CO-CONSTRUCT

Services Integration with Concrete Buildings

Guidance for a defect-free interface

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What is Co-Construct?

Co-Construct is a network of five leading construction research and information organisations - Concrete Society, BSRIA, CIRIA, TRADA and SCI - who are working together to produce a single point of communication for construction professionals.

BSRIA covers all aspects of mechanical and electrical services in buildings, including heating, air conditioning, and ventilation. Its services to industry include information, collaborative research, consultancy, testing and certification. It also has a worldwide market research and intelligence group, and offers hire calibration and sale of instruments to the industry.

The Construction Industry Research and Information Association (CIRIA) works with the construction industry to develop and implement best practice, leading to better performance. CIRIA's independence and wide membership base makes it uniquely placed to bring together all parties with an interest in improving performance.

The Concrete Society is renowned for providing impartial information and technical reports on concrete specification and best practice. The Society operates an independent advisory service and offers networking through its regions and clubs.

The Steel Construction Institute (SCI) is an independent, international, member-based organisation with a mission to develop and promote the effective use of steel in construction. SCI promotes best practice through a wide range of training courses, publications, and a members advisory service. It also provides internet-based information resources.

TRADA provides timber information, research and consultancy for the construction industry. The fully confidential range of expert services extends from strategic planning and market analysis through to product development, technical advice, training and publications.

For more information on Co-Construct visit www.construction.co.uk.

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Introduction

The aim of this document is to provide designers with guidance on the provision of both vertical and horizontal holes through concrete elements, both pre-formed and post-formed. The guidance given represents a sound common-sense approach to the design and detailing of holes and openings and should cover most eventualities.

This guide, the third in a series called Interface Engineering Publications, is designed to appeal to both structural and services design engineers. BSRIA and The Concrete Society have pooled their technical knowledge to provide both professions with consistent, interlocking advice.

This advice is often based on material repackaged from existing BSRIA and Concrete Society guidance. Details of the original publications, relevant European and British Standards and other references for further reading are provided at the end of this publication.

A document such as this cannot cover all services to concrete interfaces that may arise, and it is also dangerous to generalise when so many interfaces are specific to a particular context: the nature of the project, the relationship of the professional parties in the contract, and the client requirements for the building, which may be very particular.

In order to demonstrate how many of the key interfaces should be handled, the authors have used a recent project as a case study: The concrete-framed headquarters for the SAS Institute in Buckinghamshire. This project has been used to illustrate practical aspects of the more generic guidance on the integration of services with structure provided in this publication.

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CASE STUDY

Photograph: ©Oak Taylor-Smith/MFllp

CASE STUDY

How to use this guide

Advice about the services engineering requirements of running mechanical and electrical services through concrete elements will be found in blue-tinted boxes.

Advice about the structural engineering requirements of running services through concrete elements will be found in green-tinted boxes.

Comments marked by ■ link to structural engineering sections listed under *also see*.

Comments marked by ■ link to mechanical engineering sections listed under *also see*.

Comments marked by ■ denote a link common to both specialisms.

Key services watchpoints

☐ Essential mechanical engineering messages from the guide

Key structural watchpoints

☐ Essential structural messages from the guide

Also see

1 **Links** to services sections
2 **Links** to structural sections
3 **Links** to common sections

Standards for structural and services design

Further reading to support this guide

Glossary for terms and definitions

A clients' guide to

Early design issues

The need to cast or cut holes in a concrete element to allow for the passage of services is a common requirement. For some interfaces the problems are easy to resolve, but others require more design expertise and greater involvement between structural and services engineers. For critical areas, like exposed concrete finishes in occupied areas, engineers need to liaise very closely with the client, architect and installing contractors over the details to ensure a functional and aesthetically acceptable solution.

Figure 1: Even the simplest concrete-framed building has a wealth of integrated engineering services.

The structural perspective

Services and structural engineers need to work together very closely to ensure that the decisions made by the structural engineer will suit the building's comfort requirements. The reverse is also true, as the technical requirements of a particular services solution may dictate elements of the structural design. It is in the client's interest to foster a close working relationship.

It is a common occurrence for holes to be cast or cut into reinforced concrete elements, usually to allow for the passage of services. Wherever possible, the structure should be designed to include a service zone to minimise the need for holes for service runs. Even though this is a common situation faced by designers, guidance on the design and detailing holes is limited. This guide aims to satisfy that need.

Project pre-planning

Pre-planning is preferable to retrospective provision of any holes or openings. Pre-planned holes or openings are those marked on the layout drawings. They have been designed into the structural configuration so that the resulting stresses are distributed and the structure is not compromised.

Circular holes are preferable as square and rectangular holes can induce stress concentrations around their corners, increasing the risk of cracking. Whether the hole is formed in an element at the precast factory or formed *in-situ* makes no difference.

There are three forms of pre-planned holes:

1. ☐ Holes that are cast at the point of construction of the element and are left open ready to receive services
2. ☐ services that are cast into the element and remain in position
3. ☐ areas within a concrete element that are designated for holes to be cut retrospectively.

Occasionally there may be a need for a large hole in an element where standard guidance will not apply. It is not possible to give definitive guidance for such situations because each case will be different.

When large holes are required, an experienced structural engineer should be used to assess the resulting capacity of the element and to design any additional strengthening.

Post-cut holes

4. Refurbishment, change of use or poor planning presents other problems, notably when the need for new or extra services

Services engineering issues

Structural issues

requires additional holes to be cut in an existing structure. Questions that need to be addressed include:

- ☐ Why is the hole required?
- ☐ will the hole be cut through re-inforcement or prestressing strand?
- 5 ☐ does the hole and service interface need to be sealed against water, sound or fire?
- ☐ is the concrete element pre-stressed?
- ☐ did the original design provide nominated zones, free of reinforcing bars or stressed tendons, for services distribution?
- 6 ☐ what additional strengthening is required?
- 4 ☐ can the services be fixed directly to the concrete or is a separate fixing needed?

Structural surveys

Before undertaking any work that involves cutting into an existing concrete structure (apart from minor fixings), it is important to understand the form of construction and hence how the operation may affect the safety and performance of the structure. Reinforcement can be in both the top and bottom part of an element.

The location and orientation of steel reinforcing bars and prestressing strands can be determined using a covermeter. A covermeter is a simple, hand-held electro-magnetic device consisting of a search head and a control box. The head is moved across the surface of the concrete and an audible signal or digital readout is used to locate the position of the reinforcing bar. For more details see Concrete Society Technical Report 54, *Diagnosis of deterioration in concrete structures*.

With composite decks the steel soffit will probably impair the reading of a covermeter. However, as they are generally standard details, the location of reinforcing bar is less of a problem. The location and size of the hole is, however, crucial to maintaining structural integrity.

Key structural watchpoints

- ☐ Pre-planning is always preferable to retrospective provision of any holes or openings
- ☐ The location and size of a hole is crucial to maintaining structural integrity
- ☐ Circular holes are preferable as square and rectangular holes can induce stress concentrations around their corners, increasing the risk of cracking
- ☐ When large holes are required, structural engineers should assess the resulting capacity of the element and design any additional strengthening
- ☐ Structural engineers should determine whether holes need to be sealed against water, sound or fire penetration, and whether additional strengthening of the structure is required

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