CROSS
Confidential Reporting on Structural Safety
For an introduction to CROSS see www.structural-safety.org. Email: structures@structural-safety.org

NEWSLETTER NO 30, APRIL 2013

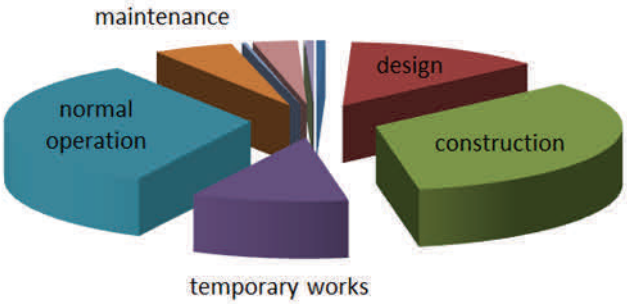
REPORTS IN THIS ISSUE:

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.

CROSS Contact
Director:
Alastair Soane
Email:
structures@structural-safety.org
CROSS Website:
www.structural-safety.org

INTRODUCTION

This issue concentrates on competency and on issues identified on site. Statistics are collected from reports and one category is the stage of a project when a concern is identified. As shown in this pie chart almost a half of all events, 44%, are related to construction (34%) and temporary works (10%), with design accounting for 13%, and normal operations i.e. building or structure in use, 34%. Maintenance operations amount to 5% of the total and there are a few other minor categories. Lack of competency is reported to be a major reason for most of the safety-critical matters described below.



It is very satisfactory to note that there is now a backlog of reports awaiting publication and in order to control this some reports will in future be added directly to the data base after anonymising rather than being included in Newsletters. Reporters will be told if this is to happen and lists will be given in Newsletters. All reports, together with expert comment from our panel of volunteers, are on the data base which is freely searchable.

The growth of the CROSS programme depends on receiving reports and individuals and firms are encouraged to participate by sending concerns in confidence to structural-safety.

297 NEW BASEMENTS BENEATH EXISTING PROPERTIES

A reporter is concerned about the construction of some basements in London. He has reviewed two projects covering basement works in relation to Building Regulation checks on the structural aspects.
The following characteristics were seen by the reporter:

- they were probably two projects with the least percentage of costs spent on architectural and structural design that he has come across in three decades of practice,
- there was a definite danger to the builder, based on the submitted designs,
- they were very likely to cause major problems for the neighbours,
- It was suspected that the works would be outside the competency of all parties, and this included the client and the Building Inspector.

After the reporter expressed concern he said that the projects were passed to another engineer.

Comments

The increase in major or complex basement constructions in London in particular is a concern as the implications do not always appear to be appreciated by those involved. Such projects may not be 'building works' but

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
- DRD Roads Services in Northern Ireland
- Health & Safety Executive
- Highways Agency
- Institution of Civil Engineers
- Institution of Structural Engineers
- Local Authority Building Control
- Scottish Building Standards Agency
- Temporary Works Forum
- UK Bridges Board

*To find reports in the data base go to the **Quick Search** box on any page of the Structural-Safety site and enter a subject e.g. "wall" and a list of summarised reports will follow. Searches can be refined using **Search data base** facility.*

'construction projects', with an attendant necessary increase in competency. Indeed it has also been reported that in London basements under terraced houses are being constructed without any engineering input and no regard to the Party Wall Act, ground water movement, or the effect on neighbouring dwellings. Danger during construction is beyond the scope of Building Control but it is essential that this is considered during the process. There are usually understandings between Building Control and HSE such that once a project gets underway on site unsafe actions are referred to HSE. The aim however should be to intercept these projects prior to construction and perhaps this report reinforces the need for licensing certain types of work. It is to be hoped that available guidance would be consulted or competent specialists brought in as required. Competency of those in the chain of responsibility is very important and features in many reports to CROSS about failures. "Simplifying design and construction" from the Basement Information Centre gives general advice and is soon to be up updated.

317 Chain hoist problem

A number of brand new proprietary hoists were being used during the progressive demolition of a gas holder says a reporter. One, a 20 tonne hand chain block was left under load over a weekend and afterwards one strand of the 6 strands of chain was found to be broken. The remaining hoists were inspected and five were removed as being unsatisfactory. Detailed examination showed that:

- there was damage to the bottom block including damage to the edges, a broken weld and plate distortion,
- a section of the broken link from the load chain was gouged and bruised consistent with the chain becoming trapped in the guide plates,
- other, and different, marks were found on the load chain together with further sharp edges,
- there were dimensional discrepancies between the manufacturer's literature and the supplied hoist,
- the manufacturer's operating instructions were not clear.

All hoists were returned to the manufacturer for remedial works included machining to remove sharp edges, which should not have been present in the first place, and all chains were replaced.

Comments

Safety-critical lifting equipment requires careful attention. The standards for such a hoist are covered by the Lifting Operations and Lifting Equipment Regulations (LOLER) which set out stringent compliance requirements including inspection before use. In this case all, or some of these, were not met which raises doubt regarding manufacturer and supplier and possibly also the procurement and implementation procedures.

324 Lack of experience on steel column erection

Geometric constraints, explains a reporter, required that some column baseplates used a 2-bolt solution with the bolts located between the flanges of the UC sections. Notes on the drawings identified a temporary stability issue and said that the columns required propping until fully grouted. Several requests were made to the contractor to provide a method statement for erection but this was not provided and the reporter only noticed via a project webcam that the works had started. The erection was being carried out by a large civil engineering contractor who had chosen to procure from a supplier and erect themselves rather than sub-contract the package to a steelwork specialist. The site team, says the reporter, did not

Structural-Safety Alert Anomalous documentation for proprietary products

This Alert published in February created considerable interest and there have been requests for more information. Any reports of experiences with false or misleading documents and how to spot them will be welcome. Go to www.structural-safety.org and follow the Confidential reporting tab.

have much experience in steelwork erection and did not understand the importance of the temporary stability notes. The reporter also believes they were too programme-focused to respond to his requests for a method statement. While the column posts were only 2m tall, they were 6 storeys up and adjacent to a train line. Had the correspondent not noticed the works on the webcam then progress would have continued un-checked and, had there been windy weather conditions, there could have been a serious accident.

Comments

A proper system of work is a pre-requisite to any safety-critical action on site and should be recognised. In this case it appears that information was given by the Designer regarding stability but ignored by the Contractor. An unstable column high above a railway line is a safety-critical situation which carries considerable risk and warrants immediate attention. There have been cases where insufficiently supported or braced steelwork has fallen and resulted in fatalities. It is another case where competency may have been assumed but in the event was not justified. As more and more high rise towers are built in cities it is of utmost importance for industry to address such issues. In 2004 a UK company was fined a total of £100,000 following the death of a 16-year-old ground worker in an incident in which two structural steel columns were blown down by the wind. The need for temporary propping in such situations should be considered the norm. Locating bolts are not the same as holding down bolts and this is another case where temporary works should be designed to avoid such problems.

327 Erecting reinforcement cages

A reporter asks about best practice guidance for the installation of pre-assembled reinforcement cages as shown on this photograph. He can find very little guidance on the web and in this case the contractor appears to have left the solution to the steel fixers on site. Whilst the reporter is not suggesting they are not suitably experienced, he does not consider that this is the right approach. He would have expected a qualified Temporary Works Engineer to have designed a system for the work which should have included:

- Consideration of the bending moment and shear force induced as the cage is moved from the horizontal to the vertical, the dynamic loading effects and where applicable, the loads induced by the cage trapping onto a casing or guide-wall.
- Individual cage weights.
- Specification of lifting points including details of type (bands, bar or helical), steel grade, size and connections details (tying wire or welding).
- Position of lifting points for horizontal lifts, vertical lifts, lifting from horizontal to the vertical and for moving cages (note: these may be the same).
- Method of identifying lifting point. For example, coloured spray or tags.
- Details of how cage is to be lifted (i.e. single cage or multi-cage lifts).
- Details of pre-slinging requirements, including details of sling type (i.e. single or multi-use), length and safe working load.
- The amount and position of ties required and thickness of tying wire to take into account the strains placed on the ties by the cage in buffeting winds. It may be necessary to weld some vertical steels together.
- Any temporary support necessary.
- Establish that the recently poured concrete slab containing the starter bars had reached sufficient strength to withstand the uplift forces that would be imposed upon it by movement of the installed cage, which may be buffeted by the strong winds.

NEWS

WELDING INSTITUTE CONFERENCE

The Welding Institute Conference 2013 will be held in Rotherham on 5 June 2013. Due to the state of preparedness of large parts of the construction sector with only a year to go before the CPR and CE marking of structural steel products are enforced, they have decided to turn the day over to informing industry about the CPR, EN 1090 and ISO 3834 requirements. The speakers will address issues regarding control of welded production, personnel competence requirements for welding coordination and the challenges for manufacturers operating at the higher execution classes for structural steelwork.

A rebar cage similar to those referred to above

Comments

The reporter has made very valid observations and it does seem that little advice is publicly available. The comments made on report 357 "Wall reinforcement cages collapse" (below in this Newsletter) are general and may be of some help but more work is needed and the views of readers will be welcome.

357 WALL REINFORCEMENT CAGES COLLAPSE

In 2012 a contractor says that he experienced two cases of wall reinforcement cages collapsing. In both cases the walls were part of the construction of new RC water tanks where the height of the walls exceeded 6m and the vertical reinforcement was relatively light (12mm or 16mm bars). In both cases the site teams had identified a risk of collapse but the temporary works put in place to restrain the cages proved inadequate in both design and management. One of the collapses happened over a weekend during which high winds were experienced. The other collapse appears to have been instigated by pulling sideways on the partially completed cage while the reinforcement was being fixed. Both of the reinforcement cages were inherently unstable in the temporary condition before shutters were erected. In both cases, although the subcontractor responsible for erecting the reinforcement had identified the risk of collapse and taken steps to mitigate the risk by providing props, these were ineffective.

The following advice has been given internally to mitigate the risk of further collapses.

1. Where wall reinforcement is more than 3m high the temporary stability of the reinforcement should be managed as a temporary works item.
2. The stability of reinforcement should preferably be assessed by calculation. Alternatively the reinforcement should be assumed to need propping and suitable propping should be designed and installed.
3. Propping designs need to be reviewed by the responsible Temporary Works Coordinator and any deficiencies such as a lack of information on connections and fixings corrected prior to use.
4. The propping should be installed either before fixing starts or incrementally as fixing proceeds but the required sequence needs to be briefed to all involved with the construction activities. Generally the propping should be on one side only to permit erection of formwork on the other side of the wall.
5. The method statements for propping installation, reinforcement fixing and formwork erection should include hold points for the Temporary Works Coordinator to inspect the installed temporary works at suitable points in the construction process.

Comments

There have been many cases where rebar cages have collapsed, sometimes with fatal consequences, and it appears to be a risk about which there is limited awareness. Report 327 "Erecting reinforcement cages" (above in this Newsletter) suggests that recommendations are not readily available. In general it should be self-evident when there will be temporary stability issues during construction. However it may be that the expectations of each party in relation to the skill and understanding of others is not always justified. How much should the designer expect the contractor to know? Who in the contractor's supply chain should have the experience? When does expert knowledge take over from common sense? Experienced steel fixers might know when a cage is stable as a result of familiarity and on-the-job training. However the steel fixers on a project with unusually high wall or column lifts might not have had previous relevant experience and not recognise the risk of instability. Even if some risk is seen the knowledge as to how to stabilise a cage may not be there.

Similarly those others who are engaged in the design and construction process may not have the specialist knowledge to recognise when stability is becoming of concern. Or they may believe that is in the hands of experts who know what they are doing. Who is responsible for which actions in that difficult transition that occurs in the temporary stages of permanent construction? Is this a role for the Temporary Works Coordinator? These questions cannot be answered here but the industry as a whole should initiate steps to promote education and give advice.

In the UK reinforcement cages, prior to concreting, may be considered to be temporary works and their management should comply with BS 5975:2008+A1:2011Code of practice for temporary works procedures and the permissible stress design of falsework. The Temporary Works Forum (TWf) has also received concerns regarding reinforcement cages and is currently writing a good practice guide. (www.twforum.org.uk).

The Washington State Department of Labor & Industries published a narrative report on the death of a steel fixer when a rebar cage collapsed (SHARP Report No; 71-100-2011) [1] which included the following requirements and recommendations:

- *Ensure that reinforcing steel for columns, walls, and similar vertical structures is guyed or supported to prevent collapse.*
- *Make sure there is a programme to addresses hazards and abatement methods when installing reinforcing for columns, walls, and similar vertical structures.*
- *Ensure that the inspection of rigging and equipment is done by a qualified rigger.*
- *Use bracing that is in good working order.*
- *Frequently inspect and replace defective equipment and material.*
- *Make sure that bracing and guying are able to support the forces imposed.*
- *Ensure that loads are secured and will not inadvertently become displaced when released.*
- *A qualified person should design methods of bracing reinforcing steel when being placed into position.*
- *A competent person should determine if additional methods must be used to support reinforcing steel beyond guying and bracing.*

The terms "qualified" and "competent" are not defined and may have different meaning in different countries. In California there were 56 collapses of bridge column cages in the 15 years pre 2010 which prompted a research project: "Stability of bridge column rebar cages during construction[2]. The lateral behavior and stability of bridge column rebar cages were investigated to reduce the potential of failure and collapse during construction. Included in the report are research findings and some proposed guidelines for improved rebar cage stability. Current architectural designs incorporating "blade" columns of buildings as well as bridges means extra vigilance is required.

1. http://www.lni.wa.gov/Safety/Research/Face/ReptNarr/Narratives/Default.asp
2. http://www.dot.ca.gov/newtech/researchreports/reports/2010/2010-11_task_1098-geotech_and_structures.pdf

315 TELECOMMUNICATIONS TOWERS AND RESIN ANCHORS

A correspondent has experience of the causes of collapse of a telecommunications tower. It was held down by resin anchors which apparently passed their pull-out tests (125kN although it is not known how these were carried out) but failed 6 years later with little resistance in light winds. Although the prime cause of collapse was poor workmanship, there are many other issues.
The collapsed tower was a replacement. The original tower had been half the height, but the engineers (of the original tower) had gone to great lengths to ensure that there was no chance of a failure at the steel to concrete interface.
The reporter has several concerns:

- There is a growing tendency for towers and elements to be held down or secured by resin anchors and risks may not have been adequately considered.
- Stability should, in the opinion of the reporter, never rely on just a chemical bond without assessment of the risks.
- No data appears to be available on pull out tests carried out after a few years.
- The companies who provide the anchors may not have been informed of failures.
- Resin anchors could be used in high-risk environments such as for towers positioned beside

railway tracks.

- Pull-out tests at the time of construction might not be relevant after a few years, particularly if water can penetrate and freeze.
- There will be a need for continued and regular testing and replacement of anchors that rely on non-mechanical bonds.
- Some of these anchors do not allow for the easy testing and replacement of critical bolts at the superstructure/substructure interface because of levelling nuts below the base plate.

The reporter concludes by saying that he has reservations about the long-term behaviour of resins for exterior use.

Comments

Designers of safety-critical elements have to avoid the possibility of failure wherever reasonably practicable. This is particularly so in cases such as this when the long term behavior may be affected by a harsh environment and the quality of workmanship which is critical in post-drilled fixings. Anchor failures of various kinds have been reported including those in the spate of ceiling collapses sent to CROSS and in some serious collapses of tunnel linings. There is also an issue with the use of resin anchors to hold down structures such as freestanding towers which are predominantly subject to fluctuating wind load. It arises when the hole is completely filled with resin and the bolt is bonded along its full length. In such a situation, there may be strain incompatibility at the point where the resin and bolt meet. Over time, under fluctuating load, the bond between bolt and resin may have a tendency to weaken. This is in addition to the valid concerns raised by the reporter. There is a case for assembling a data base of resin anchor performance both short and long term and for developing more guidance on best practice which will need to include installation and testing. CROSS would therefore be interested to hear about other cases, particularly where there have been unexpected or premature failures.

321 Correct uses of concrete spacers

Concrete strip spacers are increasingly being used to support the bottom reinforcement in slabs says a reporter. They come in a variety of sizes to suit the required cover and generally are 1m in length. However if used incorrectly they can act as crack inducers. The problem, which is believed to be widespread, arises if when they are laid end to end in a continuous unbroken line and form a discontinuity in the structure. Spacer strips regardless of their material should be installed in accordance with the requirements of BS7973-1:2001, “Spacers and chairs for steel reinforcement and their specification”. Corrosion caused by the lack of cover is hidden from view e.g. in the case of ground bearing slabs, and will lead to failure if left unchecked. The worst example seen by the reporter’s firm was on a wind turbine base subject to aggressive ground conditions.

Comments

This seems to be a common issue as it has frequently been observed by others that spacers are placed in long lines. Whilst this is unlikely to result in immediate failure it could result in long term problems such as corrosion of reinforcement. It illustrates the need for designers to ensure that specifications reflect current practice and techniques. Where such spacers may be used the requirement for staggering should be specified are reference made to BS 7973-1:2001 Spacers and chairs for steel reinforcement.

Example of bad practice – spacers laid in continuous lines

359 Boom MEPW falls through precast planks

An alert was provided by a contractor to publicise the measures to be taken on sites where precast concrete floor planks are installed and may be loaded with plant or materials before an insitu topping is cast. A high injury potential near-miss (near hit) incident occurred when a boom MEPW fell through such a floor at a point where there was a notched precast plank. The plank failed because of installation and quality errors which could potentially have resulted in the MEWP and operator falling through multiple floors of the structure. The incident was fortunate to result only in property damage.

Where possible, it is recommended, says the reporter, that the works are programmed so that the structural topping is applied and cured, prior to loading the deck with plant or materials for subsequent operations. All plank installations should be reviewed to ensure they are compliant with Designer's requirements and specification, and Quality Assurance inspections are completed in-process with the required timing, rigour and diligence.

Comments

The critical point here is that the plank was notched and there have been previous failures due to this cause. It is often necessary to notch the plank at the support where the column passes through the floor. However as the planks have no lateral reinforcement they are not able to redistribute loads effectively so notching has a significant weakening effect on shear capacity. For this reason it may be prudent to provide an angle or other member on the column to support the edge of the notched panel.

HOW TO REPORT

Please visit the web site
www.structural-safety.org
for more information.

When reading this Newsletter online **click here** to go straight to the reporting page.

Post reports to:
PO Box 174
Wirral
CH29 9AJ
UK

Comments either on the scheme, or non-confidential reports, can be sent to structures@structural-safety.org

DATES FOR PUBLICATION OF CROSS NEWSLETTERS

Issue No 31	**July 2013**
Issue No 32	**October 2013**
Issue No 33	**January 2014**
Issue No 34	**April 2014**