Learner Guide

RIICSG401D Apply the principles of civil concrete structures construction

Version	*Originator*	*Authorised*	*Date*	*Notes*
1.2	Advanced Solutions	Anthony Nairn	Mar 2016	

Contents

Chapter 1: Study Guide Overview

About your study course

As a student or In-service worker, you most likely have already come to the understanding of the practical skills and knowledge required to work within the industry standards that are part of the engineering field. This course seeks to guide you towards developing those skills and knowledge. In addition, you have both a time and financial investment that makes it a personal challenge. As such, help us to help you take 'responsibility' for your own learning. Talk to the trainer and request student support if desired.

Be receptive towards your learning process and reinforce your studies with self-learning wherever possible.

Getting the most out of your study

- Talk to your trainer / facilitator and ask questions. They are experienced and able to assist you with your enquiries where possible
- Carefully choose your time and place to study outside of the class or in an environment that is comfortable and effective for learning
- Make a schedule to study and talk about your studies with your peers (many hands make light work and there is often value in collaboration)
- Consider how the learner guide information relates to what you are doing
- Seek feedback on your work and study to ensure you are on the right track and re-affirm your effective studying habits
- Make notes, use highlighters, use colours (for the visual learners), underline stuff, scribble memos, and decorate your desk with post-its – whichever approach works best for you
- Read your work examples aloud (to yourself – sometimes as a potential strategy it helps you to understand something by reading it aloud and also to identify areas for consideration)
- Consider the student activities in the learner guide to reinforce your learning as you go
- Please advise if you are having issues. We would like to assist you to make this a positive learning experience.

Required texts and recommended readings

Throughout your course you may be introduced to texts and recommended reading materials for your studies from your trainer. Take note of these. In the meantime, we have a compiled a list of resources (see the *Table of Contents* for the '*recommended further readings*' page that follows the conclusion).

The learner guide and experienced trainers are generally sufficient to help you meet the requirements though it never hurts to have further materials that you might like to seek out for your own purposes and continued learning.

Referencing guide

Information has a source and referencing provides the pathway to that source. You will be required to reference if you are providing written submissions that includes work which has been sourced from copyrighted materials that are not your own. In many cases you will be simply referring to your learner guide to provide a written response to a question. In such a case, refer briefly to the page of the guide (Learner guide P.23).

In all other cases, we would recommend using a referencing system. There are two accepted types in Australia (APA & Harvard).

For your convenience, we have provided the following links to download either document for use in your studies.

https://www.library.uq.edu.au/help/referencing-style-guides

APA Referencing guide link

https://www.library.uq.edu.au/_/filething/files/get/referencing/apa_6%202.pdf

Harvard Referencing guide link

http://guides.lib.monash.edu/citing-referencing/harvard

https://www.adelaide.edu.au/writingcentre/referencing_guides/harvardStyleGuide.pdf

Chapter 2: Introduction: Unit Description

Required texts / reading

The only required text for this course is the **learner guide** and any additional hand-outs / text resources your trainer provides during your classes.

The learner guide

This learner guide provides the required information to engage in class activities and explains in detail, the processes by which to use the applied knowledge correctly. It is essential that you learn from both the guide and your trainer in order to complete the related assignments. The learner guide can be used by students as a supporting resource for both the class and workshop environment.

Purpose of the unit

The purpose of this learner guide and in-class training is to provide the necessary background to:

- Apply the principles of civil concrete structures construction in the civil construction industry

This unit is appropriate for those working in supervisory or technical specialist roles.

No licensing, legislation or certification requirements apply to this unit at the time of publication.

In-class work and Assessment

For each course you will engage in any number of written and some practical assessments.

Unit Outline Information for students

Unit Title	Apply the principles of civil concrete structures construction
Training Package Unit Code	RIICSG401D

Unit Summary

This unit describes a participant's skills and knowledge required to apply the principles of civil concrete structures construction in Civil construction. This unit is appropriate for those working in supervisory or technical specialist roles.

No licensing, legislation or certification requirements apply to this unit at the time of publication.

Prerequisites

Nil

Assessment Method

Delivery:

- Classroom based
- Workplace based

Assessment Tasks:

- Test
- Practical Observation

Re-Assessment: Re-assessment for a completed assessment that is deemed **Not Satisfactory** will be rescheduled as soon as practical.

Prescribed reading

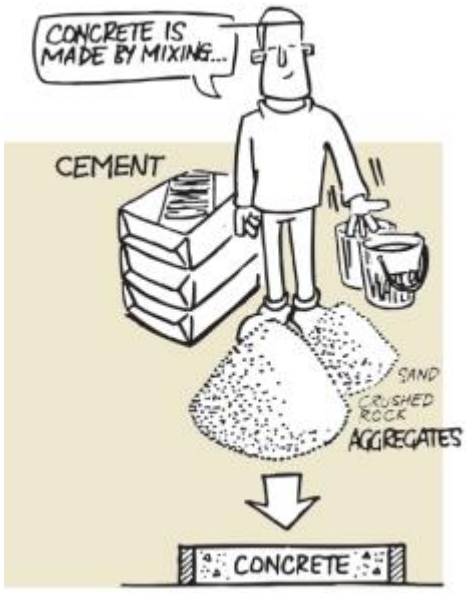
Nil

Essential Knowledge:

- Civil concrete structures construction plant and equipment capabilities and application
- Execution of civil concrete structures construction tasks
- Organisational, client and site operational requirements
- Relationship between various areas of civil works
- Team leadership techniques
- Works planning techniques
- Civil concrete structures construction monitoring methods
- Engineering survey principles
- Materials quality and delivery requirements
- Civil works construction sequencing
- Civil concrete structures construction and related activities terminology
- Set out requirements
- Ground surface treatment requirements and procedures e.g. Proof rolling
- Pavement drainage requirements
- Works planning techniques
- Monitoring methods

Essential Skills:

- Locates and applies relevant legislation, documentation, policies and procedures
- Implements appropriate procedures and techniques for the safe, effective and efficient supervision of civil concrete structures construction tasks including:
  - calculate quantities for the execution of tasks including:
    - volumes
    - grades
    - percentages
    - areas
    - resource consumption figures, including required supply rates
- Interpret civil concrete structures construction materials properties and test results, including:
  - concrete slump tests
  - concrete cylinder tests
- Maintains clear and legible written records and the reporting systems including:
  - preparing and presenting job reports
  - preparing and maintaining of log books and diaries
- Works effectively with others to plan, prepare and conduct civil concrete structures construction tasks including:
  - provides clear and timely instruction and supervision using a range of communication techniques to those involved in civil concrete structures construction tasks
- Prepares for and conducts briefings, toolbox and site meeting
- Demonstrates completion of the principles of civil concrete structures construction that safely, effectively and efficiently meets all of the required outcomes on more than one (1) occasion including:
  - provide recommendations for the improvement of the safe, effective and efficient execution of civil concrete structures construction tasks including:
    - interpreting project contract
    - specification requirements
    - procedures to problem solve
    - make decisions for activity
    - carry out continuous improvement in meeting task outcomes



Chapter 3: Plan and prepare tasks

By the end of this chapter you will understand how to :

- Access, interpret and apply civil concrete structure construction documentation and ensure the work activity is compliant
- Obtain, interpret and clarify the work instruction
- Ensure a job plan is available which makes best use of the available resources, meets task requirements and ensures safe, effective and efficient conduct of the tasks

There are many requirements that apply to the construction of concrete structures that are contained within legislation, Codes of Practice and Australian Standards and a significant amount of guidance material provided by industry organisations such as Cement Concrete and Aggregates Australia. Specifications for construction of structures may be contained in drawings and construction plans.

3.1 Legislation

The legislation relevant to the construction of concrete structures includes the Queensland Work Health and Safety Regulation 2011 which has specific requirements that relate to the construction of concrete structures including the following work which is considered to be high risk construction work:

- Tilt-up or precast concrete work is considered to be high risk construction work
- Where there is a risk of a person falling more than 2m
- Work carried out in or near a shaft or trench with an excavated depth greater than 1.5m
- Work carried out on, in or adjacent to a road, railway, shipping lane or other traffic corridor that is in use by traffic other than pedestrians
- Work carried out in an area at a workplace in which there is any movement of powered mobile plant

When High Risk Construction work is to be completed, it is a legal requirement to develop a **Safe Work Method Statement (SWMS)**, as per Figure 1.

ABC Bricklaying [ABN] 123 Mortar Street Standard Course ACT 2600 Ph: (02) 1234 5678		**Principal Contractor (PC)**	**XYZ Contracting Services** 8910 Management Road Projectville ACT 2666 Ph. (02) 9876 5432
Work Activity:	Bricklaying	**Work Location:**	Potters Hut
High Risk Construction Work:	• Powered mobile plant		Brick Street
	• In or adjacent to a road, that is in use by traffic		Pottery ACT 2600
	• Falls of more than 2 metres		
	• Energised electrical installations	**Works Manager:**	Fred Bloggs
	• Structural collapse	**Contact Phone:**	0400 111 111
Have workers been consulted about the SWMS?	Yes		

Person Responsible for ensuring compliance with SWMS	Joe Bloggs Leading Hand	**Date SWMS Provided to PC:**	5 January 2012
Person(s) Responsible for reviewing the SWMS	Fred Bloggs Works Manager	**Last SWMS Review Date:**	12 January 2012
Signature:		**Date received:**	

Workers name:	Tom Smith	**Date received:**	14 January 2012
Signature:			

What are the tasks involved?	What are the hazards and risks?	What are the control measures?
Delivery of bricks • Movement of powered mobile plant. • Work in or adjacent to a road, railway, shipping lane or other traffic corridor that is in use by traffic other than pedestrians.	Workers being struck by powered mobile plant. including delivery vehicle and forklift used for unloading. Workers being struck by vehicles in adjacent road or traffic corridor. Vehicles in adjacent road or traffic corridor being struck by falling objects.	Prepare and implement workplace traffic management plan and make available to workers: • Exclusion zone for mobile plant to be clearly identified (signage and barricades as per site plan) and controlled during vehicle loading/unloading operations. • Dedicated, trained road traffic controller(s) to direct traffic entering and leaving site and control traffic (pedestrian and vehicle) on adjacent pedestrian footpaths and roadways. • Use portable traffic signals and/or temporary safety barriers to direct/control traffic flow as required. • Brick delivery vehicle to be unloaded on-site (not from public roadway). Place brick pallets adjacent to bricklaying work areas (inside workplace boundaries and clear of workplace traffic routes).

What are the tasks involved?	What are the hazards and risks?	What are the control measures?
Working at ground level • Movement of powered mobile plant. • Work that is carried out near a trench with an excavated depth greater than 1.5 metres.	Being struck by powered mobile plant. Falls into excavations.	Powered mobile plant to travel on planned and controlled workplace traffic routes. Where powered mobile plant are required to travel outside of planned and controlled routes, a dedicated, trained road traffic controller is to control plant movement. Powered mobile plant and materials are not to be operated or stored within 2 metres of an open trench.
Working above ground • A risk of a person falling more than 2 metres. • Construction work that is carried out on or near energised electrical installations or services.	Worker falling from height. Worker coming in contact with and/or receiving electric shock from overhead electric lines. Plant/equipment contacting overhead electric lines.	For bricklaying activity where there is a risk of a person or object falling less than 2 metres, use fully decked heavy duty frame trestle scaffolds, with bay lengths of 1.8 metres or less. For bricklaying activity where there is a risk of a person or object falling greater than 2 metres, use heavy duty modular scaffolds with brick-guards. Scaffolds from which a person or object can fall more than 4 metres must be constructed and certified by a licensed scaffolder. For all scaffolds: • Platforms are not to be loaded with more than 100 bricks per bay (or 400 kg of blocks). • No scaffold alterations are to be undertaken except by licensed scaffolder. • Access to scaffold platforms is to be via stairs or ladder towers. The exclusion zones and approach distances to overhead electric lines at the locations and distances specified on the site plan are to be clearly identifiable and enforced by a dedicated controller.
Constructing brick walls • Structural alterations or repairs that require temporary support to prevent collapse.	Worker injured by structural collapse before completion & curing.	Brace all constructed brisk walls in accordance with Company Instruction Sheet #3.
Work completion • A risk of a person falling more than 2 metres. • Structural alterations or repairs that require temporary support to prevent collapse.	Injuries to public from unauthorised access to workplace (e.g. falls greater than 2 metres, structural collapse).	All scaffolding and site fencing is secure and serviceable. All entry and exists must be locked at the end of each day.

Figure 1: Safe Work Method Statement example

DEFINITION: A SWMS is a document that sets out the high risk construction work activities to be carried out at a workplace, the hazards arising from these activities and the measures to be put in place to control the risks

What is a construction project

The *Queensland Work Health and Safety Regulation 2011* also defines a project that has a cost of $250 000 or more to be a "Construction Project". A Construction Project requires a Principal Contractor (PC) to be responsible for the project and there is a set of defined responsibilities for the PC including:

- Signage identifying principal contractor
- Preparation of the Construction Safety Plan (includes site rules)
- Duty to inform all persons of the plan before they commence
- Duty to review the plan and ensure it is up-to-date
- Must obtain Safe Work Method Statement (SWMS) before high risk construction work commence
- Put in place arrangements for ensuring compliance with specified requirements such as facilities and amenities
- Manage risks associated with construction materials and waste, plant, traffic and essential services

The person or company paying for the project can be the PC themselves, or they can appoint another business or company to be the PC for the project. It is best to do this in writing and have all parties sign the document.

Where the project falls under the $250 000 threshold and it is not deemed to be a Construction Project, the person or business paying for the project can still appoint a PC however in that case, the PC does not have the additional duties discussed above.

There are also the following requirements within the *Queensland Work Health and Safety Regulation 2011* including:

- ✓ A person who commissions work must consult with the designer of the structure
- ✓ The designer must give a written report to the person who commissioned the design. The report is to specify the hazards relating to the design of the structure that, so far as the designer is reasonably aware
- ✓ The person who commissions the project must give information to principal contractor
- ✓ A person with management or control of a workplace at which construction work is carried out must ensure, so far as is reasonably practicable, that the workplace is secured from unauthorised access.

3.2 Civil Concrete Structure Construction

There are numerous sub-sectors within the Construction sector of the Resources and Infrastructure Industry. Civil construction is a segment of the broader construction industry focused on building core infrastructure like pipelines, telecommunications, sewers, bridges, roads, dams, water treatment systems, tunnels and light rail transit lines. Companies operating in this field design, build, and maintain physical assets.

Civil construction projects that involve the principles of concrete construction include:

- Infrastructure development
- Road construction/maintenance
- Constructing industrial buildings
- Bridge construction
- Commercial development
- Light rail construction
- Tunnels
- Highway overpasses
- Constructing water ways
- Dam building
- Sewerage system construction

What is a structure?

The WHS Act defines a structure as anything that is constructed, whether fixed or moveable, temporary or permanent. A structure includes:

- Buildings, masts, towers, framework, pipelines, transport infrastructure and underground works (shafts or tunnels), for example noise reduction barriers on a freeway, communications masts or towers, electricity transmission towers and associated cables, flying cables and supports, guyed towers such as a ski-lift tower
- Any component or part of a structure

Examples of a structure include the following:

- A roadway or pathway
- Foundations, earth retention works and other earthworks, including river works and sea defence works
- Formwork, falsework or any other structure designed or used to provide support, access or containment during construction work, for example a prop or formwork system
- An airfield

3.2.1 Key Concerns for Concrete Construction

Working with concrete is a hazardous task, but effective risk management, can reduce the level of risk associated with the hazards to a level of acceptability that is based on various controls and risk mitigation strategies being in place.

Some of the key aspects for concrete structures that must be managed as core risk controls include:

- Security of the footings
- Load bearing capacity of equipment
- The compaction rate of earthen foundations
- The weight of the concrete
- Weather effects on concreting
- Concrete mix and type
- Durability of formwork
- Curing rate of concrete
- Engineering approval
- Injuries to workers

3.3 Codes of Practice

There are three Queensland Codes of Practice that are relevant to the construction of concrete structures which are:

- *Concrete Pumping Code of Practice 2005*
- *Tilt-up and Pre-cast Construction Code of Practice 2003*
- *Formwork Code of Practice 2006*

The *Concrete Pumping Code of Practice 2005* specifically addresses:

- Risks associated with concrete pumping plant
- Planning and preparation
- Risk controls for concrete pumping plant
- Inspection and maintenance requirements
- Safety equipment
- Training and supervision

Figure 2: Concrete pumping operation

The Tilt-up and Pre-Cast Construction Code of Practice specifically addresses:

- Panel design
- Drawings
- Braces
- Wind loading
- Deadman design
- Drill–in type anchors
- Engineering and verification issues
- Non–standard panels
- Delivery and storage of panels and elements
- Crane issues
- Proximity to overhead powerlines
- Panel lifting and erection
- Operation of plant near braces and panels
- Working at height
- Work systems
- Licensing issues

Figure 3: Tilt-up Panel being raised

The *Formwork Code of Practice 2006* specifically addresses:

- Design
- Coordination and administration
- Formwork erection
- Stripping formwork
- Crane and load handling systems
- Use of ladders
- Falling objects
- Health risks
- Special requirements for wall and column forms
- Samples and examples of engineers certification, construction checklists, pre-pour certificates, and defects commonly found in formwork systems

Figure 4: Concrete form work

These Codes of Practice can be accessed at https://www.worksafe.qld.gov.au/laws-and-compliance/codes-of-practice

Safe Work Australia has a selection of guidance material covering formwork and false work can be accessed here:
http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/guidance-formwork-falsework

3.4 Australian Standards

Information relating to concrete structures can be found within several Australian Standards including:

- AS 3600-2009 Concrete structures
- AS 3610.1—2010 Formwork for concrete

What is the purpose of a Standard?

Standards are developed for a number of purposes, including:

- **Voluntary or mandatory applications** - Standards that specify requirements to achieve minimum objectives of safety, quality or performance of a product or service.
- **Regulatory compliance** - Standards that are used to specify minimum least-cost solutions to technical requirements expressing characteristics, performance and design criteria compatible with legislative requirements
- **Contractual purpose** - Standards that serve as purchasing specifications or technical conditions of contract between two parties.
- **Guidance** - Standards that may be intended for educational purposes and which include recommendations, or administrative or project management procedures. In general, these Standards will not be adopted in either legislation or contract specifications.

The Australian Standards are considered to be a guide or best practice, however when they are referenced by legislation they become part of that legislation and mandatory.

3.5 Drawings and Construction Plans

Information about the design of the structure usually is found within technical drawings and construction plans. Drawings and construction plans are developed specific to the project at hand, and the physical construction needs to be completed in accordance with these drawings and plans. Figure 5 provides an example of an engineering works drawing.

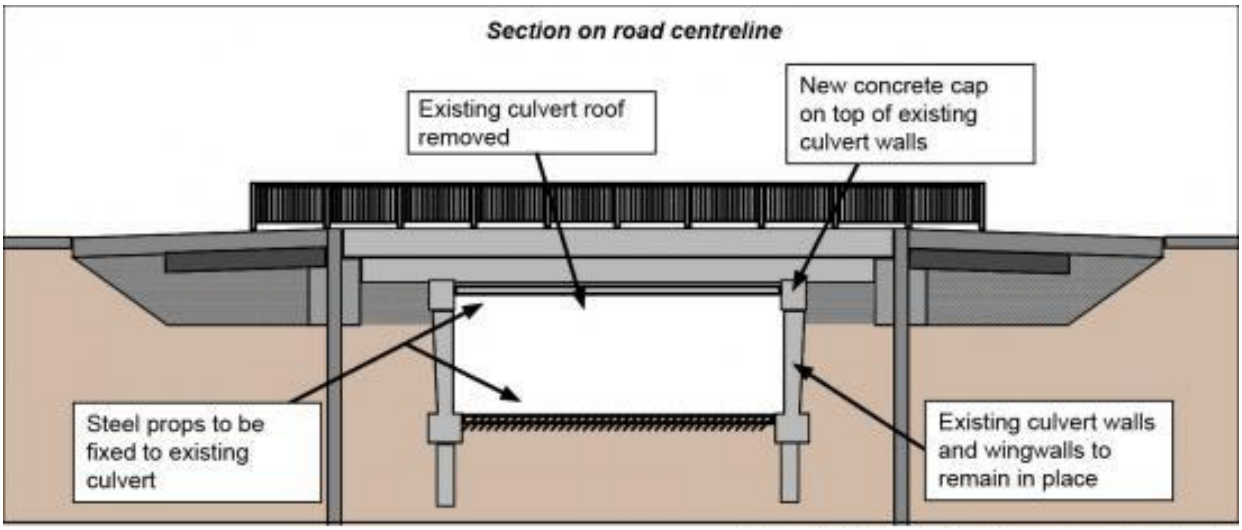


Figure 5: Engineering works drawing.

3.6 Industry Organisations

Cement Concrete & Aggregates Australia (CCAA) is made of up of member organisations who are involved in the production or use of cement, concrete and/or aggregates within Australia.

CCAA represent their members' interests through advocacy to government and the wider community; the assistance to industry professionals; the development of market applications, and provision of technical source reference information.

The role of CCAA is to:

- Building an understanding of industry and its role with stakeholders
- Maintain existing and develop new markets for members' products
- Advocate for and influence the application and use of members' products
- Influence development of codes and standards to support the use of member's products
- Demonstrate the industry's sustainability credentials
- Encourage collaboration and networking across the industry
- Supply and share information to support the industry

Figure 6: Concrete mixer truck filling hopper for concrete pump

3.7 Where to find information

Any construction company undertaking work involving civil concrete structures will need to have some base-line level documentation to ensure compliance of the works with legislation, codes of practice etc and to provide the source of 'truth' or information for those working on the project itself.

Many projects will have a 'Job Pack' prepared for the specific scope of work, the Job Pack may include:

- Project description
- Project Risk Assessment
- Scope related SWMS's
- Construction Plans & Drawings
- Staff profiles
- Equipment registers
- Project schedule of works
- Registers
- Forms

Figure 7: Aggregate used for concrete mixes

Other information relating to the company, the client of the wider project may include:

- Company policies, procedures and plans
- Business targets for safety & productivity
- Project Tender documents (if applicable)
- The Project Plan

Information about people – their skills, licences, specialist areas of expertise, limitations and other important information is available through your organisations/ Huma Resource service provider.

Information regarding the equipment is often the domain of the Technical and/or Maintenance Team, where they hold Original Equipment Manufacturer manuals, service manuals, equipment history statistics and other technical documents.

Your workplace must maintain information relevant to different parties within the organisation and from different sources, such as:

1. **Organisational Requirements** – related to the operating policies, procures, ethos', performance targets, and Key Performance Indicators (KPI's)
2. **Client Requirements** – very important! This is the whole reason why you are doing the job! The client may provide a Tender or opportunity for expressions of interest to be submitted, after which it is then important to maintain regular contact and briefings to stay in tune with expectations, quality requirements and costings
3. **Operational requirements** – will be based around the deliverables of the project and require regular communication through Toolbox Talks, Pre-start meetings and the like.

3.8 Planning and preparing the construction task

Any construction project will require a great deal of planning prior to the actual execution of the task. Planning requires information and the more accurate the information the better the planning.

Civil construction often requires input from various technical specialists such as surveyors, testing scientists, engineers and the like. According to the *Registered Engineers Institute of Australia* the engineering **survey** principles that relate to the construction of concrete structures in the civil construction sector include:

1. Provision of the initial framework via a thorough survey of the job
2. Plan the job to ensure that all risks are identified and minimised and define the job
3. Ensure that sufficient independent checks are built into the project phases to eliminate or minimise errors
4. Safeguarding – the process of ensuring that the survey results can be replicated if accidental, or other, damage occurs to the survey markers or field observations

Information provided by Engineers, competent tradespersons, architects and the like allow the job to be planned in a structured manner based on science, tested processes and experience. A building is '**Set out'** in order to clearly define the outline of the excavation and the centre line of the walls, so that construction can be carried out exactly according to the plan. The centre line method of setting out is generally preferred and adopted.

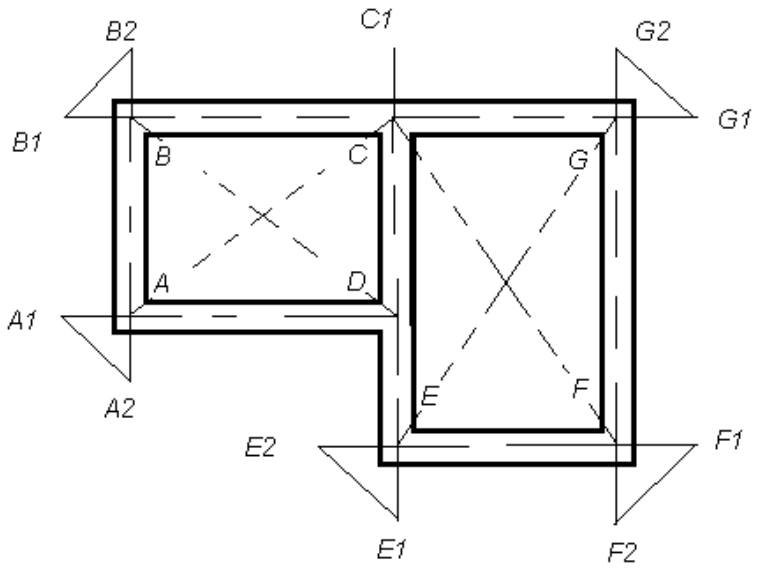


Figure 8: Example plan to be set out on the ground

1. From the plan (Figure 8), the centre line of the walls is calculated. Then the centre lines of the rooms are **set out** by setting perpendiculars in the ratio 3:4:5. Suppose the corner points are a, b, c, d, e, f and g which are marked by pegs with nails on top.
2. The setting of the corner point is checked according to diagonals ac, bd, cf and eg.
3. During excavation, the centre points a, b, c, d, e, f, g may be removed. Therefore the centre lines are extended and the centre points are marked about 2m away from the outer edge of excavation. Thus the points A1, A2, B1, B2 and like-wise, are marked outside the trench. Centre lines are shown clearly by stretching thread or rope. The centre points fixed 2m away from the excavation are marked with **sit out pegs.**
4. From the plan details, the width of excavation to be done is also marked by thread with pegs at appropriate positions.
5. The excavation width is then marked by lime or by with furrow with spade.
6. If the plan is overly complicated and follows a zigzag pattern, then the centre pegs are kept at suitable positions according to site conditions.

Basic Calculations

To calculate the ***volume*** of something you multiply the length (L) by the width (W) and the depth (D) – V = L x W x D E.G. 300m x 700m x 250m = 52,500,000 cubic metres (Total Volume Amount)

To calculate the surface ***area*** of something you simply multiply the length (L) by the width (W) – A = L x W E.G. 300m x 700m = 210,000 square metres (Total Area)

To calculate a ***percentage***, we look at the whole as equal to 100%. For example, say you have 10 spanners (=100%). If you lose 2 spanners, then you have lost 2/10 × 100% = 20% of your spanners and you are left with 80% of your original tools set of spanners.

Sometimes you're given the percentage of an amount and need to know the numerical value of the percent. Examples include calculating total cost of something, including the GST, or working the contingency amount of the materials you need to order (+10%).

For example, you are getting a labourer, from a labour hire company, to work the entire next week. The cost is $650.00 per day, plus a 15% hire fee for the 5 days.

So, $650 / 5 days / 15% hire fee = $XXX Total cost

15.% = 0.15 ***[convert the percentage into a decimal by moving the decimal point LEFT 2 spaces]***

First multiply the daily hire fee of $650.00 by the number of days you need the labourer for (5 days) - $650.00 x 5 = $3,250.00

Now multiply $3,250.00 by 0.15 - $3,250.00 x 0.15 = $487.50

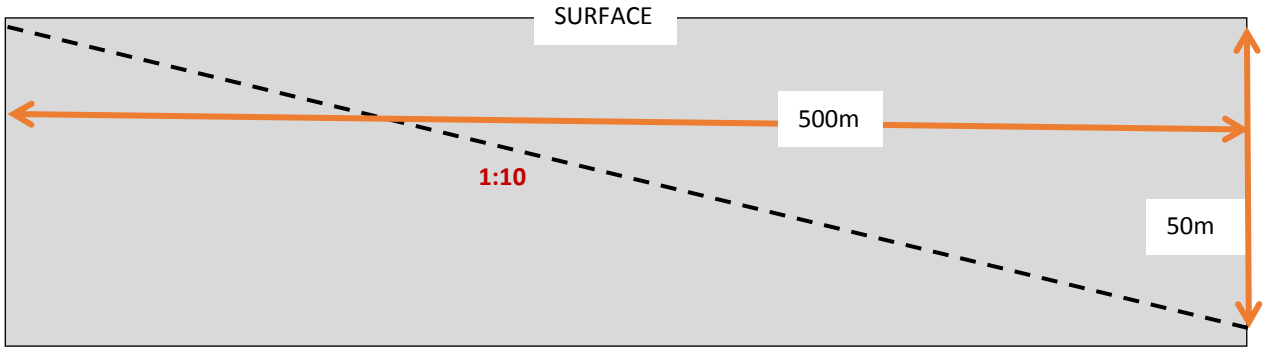
That means it will cost you $3,250.00 + $487.50 for the week (TOTAL $3,737.50)

To calculate the ***grade*** of something you need to first establish the distance (run) the slope is to span. Then you need to determine the height of slope, which will give you the amount of rise there will be on the slope. Then all you do is write this as a fraction and work it out to the lowest common denominator.

For example, a ramp is being constructed over an area of 500 metres and the rise is 50m.

$$\text{Ramp (slope)} = \frac{\text{Rise } \mathbf{50}}{\text{Run } \mathbf{500}}$$

Therefore the total grade amount is **1:10** – you drop 1m every 10m.



To calculate **consumption quantities** you first need to establish the unit of measure; e.g. number of days. Next you determine what consumables you need to calculate and the quantity they come in; e.g. 6 litres of milk are being replaced every morning in the mess hall fridge. So all you need to do now is multiply what you are using (6 Litres of milk) by the unit of measure (7 days) to work out how much milk you are consuming in a week. You are using 42 Litres of milk per week.

3.8.1 Measuring material quantity requirements

Quantities of materials for the production of concrete can be calculated by the **'Absolute volume'** method. This method is based on the principle that the volume of fully compacted concrete is equal to the absolute volume of all the materials of concrete, i.e. cement, sand, coarse aggregates and water.

The formula for calculation of materials for required volume of concrete is given by:

$$V_C = \frac{W}{1000} + \frac{C}{1000S_C} + \frac{F_a}{1000S_{fa}} + \frac{C_a}{1000S_{ca}}$$

- V = Absolute volume of fully compacted fresh concrete
- W =Mass of water
- C = Mass of cement
- Fa = Mass of fine aggregates
- Ca = Mass of coarse aggregates
- Sc, Sfa and Sca are the specific gravities of cement, fine aggregates and coarse aggregates respectively.
- The air content has been ignored in this calculation.

This method of calculation for quantities of materials for concrete takes into account the mix proportions from design mix or nominal mixes for structural strength and durability requirement.

Worked example

Consider concrete with mix proportion of 1:1.5:3 where, 1 is part of cement, 1.5 is part of fine aggregates and 3 is part of coarse aggregates of maximum size of 20mm. The water cement ratio required for mixing of concrete is taken as 0.45.

Assuming bulk densities of materials as follows:

- Cement = 1500 kg/ m^3
- Sand = 1700 kg/ m^3
- Coarse aggregates = 1650 kg/ m^3

Specific gravities of concrete materials are as follows:

- Cement = 3.15
- Sand = 2.6
- Coarse aggregates = 2.6.
- The percentage of entrained air assumed is 2%.
- The mix proportion of 1:1.5:3 by dry volume of materials can be expressed in terms of masses as:
- Cement = 1 x 1500 = 1500
- Sand = 1.5 x 1700 = 2550
- Coarse aggregate = 3 x 1650 = 4950.

Therefore, the ratio of masses of these materials with respect to cement will be as follows = $1 : \frac{2550}{1500} : \frac{4950}{1500}$

= 1 : 1.7 : 3.3. The water cement ratio = 0.45

Now calculate the volume of concrete that can be produced with five (5) 10kg bags of cement for the mass proportions of concrete materials.

The absolute volume of concrete for 50 kg of cement =

$$V_c = \frac{0.45 \times 50}{1000} + \frac{1 \times 50}{1000 \times 3.15} + \frac{1.7 \times 50}{1000 \times 2.6} + \frac{3.3 \times 50}{1000 \times 2.6} = 0.1345 m^3$$

Therefore, for the proportion of mix considered, 50 kg of cement = 0.1345 m^3 of concrete can be produced.

We have considered an entrained air of 2%. Thus the actual volume of concrete for 1$m^3$of compacted concrete construction will be = 1 -0.02 = 0.98m^3.

Thus, the quantity of cement required for 1 m^3 of concrete = 0.98/0.1345 = 364.5kg of cement.

Overall: The quantities of materials for 1 m^3 **of concrete** production can be calculated as follows:

- The weight of cement required = 7.29 x 50 = 364.5 kg.
- Weight of fine aggregate (sand) = 1.5 x 364.5 = 546.75 kg.
- Weight of coarse aggregate = 3 x 364.5 = 1093.5 kg.

3.8.2 Scheduling the delivery of materials

Space at the site can be a premium, and overcrowding of the space can cause safety hazards and damage to materials, equipment and the environment. The sequence and order for the scheduling of receiving materials for the project is very important… you don't want you concrete arriving before you have done the set-out!

Some key considerations regarding the scheduling of material delivery include:

- The ability to receive the materials using plant & equipment and/or personnel
- The storage location – so as to not require relocating due to works
- The duration that the goods will be stored – so as to not hold up other works
- Weather conditions
- Skills of personnel to utilise the materials in a 'just in time' principle
- Quality check of the materials received

Chapter 4: Implement job plan

By the end of this chapter you will understand:

- Confirm necessary resources are available
- Ensure clear, concise and timely instructions are communicated verbally or in writing to others
- Set out and allocate tasks to others

4.1 Necessary Resources

Resources for the job should include:

- The plant and equipment required for the job
- Where the plant will be sourced from, whether that is internally or hired externally
- The people who are to be involved in the job, and any relevant qualification they must have (plant operation, confined space, work at height, scaffold ticket etc.)

Figure 9: Concrete helicopter finisher

Safety information that should be in the Job Plan includes:

- The Personal Protective Equipment (PPE) required at different stages throughout the job
- Risk assessment requirements
- Requirements for Safe Work Method Statements (SWMS) and what the activity they need to address
- Specific qualifications and licensing required for certain tasks within the job
- Incident reporting and notification information
- Responsibility for the monitoring of the work to ensure it is in compliance with all requirements, and how often this monitoring is to be carried out
- Contact details for key personnel involved in the job, including internal personnel and also contractors

Where resources will be sourced internally, there may be a resource allocation or booking system that needs to be completed to 'book out' the resources. At this stage, you should ensure that the servicing and maintenance requirements are up to date and current to minimise any possible negative impact on the job, like plant and equipment break downs or someone stopping the job due to it being considered unsafe.

Where resources will be sourced externally such as being hired, contact will need to be made with the business that the resources will come from. It is important to clearly specific exactly what you need for your job to ensure that the plant or equipment you receive is matched to the tasks they will be used for.

To illustrate the importance of being specific and detailed, there are two scenarios below:

4.1.1 Scenario 1

Mike has a project to remove an old concrete culvert on a small country road and construct a new concrete culvert. Mike does not have an excavator within his own business so needs to hire one for the job. The work that Mike needs to do with the excavator is just before the concrete is booked in to arrive.

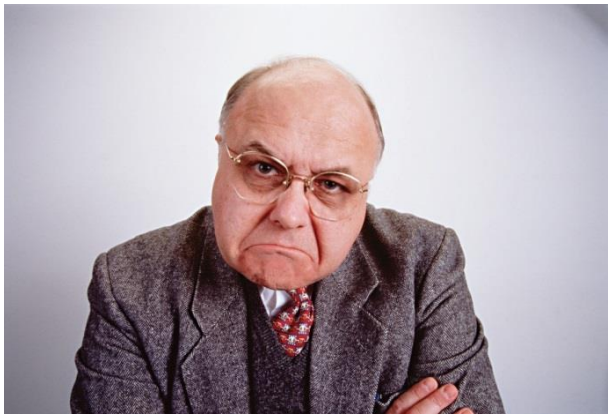
Mike calls the hire company…

"Hi Bob, I need a little 'digger' for project next week, can I book one please and it be delivered to site next Tuesday?".

A 2t excavator arrives on site on the day, and the delivery truck returns to town.

Mike soon realises that the excavator that has been delivered won't be suitable for the job as it is not big enough to lift the precast components of the new culvert. Additionally, Mike really needs a multi-combination bucket due to the way he needs to remove material in the area of the old culvert.

Mike is now faced with a few problems as a result of the poor planning.



He can:

- Call the hire company and have the right excavator with the right attachments delivered, and the excavator that is on site taken back, or
- Struggle to complete the task safely with the current machine.

Either way he will need to call the concrete company and cancel the concrete delivery. He may need to still pay for the concrete if it has already been dispatched, which will blow the budget for the project.

Depending on the wait time for the new machine and availability for the concrete to be delivered, Mike may need to call his client and advise that the completion date for the project will now be changed. This may result in 'liquidated damages' against Mike depending on the contract for the works.

Mike's reputation is damaged and his client has vowed never to use Mike again.

4.1.2 Scenario 2

Mike has a project to remove an old concrete culvert on a small country road and construct a new concrete culvert. Mike does not have an excavator within his own business so needs to hire one for the job. The work that Mike needs to do with the excavator is just before the concrete is booked in to arrive.

Mike calls the hire company

> *…"Hi Bob, I need an excavator to lift some pre-cast culvert component which weigh 6t project next week, can I book one please and it be delivered to site next Tuesday? The area around the existing culvert is very congested and I think it will be hard to remove the required material".*

Bob suggests that Mike use a multi-combination bucket for that area. Bob books in the equipment for Mike.

The excavator arrives on site on the day along with the multi-combination bucket, and the delivery truck returns to town. Mike is confident that he has arranged for the right equipment for the job.

The excavator work is completed efficiently with no problems, the concrete arrives and the job is completed on time and on budget. Mikes client is happy that the job is finished to a high quality on time and on budget, and thanks Mike for his great work.

4.2 Information and Instructions

The way information is communicated has a significant impact on how that information is received. When information is not understood as it was intended, the result can be very costly in terms of rework, missed deadlines and time wastage.
The table below contains tips and recommendations to improve verbal and written communication:

Type of communication	Effectiveness factor	Tips and recommendations to help improve
Verbal	Clear	○ *Speak at a pace that's easy for someone to understand. The most common problem effecting communication is speaking too fast* ○ *Avoid mumbling* ○ *Speak about an issue in a logical manner, making sure that you provide adequate and relevant background and context so the receiving person is able to establish a clear picture of what you are talking about*
	Concise	○ *Talk only about the issue at hand and only give enough information for the receiving person to understand what you are talking about. Giving more information than is required can be very frustrating to the receiving person*
Written	Clear	○ *Choose words deliberately* ○ *Construct sentences carefully and thoughtfully* ○ *Using correct grammar.* ○ *Writing clearly allows your audience to easily comprehend your message*
	Concise	○ *Remove words that are not needed in a sentence* ○ *Remove sentences that are not needed in a paragraph* ○ *Be aware of needing to ensure clauses or phrases are constructed in a way that is simple and as short as possible.*
Verbal and Written	Timely	○ *When responding to an issue or a discussion, your response needs to follow soon after. When this doesn't occur, the receiving person may be confused about what you are talking about as they may not be able to link your response to the issue or discussion that prompted it.*

Table: Tips for improved and effective communication

4.3 Developing the Job Plan

The Job Plan is designed to provide clarity to all that read it about the expectations for the objective of the project and the how the objective will be reached.

There are three (3) main components to any Job Plan:

1. **Explain the project plan to key stakeholders and discuss its key components.**
   The project plan is a set of living documents that can be expected to change over the life of the project. Like a road map, it provides the direction for the project. And like the traveller, the project manager needs to set the course for the project, which in project management terms means creating the project plan. Just as a driver may encounter road construction or new routes to the final destination, the project manager may need to correct the project course as well. A common misconception is that the plan equates to the project time line, which is only one of the components of the plan. The project plan is the major work product from the entire planning process, so it contains all the planning documents.

2. **Define roles and responsibilities.**
   Identifying stakeholders - those who have a vested interest in either the project or the project outcome - is challenging and especially difficult on large, risky, high-impact projects. There are likely to be conflicting agendas and requirements among stakeholders, as well as different slants on who needs to be included.
   It is important for the project manager to get clarity and agreement on what work needs to be done by whom, as well as which decisions each stakeholder will make

3. **Develop a scope statement.**
   The scope statement should include: Business need and business problem Project objectives, stating what will occur within the project to solve the business problem Benefits of completing the project, as well as the project justification Project scope, stated as which deliverables will be included and excluded from the project Key milestones, the approach and other components as dictated by the size and nature of the project.

The Job Plan ties together all of the relevant Work instructions for a job, details the resources required for the job, important safety information and timeframes or milestones.

Timeframes and milestones can be documented in various ways including:

- A simple bulleted list of dates or times against certain stages of the job
- A Gantt chart that uses 'bars' that are linked and show duration and relationship of activities within a job

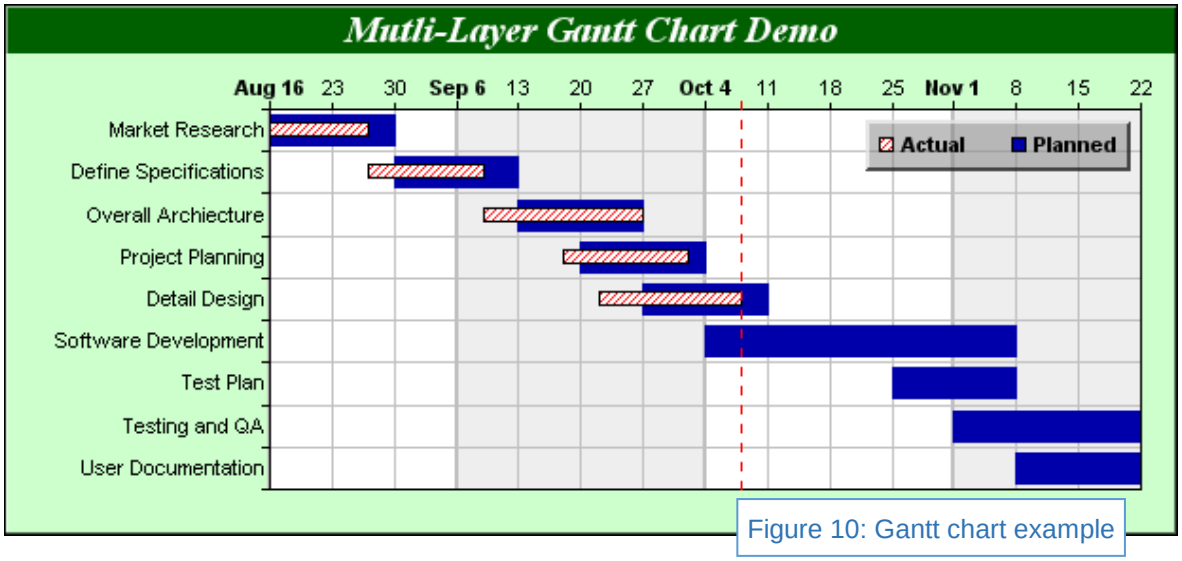


Figure 10: Gantt chart example

4.4 Work Instructions

A Work Instruction is a document that explains how to complete a certain task or activity. It breaks the task into logical steps from the start to the completion of the task or activity.

Examples of simple Work Instructions are below:

- www.cisco-eagle.com
- http://johntheplantman.com
- www.bunnings.com.au

Install formwork

- Place "A" into position
- Drive in "B" beside "A"
- Fix "A" to "B" with a 50mm x 6mm screw
- Add cleats and braces and fix with 50mm x 6mm screw
- Ensure gloves are worn when using a hammer

Setout

- Based on the drawings provided, use survey marking paint and or pegs to mark out the the job
- Wear gloves during this step to protect your hands against injury when using a hammer to drive in the pegs

Install formwork

- Place "A" into position
- Drive in "B" beside "A"
- Fix "A" to "B" with a 50mm x 6mm screw
- Add cleats and braces and fix with 50mm x 6mm screw
- Ensure gloves are worn when using a hammer

Work Instructions may come from the following sources:

- From your Supervisor
- From your Manager
- From an engineer within your organisation
- From the Quality Management System if your organisation has one

It is important to ensure you understand all of the information within the Work Instruction before you proceed with the work. Where you are not sure, you need to clarify the information with your Supervisor, Manager, or other technical person (for example engineer) within your organisation.

4.5 Safe Work Method Statements (SWMS)

A SWMS (pronounced: Swims) is designed to enable supervisors, workers and any other persons at the workplace to understand the requirements that have been established to carry out construction work in a safe and healthy manner. The SMWS sets out the work activities in a logical sequence, identifying hazards and their control measures.

Any activity, no matter how simple or complex, can be broken down into a series of basic steps that will permit a systematic analysis of each part of the activity for hazards and potential accidents. The description of the process should not be so broad that it leaves out activities with the potential to cause accidents and prevents proper identification of the hazards, nor is it necessary to go into fine detail of the tasks.

The SWMS must be able to be easily read by those who need to know what has been planned to manage the risks, implement the control measures and ensure the work is being carried out in accordance with the SWMS. Relevant persons include:

- The supervisor of the high risk construction work
- The worker carrying out the construction work
- The Principal Contractor or the person who has management and control over the risk construction work, such as the Project Manager.

An example SMWS was provided in Figure 1 on page 11 of this Learner Guide.

4.5 Leading, Managing and Supervising

There are many characteristics of an effective Leader, Manager or Supervisor on any construction Project, primary amongst the responsibilities of anyone in such a role is the safety of others – in fact this is a legislative obligation under Australia WHS law.

The balance of productivity with safety is what makes a difference to the bottom line, the business future and the safety of all persons associated with the work site.

Six (6) Principles for Construction Leadership:

1. The demonstration of safety leadership – Ensure that this is clear to all parties through effective and regular communication methods and is linked to performance expectations.
2. Promote the design for safety in all engineering solutions – 'fail to safe' and work to minimise the risk to the safety of others who may come into contact with the structure.
3. Communicate safety & project related information – keep people in the loop and welcome comments and the sharing of ideas and lessons learnt.
4. Manage risk – more than just safety, there is environmental, financial, sovereign, corporate responsibility, company reputation and many more aspects.
5. Seek continuous improvement – always remain vigilant to look for better, more safer, efficient, effective and innovative ways of doing core jobs.
6. Embed safety practices – walk the talk and lead by example. Remembering that the standard that you walk past is the standard that you accept.

4.5.1 Civil Project Supervision

There is a lot of activity happening throughout a typical day on a civil project, there are materials being delivered, sub-contractors performing different tasks, movements of loads, traffic with heavy machinery and much more. As the Supervisor of a civil project there are various tasks that are performed on a daily basis in order to ensure the safety of personnel, the quality of work and the maintenance of the project schedule, tasks such as:

1. Site inspection for hazards, damage or other issues of concern
2. Inventory control to ensure no unexpected overuse of materials
3. Authorising overtime
4. Providing required explanations for the builders and other professionals associated with the project,
5. Coordinating and collaborating with the architects, engineers, client and specialists.
6. Pre-start meeting attendance
7. Review of previous days reports, progress and incidents
8. Maintain open communication with authorities and the client

4.6 Phases of Construction

The phases of any civil concrete structures related construction project tend to follow a general process – with the finer details being unique and specific to each individual scope. The general sequence of phases is:

1. Planning of the work to ensure that all that can be identified with regard to foreseeable requirements is done up front and not reactionary
2. Preparation of the work environment, which may include the demolition and removal of other structures, the creation of an access track, installation of environmental control factors and so on
3. Ground surface treatment to ensure that the ground itself is suitable for the building of a concrete structure
4. Preparation of foundation works to support the building of other works on top of it
5. Set up of formwork – to support the pouring and forming of concrete in readiness for construction
6. Testing of concrete – perform various tests on concrete either prior to delivery through vendor quality assurance of on-site when you are pouring / forming your own concrete.
7. Laying the concrete
8. Erection and stabilisation of the concrete structure – including the use of scaffolding and braces
9. Updating engineering drawings and service plans to provide accurate historical and quality data
10. Housekeeping, cleaning up and de-mobilising from the work area

4.6 Delegating work to others

Delegation is an art – and done well, it can prove a most effective tool for a manager to multi-task and complete work in a highly efficient and engaging manner. There are two important factors to consider when making a decision about who does what.

1.The tasks that need to be completed; and
2.The people who are able to complete them.

The aim is to find the most appropriate person for each task, so that the desired result will be produced.

The questions below will help you decide what tasks should be completed by which team members:

4.6.1 Why does the task need to be completed?

Quite often we are given tasks to complete, however the person giving the task may not have a very good understanding of all the other work that is being done at the time. It is important to ask 'why' before proceeding, to understand the purpose and context of the request and to ensure it is actually valid.

4.6.2 What is involved in the task?

To enable clear and concise instruction to be given to team members, it is important to understand that job steps within a task r activity. A single task or activity may contain many important job steps or sub-tasks that need to be completed for the main task or activity to be completed as desired. When only information relating to the main task is given to people to be completed, there is the opportunity for the key sub-tasks or job steps to be missed which may result in a poorly completed job.

4.6.3 What is the timeframe for doing it?

To enable the work to be completed within the time that is desired, a timeframe for completion needs to be established. A timeframe for each sub-task or activity throughout the task can be defined by working backwards from the time completion is due.

4.5.4 Where does it need to be done?

Is there a specialist location where the activity needs to be completed? For example, in a workshop with tools available. The location is important as it may be some distance from where the other work is to be completed. This may impact on driving time and total time to complete the task.

4.6.5 Who has the required skills, knowledge and training to complete the task?

To enable the task to be completed to the level of quality and outcome required it is important that is given to the person who has the required skills, knowledge and training to be able to adequately complete the task.

The Job Plan can be referred to as it should include detail of what training is required for the task. For example, the task requires a concrete structure to be constructed over a waterway which will place people at risk of fall from heights.

Those team members who are currently in training can be utilised to support another team member who does have the required skills, knowledge or training. Team members who are in training should not be tasked with work alone and without supervision.

A simple skills matrix can be developed that shows who has what training and what experience. This is normally available through the Human Resources department of organisations and may be called a Training Needs Analysis (TNA) or Training Matrix.

Competency / **Personnel**	Induction	Work at Height	Confined Space	Trade Qual	Excavator Licence	Skid steer Licence	HR Licence	MR Licence	HC Licence	Car Licence
Bob										
Mike										
Jim										
Tom										

Key	
	Completed, has the required item/licence/ticket etc
	In training for the item/licence/ticket etc

Figure 11: Sample Training Needs Analysis (TNA) or Training Matrix

4.6.6 What is the priority?

Priority is an important factor to consider when deciding what needs to be done by when and in what order. Priority can be decided or based on a number of criteria including:

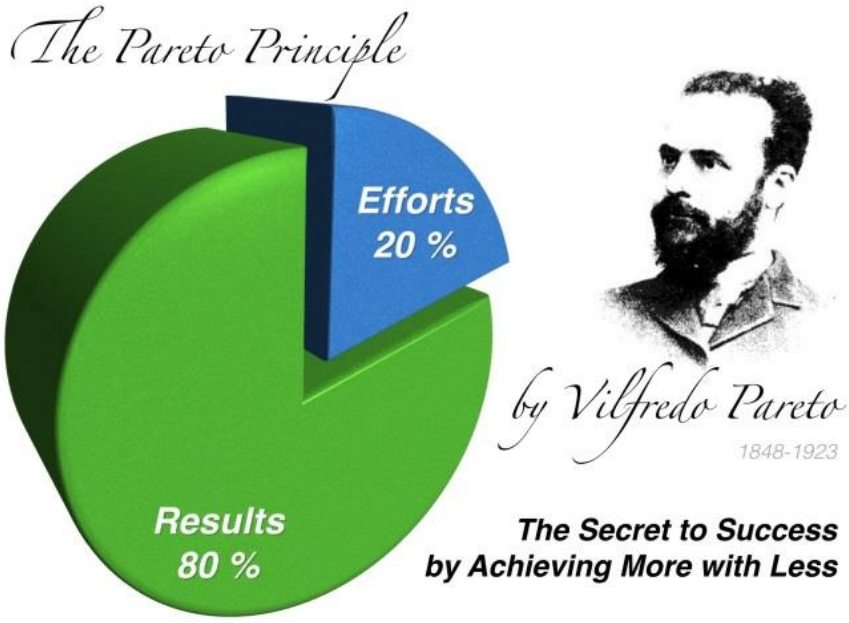
- The risk of not doing it (the resulting consequence and the likelihood of that consequence occurring). Priority needs to be given to the items that will cause the greatest negative impact if they are not addressed.
- The level of importance for the task from your line management. Your manager may have a very different view of what is important, is critical for their view to be understood.
- What is achievable in the time you have and with the resources you have. The Great Wall of China may need to be completely rebuilt but you may only have the time and resources to patch the roof of one tower

Remember

80% of the issues are caused by 20% of the factors (The Pareto Principle). This means finding the 'big ticket items' that cause most of the 'strife'.

4.6.7 Daily tasks for Supervisors

As the Supervisor, it is essential that you are aware of everything that occurs on site. This is a very complex responsibility that can sometimes become overwhelming; so, apart from using your delegation authority, you can also do the following tasks regularly/daily to ensure you stay on top of what is happening on your site:



1. Site inspection for hazards, damage or other issues of concern
2. Inventory control to ensure no unexpected overuse of materials
3. Authorising overtime
4. Providing required explanations for the builders and other professionals associated with the project,
5. Coordinating and collaborating with the architects, engineers, client and specialists.
6. Pre-start meeting attendance
7. Review of previous days reports, progress and incidents
8. Maintain open communication with authorities and the client

Chapter 5: Oversee the execution of tasks

By the end of this chapter you will understand how to:

- Monitor civil concrete structures construction task performance
- Implement adjustments to work processes/job plan if required to ensure required outcomes achieved
- Establish programs for plant, equipment and tool maintenance to be carried out and records kept

5.1 Monitoring

Monitoring during task completion and overall project completion is critical to give the best possible likelihood of task or project success. Monitoring can be conducted in a number of ways including:

- On the job supervision
- Formal Quality Assurance inspections against the specification and drawings
- Formal general inspection of the work using a checklist
- Informal inspection of the work

The purpose of monitoring is to:

- Engineering (hard) controls – to check the quality of design and materials
- Personnel (soft) controls – to check the progress by culture and behaviours
- Check that the structure is being completed in accordance with the plans, drawings and specifications
- Check that the people on the job are complying with the safety requirements
- Identify any hazards that place people at risk and have not been controlled
- Identify any issues that may negatively impact the job and cause delay
- Track usage of materials to avoid running out

There may be requirements within the scope of work, specification or contract that require samples of concrete to be taken and analysed as part of a Quality Assurance Program. The Quality Assurance documentation shall be provided at this time by your organisation.

5.2 Methods for concrete placement

Before any concrete is placed the entire placing program consisting of equipment, layout, proposed procedures and methods is planned and no concrete poured until the formwork is inspected and found suitable for placement.

Equipment for conveying concrete should be of such size and design as to ensure a practically continuous flow of concrete during depositing without segregation of materials considering the size of the job and placement location.

Concrete is placed in its final position before the cement reaches its initial set and concrete is compacted in its final position within 30 minutes of leaving the mixer and once compacted it should not be disturbed.

In all cases the concrete is deposited as close as possible to its final position and should not be re-handled or caused to flow in a manner which may cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded inserts or impair its strength.

For locations where direct placement is not possible and in narrow forms suitable drop and Elephant Trunks to confine the movement of concrete is provided. Special care is taken where concrete is dropped from a height especially if reinforcement is in the way particularly in columns and thin walls.

Concrete should be placed in the shuttering by shovels or other methods and should not be dropped from a height more than one metre or handled in a manner which will cause segregation.

Concreting once started should be continuous until the pour is completed and should be placed in successive horizontal layers of uniform thickness ranging from 150 mm to 900 mm. These should be placed as rapidly as practicable to prevent the formation of cold joints or planes of weakness between each succeeding layers within the pour.

Figure 12: Placement of concrete

The thickness of each layer should be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit should be spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with a minimum of shovelling. Any tendency to segregation should be corrected by shovelling stones into mortar rather than mortar onto stones. Such a condition should be corrected by redesign of mix or other suitable means.

The top surface of each pour and bedding planes should be approximately horizontal unless otherwise specified in drawings.

5.3 Ground Condition testing

The ground at the top of the foundation wall offers the first line of defence against a wet interior space below. The more water that can be removed from the equation at the earliest opportunity, the better the total waterproofing or damp-proofing system will function. This area is sometimes neglected but is crucial to success in both damp-proofing and waterproofing.

Figure 13: Soil sampling

A few simple procedures at the surface level are:

- Keep the water that comes off the roof from ending up in under the foundations by using a thorough gutter system.
- Collect the water in gutters and send it well away (3metres at least) from the foundation wall in downpipes.
- Compact backfill in lifts next to foundation walls, otherwise it will settle over time and form a reverse slope, putting water where it's unwanted.
- Implement effective edging to divert water AND link to water drainage systems
- Final grading should form positive drainage away from the structure.
- Even properly graded and compacted surfaces can change over time, so the ground around the structure may occasionally need to be re-dressed to account for settlement of the backfill.
- In areas where expansive soils are present (such as active clay which expands when wet), it is doubly important for structural reasons to prevent water from infiltrating under footings or slabs.

There are a number of treatments that can be applied as part of the Ground Surface Treatment Plan.

1. Proof rolling

Proof rolling is the process of identifying any unsuitable material by moving a heavy vehicle over the subgrade or existing surface and observing the resultant deformation. Material which is observed to move under the loading of the machinery is deemed to be unsuitable material. Proof rolling shall be carried out:

- Over all areas where fill is to be placed
- Over all of the formation in cut
- Within 2 days of stripping in areas of fill or completion of a cut
- Prior to any hauling over the prepared area.

Figure 14: Proof rolling

2. Compacting materials

This process involves the preparation of the ground surface before placing fill (including topsoil fill), ground slabs or load bearing elements. It is done to:

- Provide shape to the ground to assist drainage
- Remove materials which will inhibit or prevent satisfactory placement of fill layers, loose material, debris and organic matter
- Compact the ground exposed after stripping to achieve the required density of overlying fill in order to support structural build.

3. Acid Sulphate soil testing

These are soils or sediments that when exposed to air can rapidly form sulphuric acid. This acid can leach into surrounding environments, possibly causing damage to concrete and steel structures such as foundations and swimming pools. These soils occur predominantly on coastal low lands with elevations generally below 5m. Indicators of acid sulphate soil include:

- Soil physical feature
- Soil chemical features
- Signs in the environment
- Signs on infrastructure

Figure 15: Acid damage to concrete structures

Figure 16: Acid indication in soil

4. Pavement drainage

Specifications may vary from one area to another; therefore, it is important you check with the local council and the works plans to ensure you have the correct information. Queensland's Department of Transport and Main Roads has a Technical Specification (MRTS38) that provides detailed information for what are the minimum requirements when constructing pavement drains. (www.tmr.qld.gov.au/)

The key things you need to know are:

- Grading for fall
- Subgrade requirements
- Linkage to water control and flow features
- Edging requirements

5.4 Concrete works testing & inspection

Concrete is a variable based product comprised of separate components that have the ability to be affected by the ratio of the parts, the weather, the order of addition of components and the quality of the component materials themselves.

As a result it is ESSENTIAL that testing be conducted on the quality of the concrete that is being used for civil construction works.

Tests include:

1. **The SLUMP Test** (Figure 17)
   - Indicates the workability of concrete.
   - Workability shows how easy the concrete is to place, handle and compact.
   - The measured slump must be within a set range (tolerance) from the specified slump.

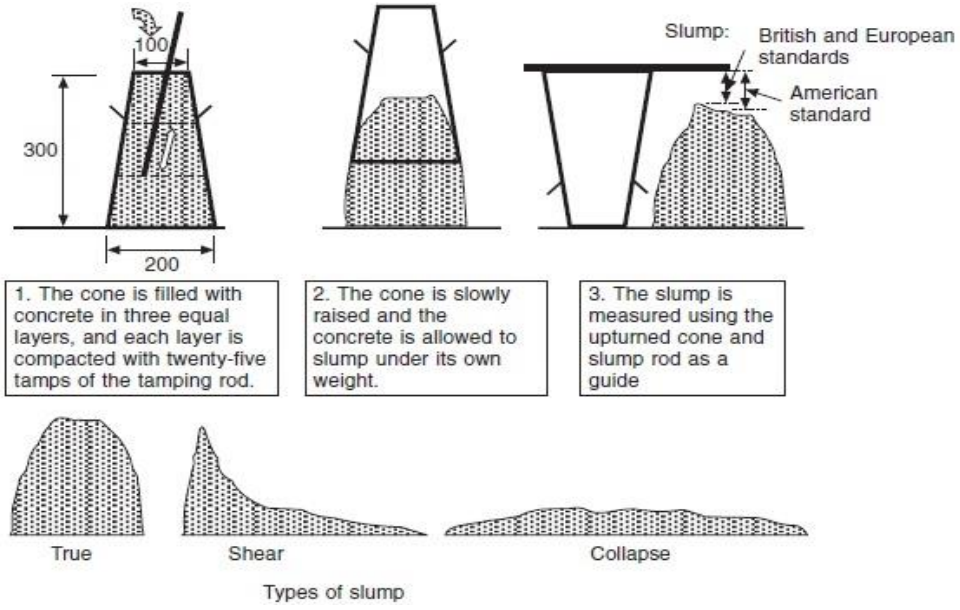


Figure 17: Slump testing

Degree of workability	Slump (mm)	Compacting Factor	Use for which concrete is suitable
Very low	0 - 25	0.78	Very dry mixes; used in road making. Roads vibrated by power operated machines
Low	25 - 50	0.85	Low workability mixes; used for foundations with light reinforcement. Roads vibrated by hand operated Machines
Medium	50 - 100	0.92	Medium workability mixes; manually compacted flat slabs using crushed aggregates. Normal reinforced concrete manually compacted and heavily reinforced sections with vibrations
High	100 - 175	0.95	High workability concrete; for sections with congested reinforcement. Not normally suitable for vibration

>Table : Workability, Slump and Compacting Factor of concrete with 19 or 38 mm (3/4 or 1½ in) maximum size of aggregate.

2. The CYLINDER (Compression) Test (Figure 19)

- Shows the best possible strength that the concrete can reach under ideal conditions.
- This test measures concrete strength in a hardened state.
- The testing is done off-site in a laboratory using a sample provided by the site.
- The strength is measured in Mega Pascals (MPa) which represents the characteristic strength of the concrete 28 days after it was mixed.
- The compressive strength of the test sample provides an indication of the concrete's resistance to loads which could crush it.
- Compressive strength is determined by loading properly prepared and cured cylindrical specimens of concrete under compression (in the lab).

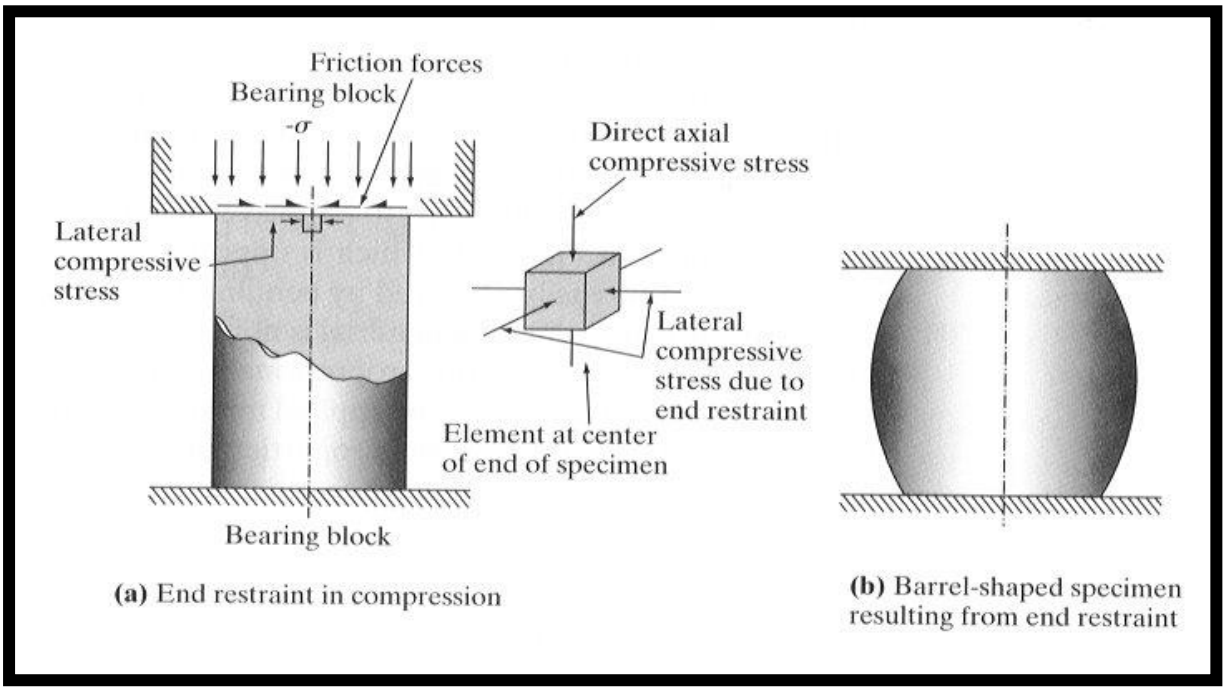
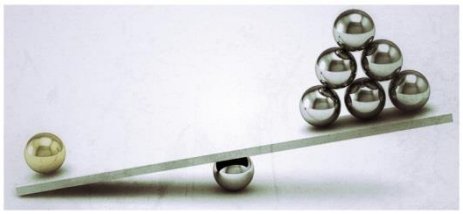


Figure 19: Cylinder testing

5.5 Implement adjustments to work processes if required

During the conduct of monitoring the task or work being carried out, there may be issues identified that create a need to change or modify the work plan. Examples of these include:

- Plant and equipment breakdowns
- Personnel being absent from work
- Materials not arriving on time
- Materials being delivered that don't meet the specification required by the designs



When it is recognised that the schedule or Job Plan will no longer be able to be complied with, these will need to be updated to reflect the change that is needed to be applied.

Any change to the schedule or Job Plan needs to be communicated to those people involved in the work, and possibly suppliers and contractors also involved in the work.

5.6 Establish programs for maintenance and record keeping

The purpose of establishing maintenance programs for plant and equipment is to primarily ensure that risks associated with their operation are identified and managed.

Plant and equipment are usually scheduled in for regular maintenance and service checks as part of the program provided by the OEM, and as fits in with their utilisation.

Records from maintenance checks are essential for a number of reasons:

- Provide historical data of work applied to the machine
- Examination of total utilisation
- Provide an audit trail in the event of an incident
- Track misuse of equipment and identify corrective actions

Figure 20 provides an example of a monitoring and testing report.

REINFORCED IN-SITU CONCRETE - REINFORCEMENT & CONCRETE PLACING CHECKLIST

PROJECT NAME:	Location:	Lot #				
Ref	Nature of Inspection	Inspected By:	Date	Pass	Fail	NCR No
1	Submissions	(PSC)				
	- proposals of concrete placement and sawing - concrete mix design (W)					
2	Fixed reinforcement	(F)				
	- grade - section/profile - dimensions - laps - all bars and mesh included - position, alignment and spacing within tolerances - minimum cover - tying wire (not < 1.25mm) and supports - free from mud, oil, grease etc - free from excessive rust - welding, splicing and hot bending only as approved - dowels , location tolerance +-half diam , alignment 2mm/300mm					
3	Inspection Before Pour	(F)				
	- grade of concrete..... - volume of pour.....m^3 - placing equipment as approved - embedments & anchor bolts in position & protected - membrane or film underlays installed? - free fall within specified limits (1500mm/100 mm element thickness, max 3000mm)					
4	Structural Engineer's Certificate (if reqd)	(PSC)				
	- attach Engineer's Certificate					
5	Monitor at point of placement	(F)				
	- working base min 50mm thickness tolerances +/-5mm from plane and +/- 5mm from 2m straight edge - continuity of placement between construction joints - maintenance of 'wet edge' - compaction in horizontal layers as specified - no. of samples required - elapsed time for delivery - movement joints and joint materials					
6	Monitor finishing of unformed surfaces	(F)				
	- levels & tolerances - colour consistency & texture - free from cracking - type of surface finish - tolerances as per 3 m straight edge					
7	Monitor curing	(F)				
	- curing compounds to standard AS3799 - protection - curing period cumulative: fully enclosed internal surfaces 3 days, other surfaces 7 days					
8	**FINAL INSPECTION (by Company)**	(PSC)				
	- Review records - **test records**					

Reasons for failure:

Figure 20: Sample Monitoring checklist

Chapter 6: Report on execution of tasks

By the end of this chapter you will understand how to:

- Complete and submit written reports as required
- Recommend changes to improve safety, efficiency and effectiveness

6.1 Complete and submit written reports as required

There is an old saying 'If you measure something, then you can control it'… the results of your measuring and monitoring must be kept for historical purposes for a number of reasons, including:

- To provide an audit trail in the case of a query or investigation
- To provide a reference point for future works and comparison
- To comply with legislation, corporate and client requirements
- To enable the Project Manager to maintain effective control of the project

The reports that are completed may be comprised of different types of data, including:

- The measurements used for the ordering of materials
- The test results of materials (such as those shown in figure 22)
- Photographs of the project under completion
- Diary notes of the Project Manager providing insight into daily tasks, events and attainment of milestones

Reports are usually based on common templates and should be completed in a legible, non-emotional based and concise manner – remember, you're not writing '*War and Peace'*, and the person reading the report needs to get sufficient information from the report to have a clear understanding of the information be relayed.

In recent times, the use of 'info-graphics' is becoming more and more popular, in order to present a great expanse of critical information in a simple, engaging and attractive manner. They are graphic visual representations of information, data or knowledge intended to present information quickly and clearly. They can improve understanding by utilising graphics to enhance the reader's ability to see patterns and trends.

Reports may be submitted to various entities and for different reasons, including (but not limited to):

- Incident reports to Corporate Office, Client and Regulators
- Budget expenditure reports to finance department
- Company Senior Management / Client
- Sub-Contractors
- Principal Contractor
- Suppliers of goods

6.2 Recommend changes to improve safety, efficiency and effectiveness

Recommendations are often included with a report's conclusion, although they serve different purposes. Whereas a conclusion offers you the opportunity to summarize or review your reports main ideas, recommendations suggest actions to be taken in response to the findings of a report. You can regard recommendations as a prompt to action for the reader/s.

The content of reports should be able to assist the Project Manager or other interested Stakeholders in analysing data to identify various aspects, including:

- Cost over-runs
- Deviation from the plan

- Incident causation & contributing factors
- Trends in hazards reporting, incident occurrences and control actions
- Opportunities for gaining greater efficiency
- Opportunities for gaining greater effectiveness
- Opportunities for improving the overall project performance

Your recommendations as the 'man-on-the-ground' carry a great deal of weight and are respected by those who may not be intimately familiar with the works or project. Keep emotions out of your recommendations and base them on fact and research, not conjecture or guessing.

Effective recommendations:

- Describe a suggested course of action to be taken to solve a particular problem;
- Are written as action statements without justification;
- Are stated in clear, specific language;
- Should be expressed in order of importance;
- Are based on the case built up in the body of the report; are written in parallel structure.

A word of caution about writing recommendations: you should always consider your relationship with the reader first, if you have no authority to make recommendations, the reader may not appreciate them.

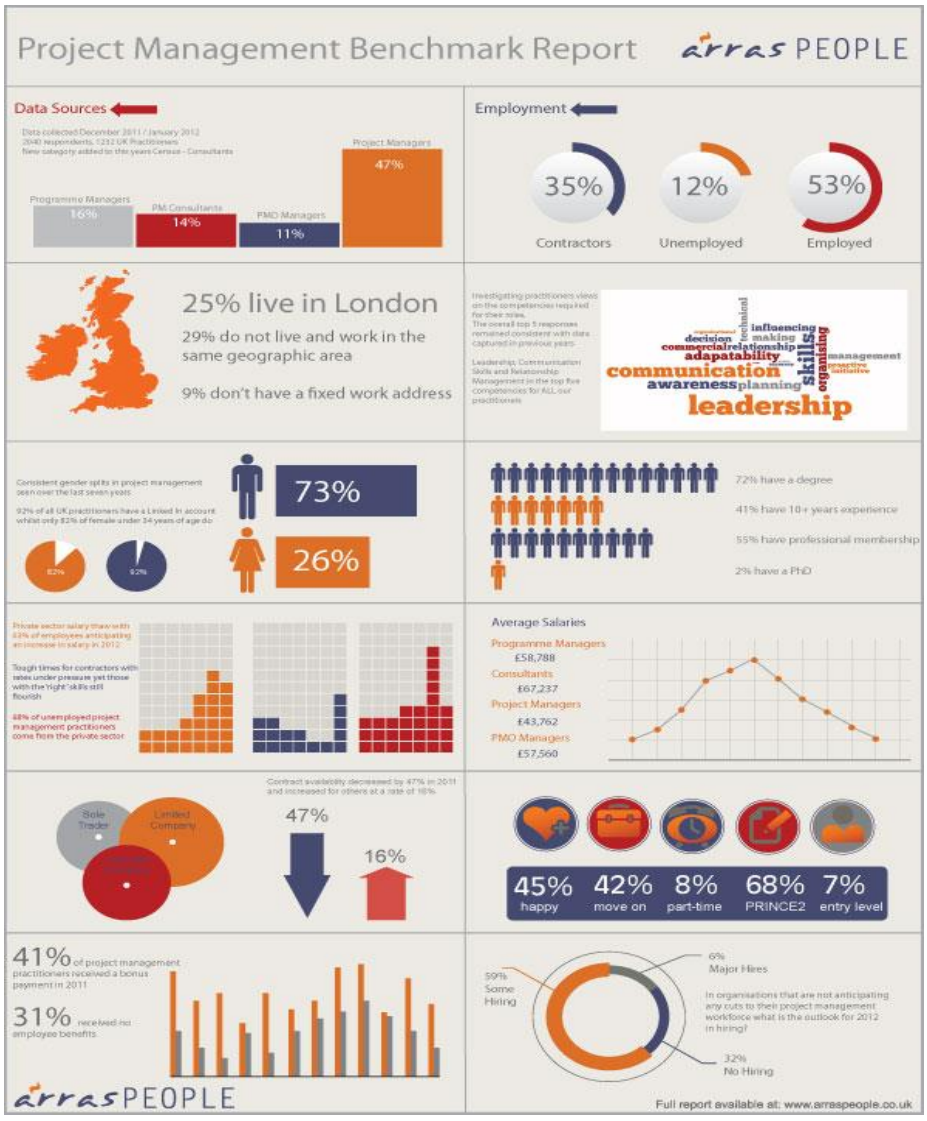


Figure 21: Sample Infographic form of reporting "*Report on a Page*"

CONCRETE WORKS CHECKLIST					
PROJECT:		**AREA:**		**POUR#**	
ELEMENT:		**DATE:**			

PRE-CONCRETE INSPECTION REPORT

Item	Contractor	Foreman	Engineer
Formwork			
• Survey			
• Class			
• Structure			
Reinforcement			
• Columns			
• Beams			
• Slab			
• Prestressing			
• Other			
Services			
• Electrical			
• Hydraulics			
• Other			
Penetrations, set-downs			
• Permanent fixtures			
Clean out & scabbing			

COMMENTS AND/OR DEFECTS

CONCRETE POUR CAN COMMENCE ☐ YES ☐ NO

SITE MANAGER: _____ **DATE:** _____

CONCRETE PLACEMENT INSPECTION CHECKLIST/REPORT			
Item	**Detail**	**Foreman**	**Date**
Concrete order			
• Amount ordered			
• Strength grade			
• Slump			
• Admixtures			
Concrete placer advised			
Services trades advised			
Concrete placement			
• Start time			
• Completion time			
• Weather			
• Temperature			
• Slump average			
• Water added	Amount		
	Stage		
• Concrete type			
• Concrete finish			
• Rejected concrete	Amount		
	Stage		
	Truck no's		
TOTAL AMOUNT			
• Wastage			
• Attach survey report	(slabs only)		

TESTING			
TYPE	**STAGE OF POUR**	**CYLINDER NO**	**DOCKET #**
Comments and/or defects			
SITE MANAGER:		**DATE:**	

Figure 22: Sample Concrete Works Checklist

Chapter 7: Glossary of terms

TERMINOLOGY	DEFINITION
BACKFILL	To fill the earth, any remaining space after placing concrete, brickwork, timber, pipes etc. in an excavation.
BATTER	The slope of a wall of buttress built at an inclination to the vertical plane.
BENCHMARK (BM)	A fixed point of reference, the elevation of which is known and referred to during levelling operations.
BRACE	A member, usually a diagonal, which resists lateral loads and/or movements of a structure
CAST IN-SITU	Concrete cast or poured in its permanent position in prepared forms (eg concrete steps, hearth slabs, floors, beams, lintels)
COMPRESSIVE STRENGTH	Resistance of a material to a crushing force.
CONCRETE	Artificial rock of cement, sand and aggregate
CONTOUR LINE	A line drawn on a site plan joining points of the same elevation
CROSS BRACE	Any crosspiece which diverts, transmits, or resists the pressure of a load
CURING	Treatment of concrete or cement rendering to facilitate hardening
DATUM	A predetermined level on a site from which all other levels are established.
EXCAVATION	A hole made by removing earth
FOOTING	The construction whereby the weight of the structure is transferred from the base structure to the foundation
FORMS	Prepared forms of timber or other material for the casting of concrete
FOUNDATION	The ground upon which the footings of a building are constructed.
GROUND LINE	The ground level or natural grade line
GROUND PLAN (FLOOR)	Plan view of a horizontal section of a building showing the layout of rooms on the ground floor
HOIST	Any device or machine used in building for lifting materials.

References

Guide to Pavement Technology Part 10: Subsurface Drainage, Austroads Publications Online, www.onlinepublications.austroads.com.au/items/AGPT10-09

Technical Specification: MRTS38 Pavement Drains. August 2011. Queensland Department of Transport and Main Roads www.tmr.qld.gov.au/

APA Referencing guide link: http://www.cqu.edu.au/about-us/service-and-facilities/referencing/which-referencing-style-do-i-use

Harvard Referencing guide link: http://www.usq.edu.au/library/referencing/apa-referencing-guide

Australian Codes of Practice https://www.worksafe.qld.gov.au/laws-and-compliance/codes-of-practice

Safe Work Australia http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/guidance-formwork-falsework

Examples of Work Instructions:

- www.cisco-eagle.com
- http://johntheplantman.com
- www.bunnings.com.au