... FROM THE EUROPEAN CONCRETE BUILDING PROJECT

Improving concrete frame construction

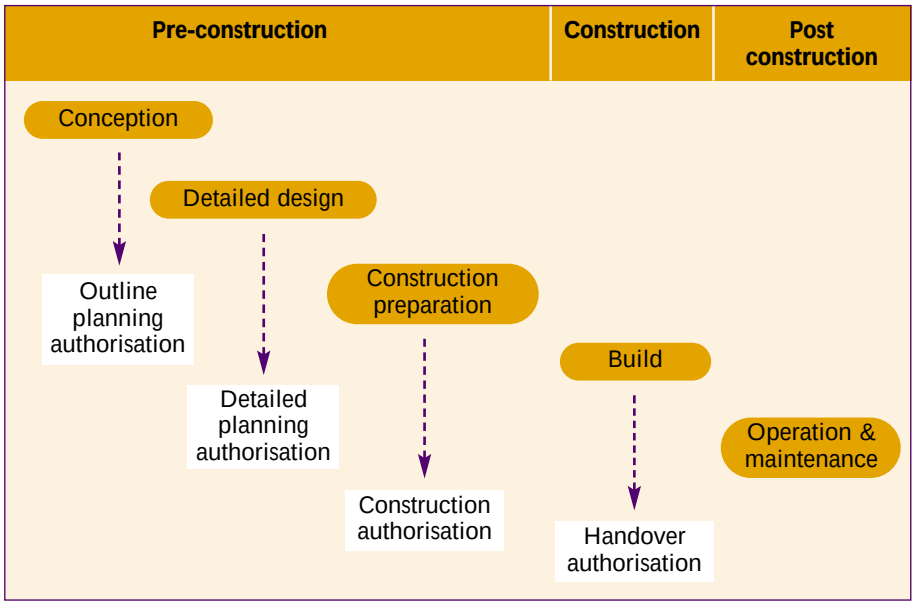

Figure 1: *Representation of the construction process*

This Guide provides recommendations for improving the concrete frame construction process

Key messages

- The concrete frame construction process must be more customer-focused, and continually improved, to provide savings in time and cost together with enhanced quality.
- Lean manufacturing techniques can be transferred from manufacturing to construction.
- The resulting improvements should produce time savings of over 30% and man hour savings of over 45% compared with current practice.

Best practice

- Understand the construction process by monitoring it, mapping it and recording the activities.
- Continually improve the process by eliminating all non-productive activities.
- Brief the construction team about the importance of adopting a process approach.
- Continually implement the planned changes.
- Continually review the process and provide feedback to management and operatives using the checklists provided.

The basis for change

Modern manufacturing techniques have been widely adopted and have led to dramatic improvements in efficiency in many industries, especially the automotive sector. This new approach, often called 'lean manufacturing,' is based on the principles shown overleaf.

Introduction

The European Concrete Building Project is a joint initiative aimed at improving the performance of the concrete frame industry.

The principal partners in the world's most ambitious concrete research programme are:

British Cement Association
Building Research Establishment Ltd
Construct - the Concrete Structures Group
Reinforced Concrete Council
Department of the Environment, Transport and the Regions

The programme involves the construction of a series of full-sized concrete structures in the Large Building Test Facility at Cardington, where they are being subjected to comprehensive testing of the building process and of their performance.

With support from the DETR and the Engineering and Physical Sciences Research Council, the first of these buildings, a seven-storey in-situ flat slab concrete frame, was completed in 1998. The results of investigations into all aspects of the concrete frame construction process are summarised in this series of Best Practice Guides.

These Guides are aimed at all those involved in the process of procurement, design and construction of in-situ concrete frames. They should stimulate fundamental change in this process in order to yield significant improvements in the cost, delivery time and the quality of these structures.

- Use well defined processes focused on the customer.
- Eliminate waste activities that do not add value.
- Just-in-time supply of materials to the place of manufacture.
- Use of multi-disciplinary teams.
- Concurrent, i.e. parallel, working.

These principles can be applied directly to construction and can lead to a similar dramatic change in performance by acting to reduce both cost of labour and delivery times whilst enhancing quality levels.

There are also some supplementary issues to address alongside the implementation of the lean principles.

These include:

- Supply chain management.
- Motivation of personnel.
- Use of multi-skilled labour.
- Productivity.
- Project organisation.

Results to be expected in construction

A study of the construction process for the in-situ concrete building at Cardington identified these potential savings.

Potential Savings

Improvement area	Reduction in total cycle time (%)	Reduction in total man-hours (%)
Supply chain management	10.5	15.0
Buildability	3.0	3.5
Resource allocation	6.5	10.5
Operational methods	8.5	13.5
TOTAL	**28.5**	**42.5**

These savings have been confirmed by findings in other construction projects and are modest in comparison with what is possible. Companies should aim for savings of:

Cycle time: *over 30%*
Man hours: *over 45%*

These figures represent achievable targets in most construction projects.

The concrete frame construction process

A concrete frame construction process consists essentially of three main stages, as shown in Figure 1 on page 1.

- Pre-construction.
- Construction.
- Post-construction.

The stages are, in turn, further sub-divided into a series of phases comprising a number of specific tasks. Passage between phases and stages is controlled by a series of formal review meetings to authorise progress to the next stage. Supporting activities (e.g. project management, health and safety, information management, task scheduling, etc.) are handled in a series of support processes that underpin the construction process.

Before a process can be improved it must be mapped and understood.

Understanding the current process

To develop an understanding of the current process the following activities are recommended:

- Identify the separate tasks and how they link to other tasks.
- Monitor people, their methods of working, movements and interaction with others.
- Monitor flow of information and materials, into and out of the site and between people and tasks.
- Maintain a site diary, one page per day for main events.
- Video the site overall and the individual tasks.
- Create a site reference grid to locate all movements and to provide a reference for the videos. Make the grid visible by using coloured tapes on the floor.
- Construct process charts: Gantt charts and flow charts for activities within each task (see Figures 2, 3 and 4).

It is not suggested that **all** these techniques are used. Particular circumstances at each site will determine which are relevant.

Improving the current process

The key activity in the improvement process is the identification of waste. Waste is any part of the process that does not add value to the concrete frame construction. It includes:

- Waiting and queuing.
- Scrap and rework.
- Over-manning and inefficient working.

The main areas for improvement are likely to be:

- Logistics and supply chain management.
- Buildability.
- Resource allocation.
- Operational methods.

Improving the following areas can also help reduce waste:

- People motivation.
- Use of multi-skilled labour.
- Information management.

Activities that do not add value and that can be eliminated must be removed. Those which are needed to support the process should be optimised to utilise minimum labour and consume minimum time.

Developing an improved process

Having mapped the current process and identified the sources of waste within it, an improved process can be developed and used to plan new projects or re-direct current projects. It is important to establish links between the pre-construction, construction and post-construction stages to provide an integrated process and a further basis for change and improvement. It is likely that the client and his advisors are best placed to ensure that this happens.

Implementing the improved process

The process improvements should be implemented at all three stages of the construction process as described below.

1. Pre-construction

- Provide secure information links between designers and the contractor and ensure that there are no misunderstandings.
- Brief the construction team about the importance of adopting a process approach.
- Set targets for the improvements.
- Brief suppliers to ensure deliveries are made just in time, so that they are neither cluttering the site, nor holding up the process.
- Plan information management.
- Consider introducing information technology, e.g. bar-coding of supplies, secure Internet communication between stake-holders.
- Organise systems for scheduling and define work methods.

No	Task name	Duration	Start date	Finish date	M	T	W	T	F	S		M	T	W
1	Stripping columns	1.1 hr	31/3	31/3										
2	Erecting edge protection	14 hr	31/3	1/4										
3	Reinforcing	42 hr	31/3	6/4										
4	Backpropping	8 hr	1/4	1/4										
5	Levelling deck	18 hr	1/4	2/4										
6	Forming and positioning block outs	7 hr	1/4	1/4										
7	Shuttering for pre-cast beam	8.5 hr	1/4	2/4										

Figure 2: *Gantt chart for floor construction*

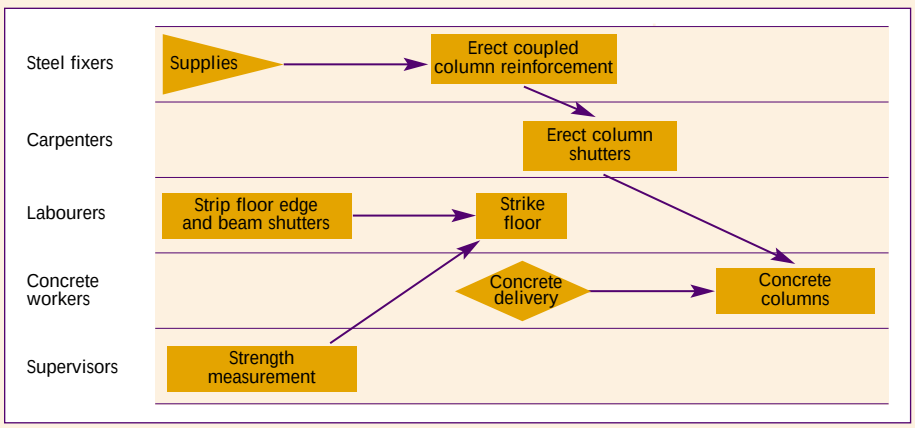

Figure 3: *Flow chart for construction activities for day after concreting of 2nd floor*

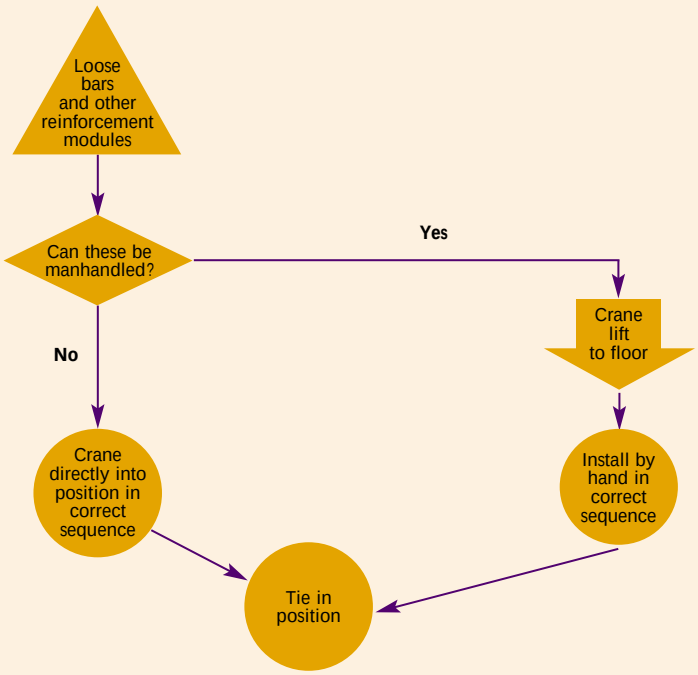

Figure 4: *Reinforcing floors - task flow chart*

- Fix project review points and targets for each review.
- Determine a policy for conflict resolution.

2. Construction

- Ensure the improved process is followed.
- Identify and record where the process can be further improved and continually make these improvements.
- Involve suppliers in process improvement.
- Feed back findings continually to professionals, site staff and other interested parties.

3. Post-construction

- De-brief the team and categorise and document the lessons learnt.
- Review the optimised process and further improve it.
- Consider further applications of information technology to underpin the process improvement.
- Measure the improvements in terms of man hours, quality and delivery time.
- Try to gauge other supplementary improvements, e.g. morale, lessons learnt, etc.
- Provide feedback to all personnel, including designers and suppliers and their organisations.

Checklist for improving the concrete frame construction process

1. Pre-construction stage

- What do you expect to achieve?
- What are your initial targets?
  cycle-time reduction
  man-hour reduction
- What is the relationship with the design team?
- What is the relationship with suppliers?
- Is the construction team briefed?
  operators
  supervisors
  managers
- Who is responsible for the whole construction process and its improvement?
- Do you know and understand the complete process and have you mapped it using time-charts, flow diagrams, etc.
- Who will mediate disagreements?
- How is information to be circulated?

- Who is the customer and how is he involved in the process?

2. Construction stage

- Is the construction workforce briefed?
- How have briefing meetings been prepared?
- How will these briefings be organised?
- How will you collect data?
  from the site as a whole
  from the point of construction
- Is the workforce aware of the data collection?
- How is progress to be reviewed?
  day by day
  week by week
- How is the project being managed?
- How do suppliers fit into this scheme?
- What interviews are carried out with site personnel and with whom?
- How will casual and detailed verbal exchanges be recorded?
- How do you intend to employ information technology?
- How are suppliers being controlled regarding supply logistics?
- Who liaises with suppliers?
- Has the use of pre-assembled sub-units been discussed?
- Who is responsible for manpower allocation and methods of working?
- Who takes responsibility for the site diary?

3. Post-construction stage

- Did you construct the time-charts and flow diagrams?
- Who is responsible for the process analysis to generate improvement measures?
- In comparison with pre-construction plans, how do the following measure-up?
  supply logistics
  scheduling
  buildability
  manpower allocation
  project planning
  working methods
- Have there been disputes and how were they resolved?
- Have there been communication problems?
- How was information shared?
  with construction team
  with designers
  with suppliers
  with the workforce
  with the customer
- Did a project debriefing take place?
- What were the estimated results of improvements?
  cycle time
  man-hours
- How do results compare with initial targets?
- Was the workforce informed of results?
- Were suppliers and customer informed?
- Were improvement suggestions recognised and rewarded?
- What has been learnt and how will this affect the next project?
- Have the lessons learnt been adequately documented?
- Have these lessons been disseminated to all who could benefit from them?
- Was the project formally closed with a debriefing involving such aspects as relationships, information sharing and knowledge capture with the following participants?
  customer
  suppliers
  designers
  contract team
  workforce

This Best Practice Guide is based on research report, *Re-engineering the concrete frame business: construction phase report,* by A.I. Darzentas, P.J. Deasley and J.H. Rodgerson. BRE Report 388, published by CRC Ltd.

Further reading

Business process re-engineering

1. Hammer, M, and Champy, J. *Re-engineering the corporation.* London, Nicholas Brealey, 1993.
2. Peppard, J, and Rowland, P. *The essence of business process re-engineering.* London, Prentice-Hall International, 1994.

The construction process

1. The Construction Task Force. *Re-thinking construction.* London, DETR, 1998.
2. McGeorge, W. D. and Palmer, A. *Construction management: New directions.* Oxford, Blackwell Science, 1997.
3. Cooper, R., University of Salford, and Thorpe, A., Loughborough University. *Generic design and construction process protocol.* EPSRC-IMI research project report, 1999.

Best Practice Guides in this series

- Improving concrete frame construction
- Concreting for improved speed and efficiency
- Early age strength assessment of concrete on site
- Improving rebar information and supply
- Early striking for efficient flat slab construction
- Rationalisation of flat slab reinforcement

Further Guides are planned

Research partners for this Guide

Cranfield University
Building Research Establishment Ltd

97.501
First published 2000
ISBN 0 7210 1552 2
Price group A

Published by the British Cement Association on behalf of the project partners.

British Cement Association
Century House
Telford Avenue
Crowthorne, Berkshire RG45 6YS
www.bca.org.uk

For further copies of the Best Practice Guides ring the Concrete Bookshop on 01344 725704.