards, and the wall came down as a single piece of brickwork weighing the best part of half a tonne, on top of her. Apart from bruising and laceration, her neck was broken in two places. Amazingly, and according to the medical experts as a result of outstandingly good emergency treatment coupled with outstanding long term care, she has only limited disablement.

The reporter believes that simple guidance should be more readily available to builders and the public.



Collapse that caused serious injury (report 094 above)



Collapse that caused death of a child (report 059 below)

FATALITY FROM FREE STANDING WALL COLLAPSE

A report was received from a local authority about a boundary wall to the front garden of a domestic property that collapsed suddenly resulting in the death of a child who was passing. The 1.7m high wall was constructed from a single leaf of 100mm thick hollow concrete blocks. The wall was subject to lateral pressure from an immediately adjacent tree and building materials stored at the rear of the wall.

CROSS comments: As well as these reports to CROSS there have been many articles in the press about injuries and fatalities from free standing wall collapses. Several years ago there was lengthy correspondence on the subject in the Journal of the Institution of Structural Engineers. In Northern Ireland there are moves to introduce regulations covering new construction while in Scotland there have been regulations covering walls more than 1.2m high for some years. It is widely known that free standing walls are often poorly constructed and not adequately maintained. SCOSS hopes to discuss this with the Sustainable Buildings Division of Communities and Local Government.

As is the case with shear failures in concrete discussed above, failure in free standing walls occurs with little or no warning and because they are cantilevers collapse is inevitable. The main design document for brick and blockwork walling is the **British Standard BS 5628, Code of Practice for the use of masonry: Part 1 Structural use of unreinforced masonry, and Part 3 Materials and components, design and workmanship**. There is also the emerging **Eurocode BS EN 1996 on masonry**. Other guidance documents available which give advice:

Design of Free Standing Walls - Brick Development Association
A Reinforced Brickwork Freestanding Boundary Wall - Brick Development Association

Building brick or blockwork freestanding walls - Building Research Establishment, Good Building Guide GBG 14

Surveying brick or blockwork freestanding walls - Building Research Establishment GBG 13

Planning Portal - Communities and Local Government Planning Portal
<http://www.planningportal.gov.uk/england/genpub/en/1115315233001.html>
 contains advice on garden walls generally and guidance on heights in relation to thickness.

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The problem is how to recognise existing walls that are unstable and potentially dangerous. Keeping a careful eye on suspect walls for cracks is important as these could be the early signs of the wall distress. Walls should obviously be vertical and not out of plumb. Walls that have not been constructed with appropriate materials may show long term damage from frost and rain penetration. If there is material piled on one side of a wall this can be dangerous as can tree roots and nearby excavations. Boundary walls often act as partial retaining walls and even with small differences in level trapped water can build up and lead to problems. This is not an exhaustive list and other factors may have to be considered. So far as children are concerned they should be discouraged from climbing on garden walls as this can initiate collapse resulting in serious injury or death. If there is doubt about the condition of a wall a structural check should be made. If a wall is manifestly dangerous the local authority should be advised as they have powers to remove such structures if there are imminent dangers. (Reports 094, 059)

CONCRETE HALF JOINTS

Half joints in concrete structures have been used successfully over many years notably in bridges and buildings, says a reporter. They can offer great advantage in terms of construction and design although their performance depends on good design and detailing and maintenance. Failures in half joints can happen if reinforcement is not detailed properly. Recently the reporter's firm has come across a half joint in some precast beams with a very poor reinforcement detail. The beams were erected as planned. However due to one of the defective joints failing, a collapse was initiated which caused the subsequent collapse of a series of beams and precast slabs as shown in the photograph. The investigation revealed that the position of the steel dowels (for shear) and reinforcement in the beams was incorrect and not sufficient to withstand even dead loads.



CROSS comments: *Half joints can be satisfactory in buildings but are not now recommended in external situations where they may be subject to weathering. The Highways Agency says that half joints in bridges pose a risk as due to difficulties of access they cannot be maintained properly. This is in addition to risks that may exist from design or construction defects. In many cases in buildings the thickness of the nib will be small so that the position of the reinforcement is not ideal. Joints should, so far as is possible, be positioned so that they can be inspected and then maintained if necessary. (Report 088)*

PROPER DESIGN AND USE OF COLD ROLLED STEEL FRAMES

A reporter has been designing structures in cold rolled steel for approximately twenty years, mainly portal frame buildings. He has informed CROSS that recently he has had a fairly close look at a commercially supplied portal spanning 9.0m, with a height to the eaves of 6.0m, and

frames at 6.0m centres. His calculations indicate that the rafters and stanchions are significantly overstressed even if all flanges were continuously restrained. There appear to be no inner flange restraints. The reporter's analysis is that, under dead + live loading alone, the rafter and stanchion frames need to be at half the spacings given.

The method of fixing the rails and purlins is also, he says, worthy of note. Normally cleats are used but this system seems to dispense with these and fix the flanges of the zeds directly to the flanges of the rafters and stanchions using self-tapping screws. The reporter considers that the information he has gleaned is sufficient to indicate that the frames could be dangerous in certain circumstances. He believes that members of the public have access to the building in this case and wonders how such the frames are getting Local Authority approval.

CROSS comments: *It may be that these frames are intended for agricultural use and do not fall within the scope of the Building Regulations, in which case the public should not have access. There are two considerations here. Firstly are there very lightweight portals that are being given Building Regulation approval despite that fact that they do not comply with the relevant codes? Designing lightweight portal frames is complicated, and designing cold rolled section prone to local buckling is even more complicated so it is important that a suitably high level of engineering is adopted. Secondly have Planning Permissions and Building Regulations been violated so that buildings apparently intended for agricultural purposes, into which the public do not normally go, are being used for other purposes? CROSS will be extremely interested to hear of similar experiences. (Report 093)*

EFFECTIVE LENGTH OF MASONRY WALL

A correspondent has written about the report on effective lengths of masonry wall given in Newsletter No 7 and the comments from CROSS. He says that the original reporter may have mis-interpreted the IStructE 'Manual for the design of plain masonry in buildings (2005)'. He says that the Manual and the British Standard BS 5628, Code of Practice for the use of masonry: Part 1 Structural use of unreinforced masonry, are clear that effective length OR effective height may be used in determining the slenderness of walls under vertical loading, it is not a question of applying a limit to both of these aspects. Provided the wall is held in position top and bottom and is not too tall to exceed the vertical slenderness limits, the length is irrelevant in terms of its structural design. Similarly, if the wall is held in position at each end and is not too long to exceed the horizontal slenderness limits, then the height is irrelevant in terms of its structural design.

CROSS comments: *CROSS does not prescribe methods of design but aims to point out where correct, or even better, where best practice should be applied. In the case of masonry walls this means complying with the code and reputable guidance documents as is suggested by this correspondent.*

HOW TO REPORT

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Post reports to:
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Comments either on the scheme, or non-confidential reports, can be sent to dir.cross@btinternet.com

DATES FOR THE PUBLICATION OF CROSS NEWSLETTERS

Issue No 10	April 2008
Issue No 11	July 2008
Issue No 12	October 2008
Issue No 13	December 2008