SECTION 3

EXECUTING A CONSTRUCTION PROJECT

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Section 3.1: Administering the contract

Conditions of contract

The conditions of contract are the terms that collectively describe the rights and obligations of contracting parties (i.e. the employer and the contractor) and the agreed procedures for the administration of their contract. **Typically these conditions address the following:**

- The parties' main responsibilities e.g., the employer provides the site and the right of access thereto while the contractor provides the works in accordance with the requirements established in the contract.
- The timing of the works, e.g. start date, time for completion, period for defects liability, etc.
- Testing and remedying of defects.
- Payment, e.g. manner in which the works are to be assessed and certified, time for payment and interest on overdue amounts.
- Variations and claims, e.g. the manner in which variations to the contract are to be evaluated and paid for and how the costs which result from employer liabilities are assessed and paid for.
- Title (ownership) to objects, materials within the site, etc.
- Risks and insurances, e.g. what are the employer's and contractor's risk and what insurances each party will take out.
- Termination, e.g. the reasons for termination, the procedures for termination and the payment to be made upon termination.
- The resolution of disputes, e.g. by adjudication, mediation, arbitration, litigation (court of law) or a combination thereof.

Conditions of contract can be standardised so that the same conditions of contract can be used on different projects, in which case they are referred to as standard forms of contract.

The cidb requires that the public sector use one of the following standard forms of contract when engaging main contractors for construction works contracts:

- FIDIC (French initials for International Federation of Consulting Engineers) (1999) (Short contract and Red, Yellow and Silver Books).
- General Conditions of Contract for Construction Works (GCC).
- JBCC Series 2000 (Principal Building Agreement and Minor Works Agreement).
- New Engineering Contract (NEC3) (Engineering and Construction Contract and Engineering and Construction Short Contract).

Communications

The single most important task in administering a contract is to ensure effective communications with the employer and his representatives e.g. principal agent (JBCC Series 2000), engineer (FIDIC and GCC 2004) or project manager (NEC3). Each form of contract stipulates requirements for communications between the parties of the contract. These usually need to be communicated in a form which can be read, copied and recorded. The contract data associated with a contract also state to whom communications are to be addressed and where certain communications are to be sent.

Section 2.8 covers the following:
- The fundamentals of a construction works contract.
- Concluding a contract.
- Concluding a contract using cidb procedures.
- Standard construction works contracts and sub contracts.
- Typical features of construction works contracts for main contractors.
- Contractor's lien.

Conditions of contract for subcontracts differ widely. Ideally, the conditions of subcontract should be similar to that of the main contract. This is only possible where the NEC3 and JBCC forms of contract are used.

The conditions of contract should not be more onerous than that of the main or prime contractor.

Each standard form of contract is very clear on what needs to be communicated, what the time frames for communications are and how communications are to be made.

The various contracts require:

- The contractor to provide a programme within a specified time period.
- The employer to pay the contractor within a specified time period.
- The employer's representative to provide a decision within a specified period.
- The contractor to give notice of his intention to declare a matter as being a dispute within a specified time period.
- The contractor to submit timely request for inspections.
- etc.

Each of these events requires different types of communications between the parties. Effective communications can mean the difference between a problematic contract and a smoothly run one.

It is also important for a contractor to communicate effectively with its suppliers, service providers and subcontractors.

Managing time

Programme

The programme shows which activities are on the critical path, or impact directly on the completion date of the contract if they are delayed. This critical path programme is the essential tool in assessing the likelihood of claims should there be changes to the works, or the conditions under which the work is done.

Construction works are unique in that each activity needs to be sequenced in order for the project to be completed. For example, it is not possible to erect the roof until the foundations and walls have been constructed. This type of logic is used to determine how long a project will take to complete. Efficient programming can mean significant time and cost savings to both the contractor and the employer.

At the start of each contract, the contractor is required to prepare a programme and have it agreed to by the employer or his representative. This programme indicates the duration and logic of the sequencing of activities for the project. The employer or his representative will evaluate whether the logic is sound and whether the estimated time frames for completion of the works are reasonable. (see section 3.6 for guidance on the preparation of bar charts).

The programme is an important tool for managing time to ensure that the works are completed in accordance with contractual requirements. It also allows the employer's representative to establish the reasonableness of any claims for an extension of time.

Extensions of time

Completion is a state of readiness for occupation of the whole works although some minor work may be outstanding.

Where the contractor is instructed by the employer or his representative to add, change or remove activities from the project or to change the scope of work, there may be grounds for a change to the time for completion. If the change to the project causes the project to be completed later than planned, then there is reason to change the completion date. If it does not, there is no reason to do so.

Some forms of contract require that the contractor submit a claim for an extension of time to the employer within a specified time period of becoming aware of an event that may give rise to such an extension, e.g. abnormal rainfall, failure by the employer to provide access to the site, etc. Failure to do so might result in the forfeiting of the right to an extension of time.

Completion

The contractor is responsible for the works from the date that possession of the site is given by the employer or his representative until such time that the works are completed or are capable of being used

by the client. The different forms of contract have different processes for declaring a contract complete. Some require the employer's representative to issue a single completion certificate while others require a practical completion certificate and a completion certificate to be issued (see section 3.9).

At this point (depending on the form of contract) retention moneys are reduced, performance bonds are released and the defects liability period commences. This is a great financial relief for a contractor.

Where the contract allows for it, the contractor is entitled to or required to hand over sections of the project before the whole project is completed. Handing over these sections means that the employer is able to utilise that portion of the works before the whole project is completed and the contractor is thereafter not liable for that portion of the works.

The risk of damage to the works also passes to the employer upon completion. It is therefore important to manage and complete the work in such a manner that completion is achieved as soon as possible.

Early completion

If the contractor is very efficient, and there are no problems experienced on site, then the contractor will be free to start a new project much earlier. The contractor needs to ascertain that by completing a contract earlier does not cost him more. In some contracts, the employer may encourage early completion by offering a bonus for early completion.

Penalties for late completion

Provisions for penalties or delay damages (a monetary value representing the damage caused by the delay) are contained in most construction contracts. These are imposed where the employer has specific deadlines or other requirements and will experience a loss of revenue, loss of use of the premises if the project is delivered late or have to pay additional supervision and administration costs relating to the late completion.

The contract document will specify the value of the penalties per day, per week or per month, or the extent of the penalties should specific requirements not be achieved.

Penalties are deducted from interim payment certificates as soon as they occur and can be objectively quantified. They are based on the difference between the time that the works were actually completed and the time according to the contract when they were supposed to be completed.

Changes to the prices for the works

Instructions given by the employer or his representative that change the scope of the work or the timing of the works (i.e. the construction programme), can impact on the cost of the works. Each of the different forms of contract assesses the impact on the contract price differently.

The contractor is required to carry out any instruction received in writing to change the scope of work or the timing of the works unless it is impossible or illegal to do so.

Changes in the scope of work most often arise through changes in the details on the construction drawings or specifications, the employer increasing or decreasing the size of the work, and new information regarding the site becoming available which necessitates that the design be amended. The contractor should always check the changes that are made to the drawings and identify how the changes affect the programme, materials ordering and utilisation of resources.

Retention monies are monies retained for a certain period by the employer to offset costs which may arise from the contractor's liability for defects or failure to comply fully with the contract.

Performance bonds are submitted to the employer or placed in the hands of a third party to guarantee completion of the work and recovery of the sums which the contractor would be recognised as owing in terms of the contract.

The **scope of work** is the document that specifies and describes the works which are to be provided and any other requirements and constraints relating to the manner in which the contract work is to be performed.

Changes in the completion date for the works frequently arise from access being denied to the site or a portion thereof for whatever reasons, the employer requiring the contractor to stop the works or an earlier completion being required.

The contract also identifies which risks are carried by the contractor and which are carried by the employer. Accordingly should an event occur on the site and the contract states that it is the employer's risk, then the contractor is entitled to have the contract price adjusted to compensate for the additional costs incurred. An extension to the time for completion may also be due to the contractor.

Certificates and invoicing

Interim invoices

Most contracts make provision for monthly interim payments based on the value of the work executed and any amounts to be added or subtracted in terms of the contract. Each form of contract contains specific procedures for payment.

The standard provisions in the forms of contract endorsed by the cidb are outlined below.

Form of contract	Who initiates an interim payment claim	Processing of interim claim	Period within which Employer pays
FIDIC Short Contract	Contractor submits a monthly statement to the Employer.	Employer is permitted to deduct any amounts for which a reason for disagreement is given.	28 days of the delivery of the statement.
FIDIC "Red Book"	Contractor is required to make application for a Payment Certificate to the Engineer at the end of each month, setting out the amounts which the Contractor believes that he is entitled to.	Engineer verifies statements and issues interim Payment Certificate within 28 days of receipt of the Contractor's statement and supporting documents.	56 days after the Engineer receives the Contractor's application for payment.
FIDIC "Yellow Book"	Contractor is required to make application for a Payment Certificate to the Engineer at the end of each period stated in the contract data, setting out the amounts which the Contractor believes that he is entitled to.	Engineer verifies statements and issues Interim Payment Certificate within 28 days of receipt of the Contractor's statement and supporting documents.	56 days after the Engineer receives the Contractor's application for payment.
GCC 2004	Contractor is required to deliver to the Employer a monthly statement for payment of the amounts that he considers due to him.	Engineer verifies statements and issues interim payment certificate within seven days to the Employer.	28 days after the Engineer issues the payment certificate to the Employer.

Form of contract	Who initiates an interim payment claim	Processing of interim claim	Period within which Employer pays
JBCC Minor Works	Principal Agent issues an interim Payment Certificate. Contractor co-operates and assists in the preparation of the valuation of the Payment Certificate.	Principal Agent issues an interim Payment Certificate by not later than the day of the month stated in the contract data, whether or not the Contractor provided any information.	Seven days after Principal Agent issues Payment Certificate to Contractor and Employer.
JBCC Principal Agreement	Principal Agent issues an interim monthly certificate. Contractor assists the Principal Agent in preparing the claim information and assessing the amounts completed.	Principal Agent issues an interim payment certificate by not later than the day of the month stated in the contract data, based on a valuation not more than seven days prior to this day, whether or not the Contractor provided information.	Seven days after Principal Agent issues payment certificate to Contractor and Employer.
NEC Engineering and Construction Short Contract	Contractor assesses amount due by assessment date provided for in the contract and applies for payment.	Employer notifies contractor of corrections.	Three weeks after the next assessment date which follows the receipt of an application for payment.
NEC Engineering and Construction Contract	Project Manager assesses the amount due at each assessment date and may consider an application for payment submitted by the Contractor.	Project Manager gives the Contractor details of how the amount has been assessed and certifies the payment within one week of each assessment date.	Three weeks from the assessment date.

Final invoices

Final payment occurs only after the defects liability period has lapsed. Each form of contract contains procedures for final payments.

The standard provisions in the forms of contract endorsed by the cidb are outlined below.

Form of contract	Who initiates a final payment claim	Processing of final claim	Period within which Employer pays
FIDIC Short Form of Contract	Contractor provides Employer with final account within 42 days of the expiry of the notifying (defects liability) period.		28 days of the delivery of the final statement.

Form of contract	Who initiates a final payment claim	Processing of final claim	Period within which Employer pays
FIDIC "Red Book" and FIDIC "Yellow Book"	Contractor provides Engineer with draft final statement within 56 days of receiving the Performance Certificate.	Engineer verifies statement. Contractor issues to the Engineer Final Statement and the discharge within 28 days of the issuing of the draft final statement. Engineer issues Employer Final Payment Certificate within 56 days of receipt of draft final statement.	56 days after the Employer receives the Final Payment Certificate.
GCC 2004	Contractor delivers final statement to the Engineer within 14 days after the issue of the Final Approval Certificate.	Engineer verifies final statement and issues Final Payment Certificate within 14 days of receipt of the Contractor's Final Statement.	28 days after the Engineer issues the Final Payment Certificate to the Employer.
JBCC Minor Works	Principal Agent submits the Final Account to the Contractor within 45 days of Practical Completion.	Contractor accepts or objects to the Final Account within 10 days. Thereafter Principal Agent issues final Payment Certificate to Contractor and Employer.	Seven days after the date of the final Payment Certificate issued by the Principal Agent to the Contractor and Employer.
JBCC Principal Agreement	Principal Agent issues the Final Account to the Contractor within 90 days of Practical Completion.	Contractor accepts or objects to the Final Account with 45 days of receipt. Thereafter the Principal Agent issues final Payment Certificate within seven days to Contractor and Employer.	Seven days after Principal Agent issues final Payment Certificate to Contractor and Employer.
NEC Engineering and Construction Short Contract	Contractor assesses amount due and applies for payment within one month after defects date.	Employer notifies Contractor of corrections.	Seven weeks after the next assessment date which follows the receipt of an application for payment.
NEC Engineering and Construction Contract	Project Manager assesses the amount due within four weeks of the Supervisor issuing the Defects Certificate and may consider an application for payment submitted by the Contractor.	Project Manager gives the Contractor details of how the amount has been assessed and certifies the payment within one week of each assessment date.	Three weeks of the assessment date.

Tax invoices

Section 20(1) of the Value Added Tax Act of 1991, (Act 89 of 1991), requires that a supplier (person supplying goods or services) who is registered as a VAT vendor (see section 1.4) issues to the recipient a tax invoice within 21 days of the date of a supply whether requested or not.

Tax invoices for amounts in excess of R3 000 must include:

- The words **"tax invoice"** in a prominent place.
- The name, address and VAT registration number of the supplier.
- The name, address and where the recipient is a vendor, the recipient's VAT registration number.
- The serial number and date of issue.
- An accurate description of goods and/or services (indicating where applicable that the goods are second-hand goods).
- Quantity or volume of goods or services supplied.
- Price and VAT.

A **tax invoice** is a document which is provided for in the Value-Added Tax Act, 1991 ("the VAT Act") to enable the vendor to claim input tax.
The VAT Act prescribes that a tax invoice must contain certain details about the taxable supply as well as the parties to the transaction.

Disputes

A dispute can arise in the contract when both the contractor and the employer think that they are right, and they both think the other party is wrong. There are a variety of reasons for a dispute, but the most common reasons are regarding money or time for completion.

The contract specifies the manner in which disputes will be resolved on the contract. **The different forms of contract deal with disputes differently and typically include provisions for the initial resolution of a dispute by:**

- **Mediation** – a third party is appointed to facilitate conciliation between the parties and agreement on the outcome of the dispute.
  or
- **Adjudication** – a third party is appointed to make a decision on the dispute, which is binding on the parties and is final unless it is reviewed by either arbitration or litigation.

Where a party to the contract is dissatisfied with the decision of an adjudicator or fails to settle the dispute through adjudication, the dispute is referred for final resolution to:

- **Arbitration** – one or more arbitrators are appointed to resolve the dispute in accordance with procedures laid down in the Arbitration Act 42 of 1965.
  or
- **Litigation** – one or more advocates are appointed by both parties. The advocates present their sides of the argument in a court of law to persuade the judge which party has the better legal case.

Mediation and adjudication (see section 2.8) are intended to provide an inexpensive means for resolving disputes without legal representation. Only if these procedures fail to resolve the dispute is the matter referred to arbitration or litigation for final resolution.

The procedure for the adjudication of disputes is intended to resolve disputes quickly. Most contracts have time periods for referring disputes for resolution by an adjudicator. Disputes that are notified outside of these time periods are automatically referred to arbitration or litigation.

The parties to a contract are always free to agree to settle a dispute amicably in any manner that the parties choose, no matter what the contract stipulates.

Not all disputes end up being declared as such. Most disputes are sorted out on site between the contractor's representative and the employer's representative. The parties come to an agreement to settle the dispute in a friendly way, and all parties compromise on their position until they reach a common ground. This is the most effective way of sorting out differences.

Termination of a contract

Each of the forms of contract endorsed by the cidb permits the parties to the contract to terminate the contract should the other party be in material breach of the contract, e.g. the employer has failed to pay the contractor or the contractor is not performing the work in accordance with the provisions of the contract.

The reasons for terminating a contract due to default by the contractor include:

Form of contract	Reasons for the employer to terminate due to default by the contractor
JBCC Minor Works Agreement	**Where the Contractor defaults by failing to:** • Provide the security and the Employer elects to terminate. • Execute the works. • Comply within a reasonable period with a valid contract instruction issued. • Continue work on site without reasonable cause for more than a continuous period of ten (10) working days. • Provide evidence of insurance where responsible.
JBCC Principal Building Agreement	Where the Contractor fails to comply with contractual obligations or refuses to comply with a contract instruction.
FIDIC "Red Book"	**Where the Contractor:** • Fails to provide a performance security or comply with an instruction. • Abandons the works or plainly demonstrates the intention not to continue performance of obligations. • Without reasonable excuse fails to proceed with the works. • Subcontracts the works or assigns the contract without the required agreement. • Becomes bankrupt or insolvent or carries on business under a receiver. • Gives or offers to give to any person any bribe, gift, gratuity, commission or other thing of value as an inducement or reward.
FIDIC "Short Contract"	Where the Contractor abandons the works, refuses or fails to comply with a valid instruction or fails to proceed expeditiously and without delay.
GCC 2004	**Where the Contractor has:** • Made application for sequestration of his estate. • Abandoned the contract. • Without reasonable cause failed to commence the works. • Failed to proceed with the works with due diligence or to execute the works in accordance with the contract. • Failed to remove materials from the site or to pull down and replace work condemned and rejected by the Engineer. • To the detriment of good workmanship or in defiance of the Engineer's instructions sublet any part of the contract. • Assigned the contract or any part thereof without consent. • Anyone in his pay or in his employ bribes a person in the employ of the Employer. • Furnished inaccurate information in his contract.

Form of contract	Reasons for the employer to terminate due to default by the contractor
NEC3 Engineering and Construction Works Contract	**Where the Contractor:** • Becomes insolvent. • Has defaulted by substantially failing to comply with his obligations, not providing a bond or guarantee, appointing a subcontractor for a substantial portion of the works without acceptance by the Project Manager, hindered the Employer or broken a health or safety regulation.
NEC3 Engineering and Construction Short Contract	**Where the Contractor:** • Becomes insolvent. • Has defaulted by substantially failing to comply with the contract, hindered the Employer or broken a health or safety regulation.

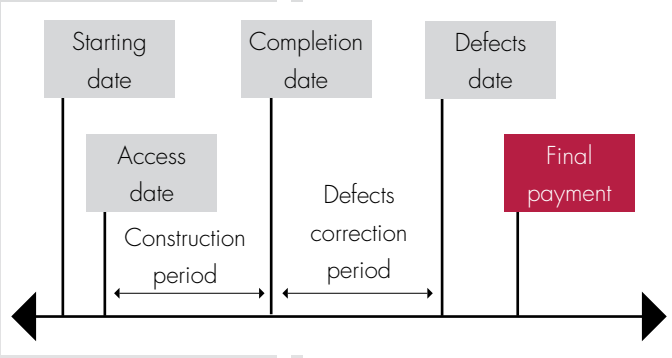
Reasons for the contractor to terminate if the employer fails to meet their contractual obligations:

Form of contract	Reasons for the contractor to terminate due to default by the employer
JBCC Minor Works Agreement	• The Employer fails to appoint a Principal Agent, give possession of the site or pay a certified amount. • The Principal Agent fails to issue a Payment Certificate or a completion certificate.
JBCC Principal Building Agreement	• The Employer fails to appoint a Principal Agent, effect special insurances, give possession of the site or pay a certified amount. • The Principal Agent fails to issue a Payment Certificate or a Completion Certificate.
FIDIC "Red Book"	• The Employer fails to pay the Contractor in accordance with the contract. • In the event of a prolonged suspension which affects the whole of the works.
FIDIC "Short Form of Contract"	• The Employer fails to pay the Contractor in accordance with the contract.
GCC 2004	• The Employer fails to pay the Contractor the amount due in terms of the contract.
NEC3 Engineering and Construction Works Contract	• The Employer has not paid a certified amount within 13 weeks of the certificate. • The Project Manager has instructed the Contractor to stop or not start the works for a reason which is not the fault of the Contractor and an instruction has not been given to re-start or start the works within thirteen weeks.
NEC3 Engineering and Construction Short Contract	• The Employer has not made payment within ten weeks of the assessment date which followed the Contractor's application for payment. • The Employer has instructed the Contractor to stop or not start the works for a reason which is not the fault of the Contractor and an instruction has not been given to re-start or start the works within eight weeks.

Section 3.2: Preparing to start the contract

The construction process

Every construction works contract that is endorsed by the cidb makes provision for a start date, an access date, a completion date and a defects date.



At the start of any contract, the contractor needs to deliver certain items that are required in terms of the contract. These items can include:

- Proof of the insurances that the contractor is required to have.
- Provision of a performance bond.
- Provision of the preliminary contractual programme.

These contractual requirements are needed by the employer to justify providing the contractor with access to the site. The contractor must comply with these requirements timeously; otherwise he will be in breach of contract and may have the contract terminated due to lack of performance.

Allowable rates

Before the work on site can start, the contractor should make certain preparations. These preparations include careful planning of resources and methods of work in order to ensure that the manner in which the work is performed on site is in line with the thinking at tender stage.

This process is known as the pre-contract planning stage of the contract, and will result in a set of allowable rates or lump sum amounts for activities that have been calculated, in order to guide the productivity requirements on site. The contractor uses productivity rates from past projects of a similar nature to determine productivity hours.

"Allowable rates or lump sums" are the costs or time period that a contractor can allow for the task at hand, covering labour, equipment, transport, supervision and planned profit. These allowables can help the contractor to plan the work more efficiently and make the most of cutting costs of production and thereby maximising profits.

When putting the price together for the tender submission, the contractor was required to make certain assumptions regarding the manner in which the work would be done. This includes how many people of what category are to be used for the work, how long they will take to perform a task, and how much work they will be able to complete in a day (see section 2.9).

The difference between the estimates and the allowables is that the allowables are calculated backwards from the tendered rates submitted in the tender. The cost allowables are calculated by dividing the direct project cost for the item of work by the total quantity of work to be done on that item. **Each item of work will contain at least one of the following components:**

- Labour
- Equipment
- Materials
- Transport

Take an example of a typical item within a construction project, such as pouring concrete to foundations:

Quantities taken off drawings				Direct project costs					Tendered Rate
Item	Description	Unit	Quantity	Labour	Equipment	Materials	Transport	Total Cost	
3.1	Concrete to foundations	m^3	4	R448	R128	R1648	R320	R2544	R750

*The direct project **costs** to mix and place 4.0 m^3 of concrete to foundations:*

Labour = R448-00/ 4.0 m^3 = R112-00/m^3
Equipment = R128-00/ 4.0 m^3 = R32-00/m^3
Transport = R320-00/ 4.0 m^3 = R80-00/m^3

This leaves over a total of R412-00 per m^3 for materials.

The total of the cost per m^3 is R636-00/ m^3. The difference between the tendered rate of R750-00/m^3 and this figure represents the profit included in this item (18% profit) when the tender was calculated.

The benefit of doing this analysis before the work starts on the contract is that the contractor is immediately provided with a clear allowable amount for expenditure on each component of the work.

In this example, the contractor will know that a price of R412-00 per m^3 plus a portion of the cost for labour and equipment for mixing the concrete cannot be exceeded if ready mixed concrete is purchased, or alternatively the equipment, sand, stone, cement and labour needed to mix the concrete should equal or be less than this amount. It also indicates how much the contractor can spend on labour in the pouring and placing of the concrete in foundations.

A contractor's profits are eroded whenever the cost of a task or activity exceeds the allowable.

Time allowables

Another important aspect to be determined when considering allowable rates is the time that should be allowed to be taken to complete a task.

The four-person labour team planned to place the concrete at a wage rate of R28-00 per hour. Accordingly the allowed time to complete the activity is R112-00 for four labourers at R28-00 per hour = one hour.

The time target for the labour team to work towards when they are casting four m^3 concrete in a foundation is four hours.

Time allowables should then be tabulated against each item that will be costed, so that each activity can be measured against allowables. This provides the contractor a means of identifying immediately where areas are taking too long to construct and where there is scope for more profit.

The drawback of not planning is that FAILURE comes as a complete surprise without the worry and stress that normally precedes it.

Resourcing the project

From the quantities identified in the contract or taken off the drawings, the contractor can identify the gross quantities of each type of material that will be required to construct the works, how many people will be required to finish the works in time, the plant required to carry out each activity and also have a good idea of the profit that might be made on the project. This will provide good indicators as to how many people are required on site, and how much equipment is needed (e.g. does the contractor need to provide his own batching plant or can he make use of ready-mixed concrete) (see section 3.6).

Resource planning stems from two main elements of a contract (see section 3.6):

- The programme of works.
- The production rates that the contractor can manage to do the work.

Work programmes are essential for the efficient performance of any job. They are an essential tool for job planning and cost control and may be used to demonstrate claims for delays and extra payments.

The programme is the tool that is used to determine the sequence in which the work needs to be done in order to be completed on time. In construction, there is a logical sequence to the activities. It is not possible to construct the roof until the walls have been built, and the walls cannot be built until the foundations have been constructed. This logical sequencing of activities is an essential tool for managing any construction project (see section 3.6).

By carefully sequencing the work that has to be done, the contractor can work more efficiently with equipment, personnel and tools and are informed at the start of the project more or less when the required materials need to be purchased. By moving activities around and carefully changing the sequence of the works, the contractor can optimise each resource's input and complete the works as soon as possible.

Different options can be explored and the one that will yield the greatest profit or the least risk can be chosen. At tender stage the methodology for the works is prepared in a hurried and broad-brush manner. When the contract is awarded, the contractor owes it to himself to ensure that the most profitable and least risky options are chosen to maximise the profits for the shareholders.

Site establishment

Site establishment, an essential part of preparation necessary to start a contract, is addressed in section 3.4.

Section 3.3: Managing occupational health and safety

Workplace accidents

A workplace accident is an unplanned event with undesirable outcomes typically relating to loss of production at one end of the spectrum and loss of life at the other. In order to avoid these undesirable outcomes it is necessary to plan for possible risky situations and to avoid or eradicate the risk (see section 3.10).

The most common injuries on site are finger, hand or foot injuries. These are mostly caused when workers have to manually move and position materials and equipment as part of their daily tasks. More serious injuries, which also frequently occur, are eye and head injuries. Many injuries can easily be avoided by using suitable personal protective equipment such as gloves, boots with steel toe caps, goggles or a hard hat.

It is every contractor's statutory duty to ensure that workers are not exposed to unsafe working environments. Construction sites are by nature prone to accidents because of the many activities that take place at the same time. The owner of a construction business is liable for any injuries or fatalities that occur on site and he needs to put suitable safety induction training in place, provide suitable personal protective equipment, and plan the works in such a way that workers are not exposed to undue risks.

Long-term health problems related to the workplace

The working environment on a construction site is nearly always noisy, dusty and dirty. This can cause long-term health problems for workers who are exposed to loud noise for a long period, or end up breathing in fine particles of dust and other debris that is thrown into the air by construction operations.

People who are exposed to very noisy operations for a long time can suffer permanently impaired hearing or even total hearing loss. The contractor must provide suitable hearing protection in the form of ear plugs or ear muffs to workers in noisy areas and most importantly, ensure that these are used.

The same applies to dusty environments. Silicosis is one of the most common chest ailments experienced by mine workers and is caused by breathing in the very fine dust that is produced when drilling holes for blasting and whilst mucking out the blasted rock debris. Construction sites are also prone to dusty conditions, especially in South Africa, where haul roads are not surfaced and very dry conditions result in the roads being pulverised to fine dust by the heavy trucks and high traffic during construction. Frequent spraying of dirt roads with water can prevent them from drying out and causing dust. This also provides a better surface for the trucks to drive on, resulting in less breakdowns and better productivity. As dust cannot be eliminated, workers exposed to dust should be required to wear face mask dust filters. A wet handkerchief does not prevent the microscopically fine dust particles that cause silicosis from entering the lungs of a worker – only a purpose designed filter will do the job.

Another area where workers are subject to long-term health problems is where there is a lot of welding to be done. The very bright light produced during arc welding causes damage to the retina of the eye, something which cannot be reversed. Those artisans who are doing the welding must always be equipped with proper welding helmets, goggles and protective clothing such as welding gloves, aprons and sleeve protectors, which also prevent burns from weld spatter and grinding operations.

Safety is a state in which the risk of harm (to persons) or damage is limited to an acceptable level. Safety on site is something that must be considered very carefully. It is not possible to determine the price of a life, or an eye, if it is lost through an accident.

Occupational Health and Safety Act (Act 85 of 1993)

Section 8(1): General duties of employers to their employees

Every employer shall provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of his employees.

Improving safety on site does not need to be an expensive task. It can entail careful induction training of all persons entering the site, ensuring that each person wears suitable personal protective equipment, and keeping a wary eye out for potential risk areas on site.

It is also important to remember workers' health is affected by the environment and conditions that they work in. Long-term health problems can be a more serious risk to workers than site accidents.

Regulations issued in terms of the Occupational Health and Safety Act (Act 85 of 1993) include:

- General Administrative Regulations
- General Safety Regulations
- General Machinery Regulations
- Asbestos Regulations
- Construction Regulations
- Driven Machinery Regulations
- Electrical Machinery Regulations
- Electrical Installation Regulations
- Explosive Regulations
- Facilities Regulations
- Noise Induced Hearing Loss Regulations
- Regulations for Hazardous Chemical Substances
- Vessels Under Pressure Regulations

An employee is entitled to benefits in the event of an injury on duty. However, if an accident is attributable to "serious and wilful misconduct" by the employee, no compensation is payable unless the accident results in serious disablement or the employee dies, leaving dependants.

Sections 17 to 20 of the Occupational Health and Safety Act deal with matters relating to health and safety representatives and health and safety committees.

Legal requirements for health and safety

General

Health and safety requirements are stipulated in the Occupational Health and Safety Act (Act 85 or 1993). These requirements are supplemented by a number of regulations issued in terms of this Act. Compensation for injury, disease or death of a worker is governed by the Compensation for Occupational Health and Diseases Act (Act 130 of 1993). Both of these laws are administered by the Department of Labour.

The Occupational Health and Safety Act is based on the principle that dangers in the workplace must be addressed by communication and cooperation between the worker and the employer. The worker and the employer must share the responsibility for health and safety in the workplace. Both parties must pro-actively identify dangers and develop control measures to make the workplace safe.

A contractor is required to provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of his employees. In order to do this, the contractor needs to (see section 3.10):

- Identify the hazards (source of or exposure to danger) in relation to the work on site.
- Evaluate the associated risks (the probability that damage or injury will occur).
- Establish the steps that need to be taken to prevent exposure of employees to the identified hazard or where prevention is not practicable, minimise such exposure.

The contractor also needs to make every employee aware of the identified hazards and to train every employee in the steps that need to be followed to prevent or minimise exposure to the hazard. The contractor must not allow any worker to work on the site that has not been informed of and trained in the steps that need to be followed. The contractor must also be proactive and ensure that the steps are indeed followed and that workers are reminded of the hazards and the steps that are to be followed from time to time.

Government has established a fund to compensate casual and full-time workers who, as a result of a workplace accident or work-related disease, become ill, are injured, disabled or killed. Workers who are injured on duty can claim compensation for temporary or permanent disablement. If workers die as a result of an injury on duty, their dependants can claim compensation.

Contractors must register with the Compensation Fund and pay annual assessment fees (see section 1.5).

Health and safety representatives

Contractors who employ 20 or more workers must appoint health and safety representatives to monitor health and safety conditions. One such representative needs to be appointed for every 50 workers. Representatives must be full-time workers who are familiar with the workplace.

Representatives are required to:

- Review the effectiveness of health and safety measures.
- Monitor, investigate and report on health and safety matters.
- Accompany inspectors during inspections.
- Make representations to the contractor regarding any complaints regarding health and safety matters.

Contractors who have appointed two or more health and safety representatives must form health and safety committees. These committees should meet monthly. They may make recommendations to the contractor regarding any matter affecting the health or safety of persons on the site and must discuss any incident on site which caused a person to become ill, be injured or to die.

Health and safety committees must make and keep records of recommendations to employers and inspectors.

Health and safety plans

Contractors shall prepare a documented health and safety (H&S) plan for each project to ensure a working environment for workers and the public that does not threaten their health and safety. The H&S plan shall address the significant and residual hazards and risks that a competent and resourced contractor would not have been expected to know relative to a specific project on a specific site. The H&S plan shall describe the work to be done, the hazards associated with that work and clearly describe the hazard control measures that will be implemented. The H&S plan shall include, inter alia, a statement of responsibilities in terms of management of various aspects of H&S on site, H&S training and incident management. Site H&S rules for each project will also be included that address, inter alia, induction/orientation and H&S training, personal protective equipment, access to the site, accident and emergency procedures, and safe work procedures. H&S method statements shall form part of the H&S plan. The contractor shall ensure that the H&S plan is implemented, reviewed and regularly updated.

Awareness of having to work safely is the first step towards improving the safety of workers on a construction site. By being aware of what could result in an injury, everyone can keep an eye out for potential risk areas and correct them before an injury occurs.

Construction supervisors and safety officers

The **Construction Regulations** require the contractor to appoint a full-time competent employee to supervise the performance of construction work. This person must be appointed in writing as the construction supervisor.

Regulation 6 of the Construction Regulations deals with the supervision of construction works.

The contractor may appoint additional people to assist the construction supervisor to perform certain of his functions, but this does not relieve the construction supervisor of his or her responsibilities under the regulations. If the contractor has not appointed additional people to assist the construction supervisor, and an inspector determines that the construction supervisor needs assistance, he can instruct the contractor to do so.

No construction supervisor may supervise construction work on more than one site unless there are sufficient additional competent people appointed to assist him.

A contractor must assess a project for size, degree of dangers that are likely to be encountered or the accumulation of hazards or risks on site, and if deemed necessary, appoint a full-time or part-time construction safety officer to assist in all safety related controls. This person must be appointed in writing.

Conducting of risk assessments

In terms of the **Construction Regulations**, the contractor must have a risk assessment (see section 3.10) performed by a competent person (who is appointed in writing) before any construction work starts as well as during the construction work. **Such an assessment shall as a minimum:**

- Identify the risks and hazards to which persons may be exposed to.
- Analyse and evaluate the identified risks and hazards.
- Document a plan of safe work procedures to mitigate, reduce or control the risks and hazards that have been identified.
- Provide a monitoring plan.
- Provide a review plan.

Regulation 7 of the Construction Regulations deals with the risk assessments of construction works.

A **risk assessment** is an important step in protecting workers as well as complying with the law. It helps the contractor to focus on the risks that really matter in a particular workplace – the ones with the potential to cause real harm. Workers and others have a right to be protected from harm.

A contractor is required to

- provide a first aid box or boxes at or near the workplace where more than five employees are employed.
- ensure that where there are more than 10 employees employed on the site that for every group of up to 50 employees at that workplace, at least one person is readily available during normal working hours, who is in possession of a valid certificate of competency in first aid.

Poor housekeeping is characterised by equipment, materials and other items lying loosely around the site in areas where people are required to walk, travel through or work. These loose lying items are a major cause of injuries and must be kept properly arranged, stored carefully and properly or removed from site in the case of rubble or old materials.

Poor housekeeping is directly linked to the number of injuries that are logged on construction sites. Many accidents happen because incorrectly stacked items fall onto someone, loose cables get caught on a moving object and strike a worker or visitor, open electrical boxes short when they get wet, or someone gets electrocuted when he touch the poorly earthed distribution board.

This risk assessment must be available on site for inspection by an inspector, client, client's agent, contractor, employee, representative of a trade union, health and safety representative or any member of the health and safety committee.

The contractor must ensure that all subcontractors are aware of any hazards on the site before construction work commences and during the construction period.

Employees

Section 14 of the Occupational Health and Safety Act requires that every employee:

- Takes reasonable care at his place of work for his own health and safety and of other persons who may be affected by his acts or omissions.
- Cooperates with the contractor in complying with the requirements of the Act.
- Carries out lawful instructions and obeys the health and safety rules and procedures laid down by the contractor.
- Brings to the contractor's or the health and safety representative's attention any situation which is unsafe or unhealthy.
- Reports incidents which may affect his health or which has caused an injury to himself, to the contractor or the health and safety representative as soon as practicable but not later than the end of the particular shift during which the incident occurred.

The **General Safety Regulations** require a contractor to prohibit an employee who is, or who appears to be, under the influence of intoxicating liquor or drugs to enter or remain at a workplace. Employees taking medicines may only be permitted to perform duties at the workplace if the side effect of their medication does not constitute a threat to the health or safety of the person concerned or other persons at the workplace.

The contractor is required by the Construction Regulations to ensure that all employees under their control are:

- Informed, instructed and trained by a competent person regarding any hazard and the related work procedures before any work commences, and thereafter at such times as may be determined in the risk assessment.
- Issued with proof of health and safety induction training issued by a competent person and carry proof of such induction when working on site.

Visitors to the construction site

In terms of the Construction Regulations, visitors to the site must be informed of the hazards and be issued with the necessary personal protective equipment, unless they are merely visiting the site office and do not come into contact with construction activities.

Specific requirements

The General Safety Regulations establish specific requirements including that relating to:

- Personal safety equipment and facilities.
- First aid, emergency equipment and procedures.
- Use and storage of flammable liquids.
- Work in confined spaces.
- Work in elevated positions.

- Working in danger of engulfment.
- Stacking of articles.
- Welding, flame cutting, soldering and similar operations.
- Ladders.
- Ramps.

The Construction Regulations establish specific requirements including that relating to:

- Fall protection.
- Structures (buildings, structures other than buildings, formwork, false work, scaffold or any fixed plant).
- Formwork and support work.
- Excavation work.
- Demolition work.
- Tunnelling.
- Scaffolding.
- Suspended platforms.
- Boatswain's chairs.
- Material hoists.
- Batch plants.
- Explosive powered tools.
- Cranes.
- Construction vehicles and mobile plant.
- Electrical installations and machinery on construction sites.
- Use and temporary storage of flammable liquids on construction sites.
- Water environments.
- Housekeeping on construction sites.
- Stacking and storage on construction sites.
- Fire precautions on construction sites.
- Construction welfare facilities.
- etc.

The General Machinery Regulations establish specific requirements for the:

- Supervision of machinery.
- Safeguarding of machinery.
- Operation of machinery.
- Working on moving or electrically alive machinery.
- Devices to stop and start machinery.
- etc.

The **Diving Regulations** establish specific requirements for diving operations. The **Noise-Induced Hearing Loss Regulations** establish specific requirements for exposure to noise, noise monitoring, control of noise exposure and hearing protective equipment. The **Facilities Regulations** establish requirements for facilities including sanitation, changing rooms and drinking water.

The **Driven Machinery Regulations** provide specific requirements for the operation of machinery such as revolving machinery, circular saws, band saws, wood planing machines, sanding machines, grinding machines, air compressors, refrigeration and air conditioning installations, etc. The **Lift, Escalator and Passenger Conveyor Regulations** establish requirements for the design and construction of lifts, escalators and passenger conveyors. The **Vessels under Pressure Regulations** establish requirements for the design, construction and manufacture of pressure vessels (e.g. boilers, a pressurised system, etc.)

The Construction Regulations require a contractor to provide at or within reasonable access of every construction site, the following clean and maintained facilities:

- at least one shower facility for every 15 workers;
- at least one sanitary facility for every 30 workers;
- changing facilities for each sex; and
- sheltered eating areas.

The Construction Industry Regulations make provision for an EB Class of Works which is defined as construction works that are primarily concerned with the installation, extension, modification or repair of electrical installations in or on any premises used for the transmission of electricity from a point of control to a point of consumption, including any article forming part of such an installation.

The EB class of construction works covers all electrical equipment forming an integral and permanent part of buildings and/or structures, including any wiring, cable jointing and laying and electrical overhead line construction.

The Electrical Machinery Regulations establish specific requirements including that relating to:

- Safety equipment.
- Work on disconnected electrical machinery.
- Switch and transformer premises.
- Switchboards.
- Electrical machinery in hazardous locations.
- Portable electrical tools and lights.
- Electric fences.
- Earthing.
- Clearance of power lines.
- Insulators and fittings.
- Overhead service connections and conductors.

The **Electrical Installation Regulations** establish design and construction requirements for any machinery in or on any premises used for the transmission of energy from a point of control to a point of consumption anywhere on the premises. These regulations require that electrical contractors who perform electrical engineering work are registered to do so with the chief inspector or a person appointed by the chief inspector.

The **Asbestos Regulations** establish specific requirements relating to asbestos work, exposure to asbestos and the disposal and demolition of asbestos. The **Environmental Regulations for Workplaces** establish requirements for the environment within which workers are permitted to work. These regulations accordingly address issues such as noise, temperature, ventilation and lighting precautions against flooding, etc. The **Explosive Regulations** deal with the handling and use of explosives.

The **Regulations for Hazardous Chemical Substances** deal with the handling and transportation of toxic, harmful, corrosive, irritant or asphyxiant substance.

Subcontractors

In terms of the Construction Regulations, a contractor may only subcontract work in terms of a written subcontract and shall only appoint a subcontractor should the contractor be reasonably satisfied that such a subcontractor has the necessary competencies and resources to perform the work falling within the scope of the subcontract safely.

The contractor is required to:

- Stop any subcontractor from executing construction work which is not in accordance with the contractor's or subcontractor's health and safety plan for the site or which poses a threat to the health and safety of persons;
- Ensure that:
  - every subcontractor is registered and in good standing with the compensation fund or with a licensed compensation insurer prior to work commencing on site; and
  - potential subcontractors submitting tenders have made provision for the cost of health and safety measures during the construction process.

Notification of construction work

The Construction Regulations require that the main contactor inform the provincial director of the Department of Labour before carrying out any work on site where the work:

- Involves the demolition of a structure exceeding a height of three meters, the use of explosives or the dismantling of fixed plant at a height greater than three meters.
- Exceeds 30 days or will involve more than 300 person days of construction work and includes excavation work deeper than one meter; or working at a height greater than three meters above ground or a landing.

Health and safety file

The Construction Regulations require that a health and safety file, which includes all documentation required in terms of the provisions of the Act and Regulations, is opened and kept on site and made available to an inspector, client, client's agent or main contractor upon request.

Health and safety inspectors

Health and safety inspectors, appointed by the Minister of Labour may, in terms of the Occupational Health and Safety Act, enter any workplace at all reasonable times, without prior notice, and question any person. They are also empowered to request and examine documents and remove any evidence of a breach of the requirements of the Act and its associated Regulations. They may also prohibit a contractor from continuing any work which, in their opinion, threatens or is likely to threaten the health or safety of any person working on the site and may block off unsafe workplace areas.

An inspector may investigate the circumstances of any incident that has occurred, which has resulted, or in the opinion of the inspector could have resulted, in the injury, illness or death of any person. Such reports are submitted to the Attorney General who may deal with the incident in terms of the Criminal Procedures Act or the Inquests Act.

Penalties

Section 38 of the Occupational Health and Safety Act contemplates the following minimum penalties:

- Committing a reckless act in the workplace – a fine of R 50 000 and one year imprisonment.
- Omissions by contractors which lead to a disabling injury – a fine of R 100 000 and a one year imprisonment.
- Omission by a contractor that leads to one fatality – a fine of R 100 000 and a two year prison sentence.

Reporting of incidents

The Occupational Health and Safety Act requires that all incidents be reported within seven days to the provincial director of the Department of Labour. If a person who is injured dies after the Department is notified, the death of the worker must be immediately reported to the Department.

No one may disturb the site of an injury or death, unless such disturbance is required to prevent a further incident, to remove the injured or dead, or to rescue persons from danger.

The health and safety file should contain at least:

- notifications
- letters of appointment
- minutes of meetings
- copies of subcontract agreements
- health and safety plans
- recommendations
- reports
- proof of registrations
- risk assessments
- details of induction training
- certificates
- names of first aiders on site
- records of inspections
- etc

An incident is an event or occurrence occurring at work or arising out of or in connection with the activities of persons at work, or in connection with the use of plant or machinery, in which, or in consequence of which:

- a major incident occurred (i.e. an occurrence of catastrophic proportions);

(continued on following page)

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- any person dies, becomes unconscious, suffers the loss of a limb or part of a limb or is otherwise injured or becomes ill to such a degree that he is likely either to die or to suffer a permanent physical defect or likely to be unable for a period of at least 14 days either to work or to continue with the activity for which he was employed or is usually employed; or
- the health or safety of any person was endangered and where:
  - a dangerous substance was spilled;
  - the uncontrolled release of any substance under pressure took place;
  - machinery or any part thereof fractured or failed resulting in flying, falling or uncontrolled moving objects; or
  - machinery ran out of control.

Reporting requirements for occupational injuries

All contractors must report any accidents that result in medical expenses and/or a worker's absence from work for longer than three days by submitting the required documents to the Compensation Fund within seven days. Employers must submit certain documents to the Compensation Commissioner within seven days of being notified.

Contractors who delay in reporting an accident may be fined.

Note: Employees may also obtain compensation for an occupational disease if the disease has arisen out of or in the course of his employment. If the occupational disease is aggravated by another disease, the employee may receive compensation for the treatment of the other disease as well. The employee must, within 12 months of being diagnosed with the disease bring it to the attention of the Commissioner, the contractor or Mutual Association concerned, failing which the claim will not be accepted and no compensation will be payable.

Section 3.4: Site establishment and administration

Introduction to site establishment

It is important for the contractor to mobilise and move onto site as soon as possible after the site is handed over by the employer. If the contractor does not do this, the employer might terminate the contract due to the contractor's breach.

Site establishment is a very important element in the performance of any contract. If the site establishment is well planned and executed, the contractor can greatly increase productivity and efficiency. A well - organised site which is neat, tidy and clean will not only look professional but will also reduce waste, accidents and lost time in searching for items that are needed.

The employer usually makes available a piece of land for the contractor to use as his site camp. Sometimes this is an area within the site itself, and other times, it is located very close to the site.

Site establishment should be regarded as the setting up of a remote operations control centre. This exercise is often strategically and financially under - estimated.

Site layout considerations

The arrangement of site accommodation such as offices, storage sheds, mechanical service yards, training areas and access routes is normally a first consideration when establishing a site. Other aspects such as the location of services such as water, electricity and telephones can also play an important part in the site layout.

When planning the layout of the site, it is important to also consider the owners or tenants of the areas next door to the site. Loud noise from a machine can disturb the neighbours if it will be running for long periods, and complaints will be received about this disturbance. In such a case, the machine should be shielded in order to reduce any possible disturbance to a minimum.

When planning the site layout, the contractor should consider at least the following:

- Location of the site.
- Conditions on site.
- Access to the site.
- Drainage of the site.
- Ground conditions (wet weather conditions, marshy conditions, ground movements).
- Services available (water, sewers, electricity, gas, telephones, etc.).
- The type and quantities of material that is to be stored.
- The type of construction equipment that is to be used.
- Disposal sites for excess soil or rubbish.
- Security on site (access security, security of materials delivered, etc.).
- Accommodation requirements for the employer and his representatives.
- Local suppliers.
- Local labour availability.

Always read the contract, particularly the scope of work, to identify any specific requirements that the employer may require.

Access

Access to the site and movement around the site must be well planned. This entails the planning for access by heavy trucks to deliver major plant, materials and equipment as well as by light vehicles to drop off personnel. There will also be pedestrian access points to consider, since many people will come to site on foot or possibly by taxi. Parking space is also needed for site management, and for the employer and his representatives.

Access to the different parts of the site is also important as different types of equipment will be required in different areas. For example, tower cranes may be required at different points on the site. On some sites, underground access, or even access to services tunnels that have already been constructed, may have to be considered.

Where there is no easy access available, the contractor will have to construct temporary access. This can entail a simple timber walkway or the construction of an access road, depending on the location and nature of the site.

A contractor shows that it values their inputs by providing good facilities for use by its workers. This can result in increased productivity, high morale in the workforce and reduced labour force turnover.

Site facilities

General considerations

Different sites will require different types of site facilities. It is important to know what is to be accommodated on site when the contractor starts to plan the site establishment. The number of personnel, types and quantities of materials which will be required, equipment that will be used, and the security requirements for the site must all be carefully considered.

Administrative offices

The administrative offices will vary depending on the size of the project and the duration of the works. Site offices are often custom designed to be transportable and can be moved from one site to the next, saving in the expense of fitting them out for each new project. The number and quality of the office accommodation should be appropriate to the length of time that site staff will be using them and by the number of personnel that will be using them.

The site offices should be as far as possible watertight, dust and sound proof and of a solid construction. Suitable lighting and ventilation must be fitted either in the form of windows or lights, air conditioners and fans. Good internal and external finishes will enhance site staff's working environment and will promote pride in their work.

Facilities for workers

Huts and sheds should be provided for workers to shelter them from bad weather and changing into working clothes. On some sites accommodation and canteen areas are also needed if the project is on a remote site far away from existing settlements, and therefore the contractor has to provide this for his workers in terms of the contract.

Ablution facilities

Toilets and bathrooms must be provided in sufficient quantity for all staff and workers including those employed by subcontractors. The number of these ablutions should be appropriate to the size of the site and should be well-kept. Clean water should be provided at all times for workers to drink and wash with.

Storage shed and areas

Depending on the size and nature of the project, other general sheds may also be needed. Sometimes the contractor will need to perform quality control testing on site and may establish a testing laboratory to do this himself, rather than to rely on external service providers. Soils or concrete testing labs take up a lot of space and need to be correctly set up in order to provide consistent and valid results.

Regulation F11 of the National Building Regulations prohibits the erection or demolition of a building unless approved sanitary facilities for all personnel employed on or in connection with such work have been provided or are available on the site or, with the permission of the local authority, at some other place. SANS 10400 - F establishes minimum requirements to allow this Regulation F11 to be satisfied. Sanitary facilities should be provided at the rate of not less than one sanitary facility for 30 workers (or part of that number). Construction Regulations GNR.1010 of 18 July 2003 also stipulates requirements for construction welfare facilities.

Storage sheds are almost always needed to keep small tools, equipment and materials dry and secure when the contractor is not working. These need to be built to the required size, and with the appropriate amount of security for the site location and the nature of the items to be stored. Storage is often also to be provided for subcontractors.

When positioning storage sheds and areas, it is important to reduce the amount of handling that is required for those materials. The more materials are handled, the greater the possibility of damage or contamination and the more expensive and time consuming it becomes to work with them.

The type of materials or equipment to be stored needs to be considered as well. Fuels and explosives have very stringent storage requirements, and, in some instances, the contractor may have to obtain permits for these items. Plastic pipes may require shade from the sun in order not to be damaged whilst stored and electrical equipment will need to be stored in a dry place. Cement is normally stored either in silos or in weatherproof buildings or containers, on platforms or pallets off the floor.

Construction equipment areas

Certain projects require heavy machinery such as graders, bulldozers, excavators and fleets of tipper trucks. These machines need an area in which they can be maintained and also a location where they can be safely stored overnight.

Depending on the nature of the project, the machines may be stored next to where they happen to be working, well away from the main site offices. However, security must be provided for this situation.

Servicing of machines is normally done where they are working on a regular scheduled basis. Repairs are often required wherever the machine breaks down, but often a central workshop is used to do major servicing or larger repair jobs. A workshops area would be required for this type of support work.

Work areas

Work areas will include those parts of the site where the contractor will construct the works, as well as any areas that are used to assemble or produce elements for the works. These areas would include pre-casting yards, batching plants, areas where reinforcing cages are tied ready to be positioned and other areas where built-in elements are assembled prior to installation.

These work areas should be positioned carefully on the site in order to maximise efficiency in the construction process. Careful planning should be done over the duration and function of some items that will function within these working areas, so that they do not need to be relocated during the project, causing delays to production. For example, the batching plant should be positioned where it can remain for the duration of the time that concrete will be needed on site, and in such a manner that delivery of aggregates and cement to the batch plant will not interfere with the operation of the batch plant itself or the delivery of concrete to the site.

The position of a tower crane is another good example. The tower crane may be required for almost the entire time, however, its position may need to be changed in order to reach sections of the building that are out of its initial reach and which will be constructed later. In such cases, the original location of the tower crane may well be built over when it is moved, using the same crane, simply relocated elsewhere.

Security

Site security is a critical part of the establishment. The perimeter of the site must be secured from a health and safety perspective to prevent unauthorised persons from gaining access to the site. The contractor is responsible for all persons who enter the site, and if a person were to wander onto the site and be injured or killed, this would have a serious impact on the delivery of the project. Perimeter security is also required to prevent vandalism or damage to the works by unauthorised people entering the site.

Watchmen are usually posted at night or over weekends when the contractor is not at work in order to maintain this security. Suitable accommodation needs to be provided for these watchmen to shelter.

Stores should be secured against theft and efficient systems put in place in order to ensure that materials are not stolen. Good systems will also reduce wastage of materials on site through proper and appropriate storage.

Section 3.5: Site administration

What is administration?

Administration is the management of the affairs of a contractor's business. Site administration is the management of the contractor's affairs on a particular construction site.

Site administration and site management (see sections 3.1, 3.3 and 3.8) is often under-resourced and neglected in favour of production pressures. Site administration and site management is the 'nerve centre' of operations and if these functions are not functioning effectively, they will hamper production output and quality will suffer.

Record keeping

General

Construction is a complex business to operate and there are many different activities that need to be managed at any one time. It is not possible to remember what happened at what time, and who did it, and why. Record keeping is essential to ensure that events can be recalled at a later stage.

There are several main types of records that need to be kept including:

- Site diary.
- Drawing register.
- Written notices, correspondence and site instructions.
- Site photographs.
- Contractual documents.
- Occupational health and safety documents (see section 3.3).

It is essential to also ensure that these records are properly filed so that they can be easily found when needed. By implementing a standard way of keeping and filing records, the contractor will save time and effort when starting new projects. It will also improve the contractor's ability to monitor and improve on production, quality and cost controls.

Site diary

The site diary should be kept by the contractor's site agent or site manager responsible for the site. This site diary should keep specific information relating to the work that is done each day, what problems were encountered, what instructions were issued by the employer's representative (principal agent, project manager, supervisor, engineer), what drawings were received, and production and milestones achieved. Each project is different and the site diary for each contract will change depending on the type of work to be done.

There are standard records that need to be kept which are needed for contractual reasons. Information kept for all projects should include:

- Day.
- Date.
- Rainfall measured.
- Personnel schedule.
- Equipment schedule.

Much of the paper received by a construction business has no long-term value but certain items are very important. The challenge is to figure out which papers are needed, where to systematically store them, and how long to keep them.

The site diary can be used as a tool for planning, checking, and controlling site activities.

The records in a diary can be used in a court of law to prove what did or did not happen on a particular day. However, if the diary is incomplete or has gaps in it, then some doubt will exist as the authenticity of the diary. It is important to ensure that entries are accurate and comprehensive.

- Record of any reportable accidents that occur.
- Production targets and achievements.
- Site instructions received.
- Drawings received.
- Issues that are causing delays.
- Work that is to be rectified.
- Site meetings held and the date for the next one.

The contractor can decide how they wish to implement the site diary and there are different approaches that are commonly used. Some contractors produce a customised printed book with carbonated copies for use on site. This is useful for specific sites where the site agent will write in the diary what the records are for the day and issue a copy to the employer's representative. Another approach is to develop a spreadsheet with the required information on it. Each day this spreadsheet is filled in and e-mailed to the employer's representative who can then store it electronically or print it out for their files or pass it on for information to the employer or other parties.

Changes to the scope of work in the form of revised drawings or site instructions issued by the employer's representative can lead to adjustments being made to:

- the time for completing the works
- the price for performing the works

Most forms of contract require that the contractor motivate claims for such adjustments within a specified time frame. Failure to maintain adequate records can result in financial loss.

Most forms of contract require that verbal communications be confirmed in writing, failing which such communications are not recognised in terms of the contract.

Drawing register

A drawing register must be kept and is essential in identifying changes and dates when these changes are notified. The drawing register must identify each drawing issued to the contractor for the contract with a revision number and the date it was received. This record is essential in determining when changes were implemented in the drawings and how it may have affected the works.

Changes to drawings may result in a variation if the work that is required for the change has already started. On the other hand, if the work has not yet started and materials have not been purchased for the original design the change may not result in a claim.

Written notices, correspondence and site instructions

Correspondence is used to convey messages and confirm verbal discussions held between the parties on site. They place the discussion on record and expand on the circumstances or approach to be followed.

Written notices are similar to correspondence but differ in the fact that they are written in accordance with a specific requirement in terms of the general conditions of contract and usually make reference to a particular clause.

Site instructions are often given verbally on site in order not to delay the work. These must be confirmed in writing as soon as practically possible, so that they are placed on record and become binding in terms of the contract. Some contractors print standard site instruction booklets similar to the site diary, with carbonated pages which can be filled in by the employer's representative and handed to the contractor.

It is important to keep copies of outgoing mail as well as incoming mail. This should also be added to the filing system. Where there is a likelihood of a large quantity of mail to be processed, it would be a good idea to implement a document management system.

Site photographs

Site photographs are invaluable in recording conditions at a particular date and time. A picture tells the whole story; however, it is important to capture additional information about the picture as well. The additional information is needed to place the image in time and place so that it can be utilised.

Digital cameras now provide a means of recording actual events cheaply and effectively. The camera records the date and time of an image within the resulting image file.

Site photographs should have the following information:

- Date and time.
- Location.
- Reason for taking the photograph.
- Name of photographer.
- The names of relevant people included in the photograph.
- The names of the subcontractors included in the photograph.

The best "diary" of a project is a regular completed site diary coupled with a series of regularly taken photographs. These photographs do not have to be taken daily but could be taken on a weekly basis or at times when specific important occurrences take place.

It is important that the photographs are correctly coded and filed with the appropriate description relating to each photograph. Electronic storage is fine as long as there is a clear way of finding a particular picture when needed.

It is said that a picture paints a 1000 words. Digital photography has dramatically reduced photographic costs. No contractor should be on site without a camera.

Contractual documents

The most important document for any construction project is the contract. This details all the rights, responsibilities and obligations of the parties to the contract. There should always be a copy of this document available for site personnel to refer to.

Other contractual documents are also important and should be stored carefully.

Documents that have contractual reference include:

- The main contract.
- Subcontracts.
- Labour contracts
- Plant-hire agreements.
- Delivery notes.
- Programmes and bar charts.
- Site-meeting minutes.
- Notifications for inspections.
- Correspondence with the employer/employer's representative.
- Payment certificates.
- Completion certificates.
- Daily labour sheets and materials and equipment usage where work is performed on a cost reimbursable basis.
- Health and safety file containing relevant health and safety documents.

Filing

The key to keeping all of these documents is an efficient filing system. There are no fixed rules and filing systems vary from person to person. One person may file everything in date order and another by subject or document type. These personal preferences will make it extremely difficult for a contractor to find their documents, since each person will need to pull out documents that they have filed themselves.

A standardised system of filing is therefore essential. There are still no rules to how this should be done; however, there are different types of documents that will need to be kept for different purposes, by different people, in different places, in different ways.

For example, delivery notes are essential documents for the stores to keep. These will need to be reconciled each month against supplier's invoices by the accounts section. These will probably be kept in the stores, possibly in lever arch files and only stores personnel and accounts personnel will have access to these documents.

Contractual documents are sensitive and confidential, and would possibly be kept in the site agent's office in a locked filing cabinet to keep prying eyes away. Payment certificates would be kept by the cost controller or the site agent, and a copy of the invoice will possibly also be made available to the accounts department so that they can reconcile them with the bank statements when the client pays.

Labour contracts should be kept by the human resources section or the wages clerks. It is important to keep these contracts at hand, since personnel change often on a site and the contracts will be required when they arrive or depart.

The contractor must devise its own system for site filing but it is recommended that it includes a particular job number, followed by a file reference number which will be consistent on all jobs. For example, the 613.10 could be the "Wages and Labour" file for contract number 613; and 817.10 could be the "Wages and Labour" file for contract 817 and so on.

The file, or files, for a site could be arranged as follows:

File reference number 10 - Wages and Labour

- 11 - Time sheets and wage sheets
- 12 - Accident reports
- 13 - Labour programme

File reference number 20 - Materials Ordering

- 21 - Requisition to order forms
- 22 - Purchase order forms

File reference number 30 - Materials delivered

- 31 - Goods receiving notes
- 32 - Suppliers delivery notes

File number 40 - Goods issued

- 41 - Requisitions
- 42 - Site issue notes
- 43 - Goods returned vouchers

File reference number 50 - Assets

- 51 - Asset register
- 52 - Small tools register
- 53 - Stock cards stored alphabetically

File number 60 - Correspondence

There should be several files or one file split into sections for particular file reference, i.e., "correspondence" is one such reference number. The correspondence can be split into various sub-sections as follows.

61 - Professional Team - This will relate to all correspondence between the construction business and the architect, engineer, client, etc.
62 - Subcontractors
63 - Meeting minutes
64 - Internal memos
65 - Drawing schedules
66 - Site instructions / Architects instructions / Variation orders
67 - Tender documentation, including all allowables for labour, plant and materials
68 - P&Gs, showing allowables that can be spent on site camp, etc
69 - Certificates

File number 70 - Photographs

71 - Photographs stored in date order
72 - Short description of what was intended by taking the particular photograph

Mail system

Whilst it is important to ensure that mail is controlled between the contractor and the employer's representative, this is not the only mail that needs to be attended to. There is correspondence between the site and the head office, with suppliers and subcontractors, with statutory bodies such as the Department of Labour, with the bank and many other stakeholders. In addition, there will also be correspondence between the site personnel, informing each other of required materials, delays or other matters.

An efficient mail system needs to be introduced on site to ensure that the message gets to the correct person as soon as possible and with as much clarity as possible.

Incoming mail, which should always be date stamped, comes in different formats:

- Written letters.
- E-mail.
- Internal mail.
- Fax.

Each of the above communication modes should be processed differently, since their means of "delivery" and receiving varies. Consideration should also be given to maintaining a duplicate set of records at head office.

There should be a standard procedure established on site for each type of mail so that the messages are properly transmitted. Careful consideration needs to be made to ensure that different people on site don't address the same item of correspondence. To avoid this, different people on site may need to be tasked to handle different types of correspondence.

When preparing for meetings the following points should be planned and organised:

- predetermine all meeting dates and times;
- advise all parties in time, and remind, and confirm;
- ensure meetings start on time;
- always have an agenda;
- always set a time limit;
- stick to the agenda;
- stick to the point and don't get bogged down in irrelevant points;
- always allocate and delegate actions and get confirmed dates for the actions;
- follow-up on previous actions; and
- always take and distribute minutes as quickly and as practically as possible.

Meetings

Meetings are essential communication tools to ensure that everyone on the team understands all aspects of the job and can perform effectively as a team. Issues can be very quickly straightened out and decisions can be taken on options available. It is essential that meetings are properly managed and controlled.

A carefully drafted agenda will assist in keeping meetings to the point and short in duration. The minutes of these meetings must be properly kept and promptly written up, as these also form part of the record of events and decisions for the contract. Minutes are also used by those attending to prompt them in the actions assigned to them.

Stores

Typically, stores are controlled independently from the production teams in order to control waste, unnecessary expenditure and to ensure that each production team is provided with what it needs. The stores control system includes the locking of the materials in a secure area, maintaining good security over the materials and keeping an inventory control system that provides immediate information on the stock levels of all items that are kept in the stores.

Inventory controls are also integrated with the accounts sections who determine what amounts are to be paid to suppliers. Delivery notes need to be signed and kept as proof of delivery of materials in order that the accounts department can make payment only for goods that have been delivered. The inventory levels can also be set so that there is always a minimum level of stock available. This minimum level should be determined by both the demand for the item and the delivery time from the suppliers. It is a great expense to keep stock in the stores if it will never be used and will be thrown away or returned to the supplier for a reduced amount.

Records need to be kept of the inflow and outflow of materials. Accordingly, documents such as the following may need to be completed:

- Requisition notes.
- Purchase orders.
- Stores issue notes.
- Goods returned vouchers.
- Stock control cards which should include the code of the particular material, the supplier of the material and information such as:
  - date of receipt of materials into the store;
  - the quantity of materials received on a particular date;
  - the date on which materials are issued to site personnel;
  - the site issue number;
  - the quantities of materials that are issued;
  - a running total of materials received less stock issued;
  - minimum stock levels; and
  - stock re-order levels.

Hired equipment

Contractors should put a system in place to record the use of each item of hired equipment on site. A hire report can be generated by simply recording for each item of equipment its status on each day as working or standing and for what time period. The operator and supervisor should sign off the records on a daily basis.

Time cards

Labour is generally paid on an hourly basis. Time worked must be recorded on a daily basis on a time card by the worker's supervisor. This constitutes the legal record of the time spent when it comes to the worker's wages for payment at the end of the month. Standard time and over time are all calculated from the daily records of each person's time card. These time cards need to be maintained by the supervisors, who will hand them in to the wages clerks on a daily basis for capture into the wages payment system. This also records if a worker is absent from work.

Bricks that are purchased are visible. Equipment hours are not. Without adequate records, equipment usage cannot be managed and controlled.

Section 3.6: Production planning and resourcing

Work programmes are essential for the efficient performance of any job. They are an essential tool for job planning and cost control and may be used to demonstrate claims for delays and extra payments.

The importance of planning and resourcing

Poor planning leads to project surprises, staff frustration and unforeseen costs in resourcing (materials and production). This can have a negative impact on cash-flow and result in penalties being applied to the contract should the contract not be completed on time. All of this erodes a contractor's profitability.

Proper planning and resourcing improves project efficiency and profitability, avoids penalties, motivates staff and demonstrates to the employer the competence of the contractor.

Activity list

The starting point in production planning and resourcing is to develop an activity list. The activity list describes what has to be done on the project by splitting the entire project into easily described bits of work or activities. Each activity is generally a continuous activity of one group of workers.

An example of an activity list for constructing a house is as follows:

- Set out foundations.
- Clear and grub site.
- Excavate footings.
- Cast footings.
- Sub-floor brickwork.
- Fill under floors.
- Cast surface bed.
- Superstructure brickwork.
- Roof timbers.
- Beam-fill.
- Roof covering.
- Plastering.
- Screeds.
- First-fix plumber.
- First-fix electrician.
- Glazing.
- Painting first coat.
- Painting finishing coat.
- Hang doors.
- Fix ironmongery.
- Floor finishes.
- Electrician second-fix.
- Plumber second-fix.
- Ceilings.
- Clean.
- Snag.
- Handover.

All of the above are construction activities which could include various actions as part of that activity. For example, **"superstructure brickwork"** includes the fixing of windows while **"fill under floors"** includes the forming of any thickenings to the surface beds that might be required.

Some allowances for quality control points and milestones are necessary. These could include inspections of the:

- Foundation.
- Slab.
- Wall-plate.
- Plumbing.
- Electrical.
- Completion of maintenance inspection.

These quality control points and milestones must be added to the activity list. For example, if the architect, project manager or clerk of works requires a "wall-plate inspection", this must be done before the contractor puts on the roof trusses and this activity must be planned to take place immediately after the contractor has finished the superstructure brickwork. If the contractor needs to issue notice that inspection is required this will need to be programmed accordingly.

Programming or sequencing of activities

Programming entails the arranging of the activity list in a logical construction sequence. There are three main aspects to consider when programming, namely:

- Physical considerations.
- Methodology or approach.
- Practicalities.

Physical considerations consider the obvious. For example, the foundations can't be cast until their excavations are complete, and the roof can't be put on until the brickwork has been built.

Methodology or approach considers the reasons why various activities cannot be performed at the same time. For example, once the superstructure brickwork has been constructed, it is possible to put on the roof, plaster the walls and hang the doors, all at the same time. Physically there is no reason why these activities cannot take place when the brickwork is completed. However, it is a safety hazard for people to work underneath other people. Materials or equipment could easily fall from the hands of the carpenters working on the roof and injure the workmen below.

Decisions relating to the sequencing of activities should be based on security, safety and quality considerations.

Furthermore, the internal doors should not be hung until such time as the roof is on to prevent damage to the doors from rain or sunlight. The external doors should be lockable before installing fittings such as lights, taps, etc., otherwise they could be stolen. The plastering should be completed and one coat of paint should be put on the walls prior to the erection of the ceilings. This prevents the ceilings from being damaged by plastering operations and allows a good paint finish right up to the ceiling.

Practicalities consider the appropriateness of performing activities simultaneously. For example, one cannot screed the floor and plaster the walls at the same time, as the workmen will get in each other's way. One cannot paint the door frame at the same time as one is hanging the door.

Ideally, only one trade should be permitted to work in one area at any particular time. Apart from providing a safer environment for workers, it can improve quality and productivity as the workmen of one particular trade feel pressurised by the workmen of another trade to get finished, particularly if the site supervisor only permits a handover from one trade to the next when the first trade's quality has satisfied all requirements.

Security becomes a problem when more than one trade is working in an area at the same time. For example, the carpenters' tools could go missing when other subcontractors or trade workers were working in the same unit at the same time. Furthermore, it is very easy to assign a single trade team the responsibility for cleaning up its mess and waste when it has finished its activities and to lock the building at the end of each day's work.

Developing a bar chart

A bar chart or construction programme is a list of activities that are planned to be completed by a particular time. The steps in developing a bar chart are as follows:

Bar charts are the easiest to understand and most widely used form of programme. They contain a list of activities with start, duration and finish of each activity.

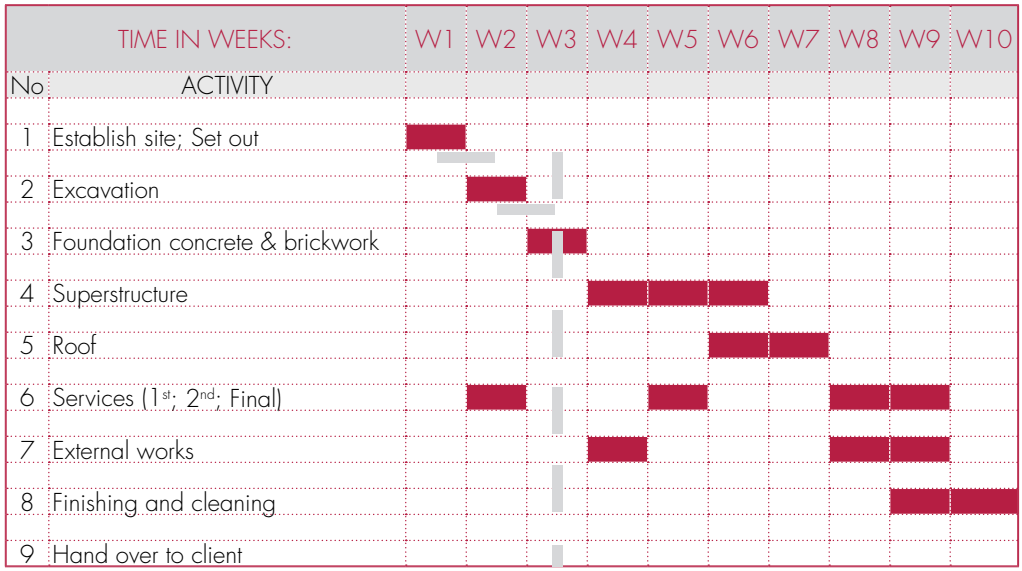
Step 1: Make an activity list and arrange it into a logical sequence of events at a level of detail that is practical and appropriate.

Step 2: Assume a rate of production for each activity taking into account the available resources. This will determine the length of time required for each activity (see section 2.9).

Step 3: Determine the logical sequence in which work is to be carried out. Include any dependencies that might exist, even if these are not at first considered to be critical.

Step 4: Draw out the logical sequence on a bar chart. This provides a visual tool to identify what activity is to start, when it is to start, and what needs to be completed before it can start (see sample below).

Typically the activities or tasks are listed vertically at the left of the page, with the time-scale in months, weeks or days horizontally along the top of the page and the "time now" line, advancing from left to right across the page indicating the current date (shown at week 3 on the chart). The actual progress made can be plotted underneath – see activities 1, 2 and 3.



Resourcing

The bar chart can be used to resource the project. The chart presents a logical breakdown and sequence of activities for the project and the timing for and duration of these activities. The resources associated with each activity now need to be identified – labour, materials, equipment, subcontractors, etc. The total resources required for each time period can be worked out by simply adding the resources that are required for each activity that is executed simultaneously.

The bar chart can then be adjusted by moving particular activities back and forth in time to reduce the quantity of that resource required to complete all those tasks at the same time or to smooth out the requirements for that resource.

Material ordering

The contractor can identify from the bar chart when materials are required for a project and order them when needed. The supplier's lead time and delivery time should be taken into account when the item is ordered so that it can be delivered at the right time. This reduces storage costs and minimises damage to the materials and possible loss due to shrinkage or spoiling.

Equipment usage

The contractor can also identify from the bar chart when equipment must be available on the site and when it can be removed from the site. Allowance must be made for the time it takes to move the equipment from one site to the other site or for the hire company to deliver the equipment. It is important to return hired equipment that is no longer required as soon as an activity has been completed to save costs.

Subcontractors

The contractor can use the bar chart to identify when a subcontractor must start their work and when the subcontractor must finish their work. This information can help to schedule the work of the subcontractors and to manage them.

Contingencies and "float"

Whilst it is important to draw up the programme to show the shortest possible time to complete a project not everything on site goes exactly as planned. There are unforeseen events such as rain or people that are absent due to sickness which will delay the work that has been scheduled for a particular day. The contractor should incorporate an appropriate amount of slack time or "float" in order to ensure that there is time allowed to deal with these contingencies. Sometimes the float is shown as a separate activity but more often it is included in the activities themselves, allowing slightly more time than anticipated to complete the work.

Many activities automatically have float built in due to the way that they were scheduled. There may be slack time for an activity if there is another activity which takes longer and which starts at the same time. Both activities can be started at the same time but the shorter one will finish earlier or can start later and finish at the same time. The shorter activity can then float between its earliest start date and its latest start date without affecting the critical path of the programme.

Critical path

Once the programme has been optimised the contractor will be able to determine the critical path. All the activities that have no float are on the critical path. If any of these activities are delayed, the end date of the programme will be delayed.

The contractor must make sure that the programme is updated with current progress because the critical path can change from day to day should a non-critical item take longer to complete than anticipated and thereby changing the critical path of the whole job.

Overall programme

It is important to remember all the activities that are required for the works. This includes the site establishment, mobilisation of plant to site, lead times for ordering of materials required for the works, disestablishment from site and the deadlines that are required along the way.

It is also essential to link all the dependencies, no matter if they are part of the critical path or not. As circumstances change on site, the start of different activities will change and the critical path activities may also be changed depending on those other dependencies.

Fabrication off site

Some projects may allow for fabrication of elements off site in order to reduce the time for completion. For example, houses can be constructed quicker if the entire bathroom were pre-fabricated complete with bathroom fittings and plumbing. The walls could be built around a pre-fabricated element that is put in place. All that is needed is to connect the hot and cold water pipes and the drains. This would reduce the time required to complete the entire house by several days or even weeks.

If there are elements that lend themselves to pre-fabrication off site the contractor can take advantage of this in the programme. If there is a shorter period spent on site, the contractor will make more profit

if the additional expense for pre-fabrication off site and transport of the element to site is less than the general overheads of being on site for a longer period using in-situ construction methods.

There is the possibility of better quality control and quality testing of elements if they are fabricated off site. Structural welds can be x-rayed where they are manufactured in a workshop much more easily than when they are at the top of a structure.

Precast elements

Precast elements can assist greatly in the speed of construction and also improve the quality of the works. There are several suppliers of precast concrete items and it can be an advantage to purchase directly from these suppliers. Alternatively, the contractor could set up a precasting yard to manufacture elements prior to their being required in the works.

Typical precast elements include kerbs, kerb inlets, pipe markers, stormwater pipes, lintels and culverts. There are also decorative items such as window sill mouldings or architraves available from these suppliers. Specialised concrete items can be made by the contractor on site to facilitate the works such as concrete tunnel lining segments or specially shaped stormwater drain sections.

Prefabricated elements

Not all prefabricated items are made of concrete. Entire warehouse building structures can be prefabricated in a workshop, disassembled and then re-assembled on site. Structural steel and wooden roof trusses are the most common sorts of prefabricated elements to be found on site. Ceiling cornice mouldings made from polystyrene are another example of saving time and expense by providing a finished product that is quick and easy to install compared to plastering the section.

The contractor can cut substantial time off the programme by using these prefabricated elements and reduce the resources that are needed to complete the works.

Specialist manufacturers

Certain built-in plant is manufactured only by certain specialist suppliers. Items such as high voltage electrical transformers or switchgear cannot be purchased from the local hardware store and require special attention. The contractor must identify these "special" items early in the contract in order to ensure that they can programme the work around the delivery dates of these items which often have long lead times.

Lead time

Specialist suppliers also typically supply items that are not very common. This means that each item may have to be specially made for the project and such items require a long lead time before delivery. The lead time for some items can be quite short whilst others can be months or even years.

Installation

Specialist suppliers are often the only ones who can install their special items. Hydraulic loading bays are another example of these specialised items and the lead times can be several months for delivery. The installation of these is another problem that should be considered when programming the works. Not only does the surrounding work need to be completed before the loading bay equipment is installed, but the loading bay suppliers need to be warned well in advance to be available to come and install the item. This is a variable that the contractor needs to take into account in the programme.

Section 3.7: Quality

What is quality?

Quality is defined as "conformance with requirements". In the case of the construction industry the requirements are the specifications and contract drawings. These two documents are used by the contractor during the construction phase to assist with the achievement of quality on a project. It is important not to confuse quality with luxury.

A house built with face bricks will have a different outcome to one built with stock bricks. The specifications for laying face bricks differ from that of laying stock bricks that will be plastered afterward. Stock bricks do not need to be laid to the high level of tolerances that face bricks are since they will anyway be covered with plaster. The bedding joints do not have to be as regular or as neatly executed as those for face bricks. When the walls have been built the result will be a quality job if they comply with the specifications, however, there is a difference in the look, maintenance and performance of the finished product.

Quality is not a programme; it is an approach to business. Results (performance and financial) are the natural consequence of effective quality management.

The price of non-conformance

The cost of all the corrective actions that had to take place due to the contractor's failure to comply with the specifications is known as the "Price of Non-conformance" (PONC).

The reason why a mistake is made is most often because of not checking a drawing to confirm the requirements or not reading the project specifications properly. **It is essential to avoid re-doing work because this is a direct cost to the contractor. The cost of re-work extends to:**

- Demolition of the work done that does not conform to specification.
- Re-construction of the work done.
- Wasted materials resulting from the work that had to be demolished.
- Delay to work that was programmed to continue directly after completion of the work that had to be demolished.
- Overheads on site and at head office that are incurred due to the delay.
- Most importantly, the loss of confidence that the employer has that the contractor is competent to perform the work.

It is far better to take slightly longer to do the job right the first time than to rush the work and have to demolish and re-build. The saying **"do it right first time"** is accurate, but could be enhanced to **"doing the right things right first time".**

Quality control

Quality control is an essential part of the construction process. By proper planning and careful work any construction project can be completed correctly without having to re-do any of the work that is required. This control over the work to prevent making mistakes is known as quality control. The old adage that **"prevention is better than cure"** is most definitely applicable in the construction industry.

By ensuring that quality work is being done from the start, the contractor ensures that when the work is complete, it complies with the specifications and there will be no call to re-do any of the sections he has completed.

The cost of quality control is cheaper than the cost of non-compliance, defective work and re-works. It involves anticipating problem areas before they reveal themselves, double-checking specifications, providing incentives to staff members for carrying through the quality plan or undertaking spot quality checks on site, testing and seeking advice from people the contractor trusts.

Quality plan

A quality plan is a document specifying the processes, procedures and associated resources which will be applied by whom and when to meet the requirements of a specific project or contract.

A quality plan should indicate how the required activities will be carried out e.g. in the case of excavations for a building to ensure that:

- The excavations have been done to the dimensions given on the drawings.
- The sides of trenches are vertical and the bottom of the trenches level.
- The inspections of footings by the local authority/building inspector/engineer (if reinforced) are carried out before the concrete is cast.

The quality plan should also identify the individuals who will be responsible for carrying out inspections.

Accordingly, the quality plan should:

- Establish and document the quality control procedure which is to be implemented on site to deal with each main activity that may be undertaken, such as:
  - setting out;
  - site establishment;
  - site administration;
  - health and safety;
  - human resources;
  - financial controls and payment certificates;
  - production in respect of each construction activity, e.g. excavations, brickwork, painting, etc;
  - quality monitoring and testing;
  - liaison with the employer and the professional team;
  - temporary works design; and
  - equipment maintenance and efficient operation.
- Provide quality control sheets for each activity.
- Assign responsibilities to people to carry out daily inspections and in preparation for any activities to be carried out.
- Require that quality control sheets are signed off by a designated responsible person.
- Require that copies of quality control sheets are kept on file for audit purposes.

Quality improvement process

Quality Control (QC) in a construction business is the control of quality within the various projects that are being undertaken. The contractor should devise a way in which it can improve the quality of its work. The way in which quality is improved is known as a Quality Improvement Process (QIP).

The following steps can be taken to ensure the continual improvement of the quality of products and services offered by a contractor:

1. Management commitment

The contractor's senior management must be committed to improve the quality of the work that the contractor does, otherwise the employees will not believe that it is important to improve the quality of the work that they perform.

2. The quality improvement team

A team should be dedicated to run and monitor the quality improvement process. Without consistent monitoring the improvements in quality cannot be measured and where there is no visible outcome the quality improvement process will fail.

3. Consistency of work and standardisation

A contractor may have several sites with different personnel on each of these sites. It is important that the contractor is consistent in the work it produces. It is of little benefit to have one good foreman who always produces a good end result and two other foremen who always battle to hand over projects. The contractor should set up systems and standard methods of approaching the work that they do in order to produce a consistent quality. To do this the contractor might get the "good foreman" to come in and discuss the systems that he uses to ensure that his work runs smoothly, document these systems and then instruct their other foreman to comply with them.

If there is a standardised approach and systems in place, there is no excuse for anybody who works within the contractor's organisation to say that "I thought it was close (good) enough". Something is either right (conforms to the specifications), or it is wrong (does not conform). However, this does not mean to say that everything must be perfect. Good construction practice allows various tolerances and the contractor should ensure that the work they perform is always within these tolerances. Conformance with specifications means constructing the works within the specified tolerances.

A tolerance is an allowance made for something to deviate in size from a standard or the limit within which it is allowed to deviate.

Unless the contractor produces consistent quality work it will not be in business for very long. There may be a quick profit on one job but there will be no repeat business if the quality of work is poor.

4. Measurement of the Price of Non-Conformance (PONC)

Measurement is the only way in which the contractor can assess how well it is doing in its quest for a quality product. Each time a mistake is made the contractor should keep a record of the cost of rectifying the works. It is more difficult to measure the loss of credibility with the employer or professional team.

The contractor would have made an allowance in the tender for time spent by the site agent with the client to go through the project quality checks and hand over of the works. The contractor should also have priced the cost of a finishing team in fixing up the snags as a result of the final inspections. This amounts to the costs that were allowed and what constitutes conformance to requirements. Any additional work done over this allowance is due to the contractor's non-conformance to the requirements.

All the re-work costs (PONC) must be added up on each project and the PONC for each project should be noted. The PONC of all projects could be displayed on the contractor's notice board, website, in a marketing brochure, or discussed at company meetings to make sure that everybody knows the seriousness of the pursuit for quality and that improvement from each employee is expected on each of their subsequent projects. Monitoring can be done on an ongoing basis and is not restricted to the end of a project.

5. Cost of quality

The cost of quality is constituted by the cost of conformance (COC) (the cost of doing things right) and the cost of non-conformance (CONC) (the cost of doing things wrong). The CONC is useful as it can be related to an organisation's monetary business volume and the percentage contribution thereto can be computed. The cost related to the achievement of quality is comprised of the cost of conformance and the cost of non-conformance. Non-conformances result in rework. Each person

within the contractor's team needs to be made aware of the price of non-conformance associated with the poor habits that they have picked up. By ensuring that each person is aware of the cost that they are incurring to the contracting organisation and incentivising them to improve, they will try to reduce the PONC as much as possible.

6. Awareness

A Quality Improvement Process must be implemented throughout the contracting organisation. All employees must be made aware that there is a process underway to improve the quality of the work performed and thereby improve the profits and repeat business.

7. Corrective action

The contractor must learn by the mistakes made on current projects and set up systems to ensure that the same mistakes are not repeated. The contractor should make it standard practice to do a project close out analysis which can identify where there were mistakes made that could be avoided in future projects. These changes should be incorporated into the contractor's operations manual.

8. Zero defects planning

Strive for zero defects and determine what must be done within the contracting organisation to achieve zero defects. Each time a mistake is made and work has to be repeated the profitability of the contractor is affected.

9. Employee training

The contractor should provide training to all employees to enable them to actively participate in the quality improvement process. This can be done by means of courses that are run by various external organisations or, depending on the size of the contracting organisation, even the foreman or a skilled artisan should take time to show the workers how to perform the specific tasks correctly.

10. Goal setting

Together with the measurement of the price of non-conformance comes the ability to set targets. The contractor should contemplate setting goals that are reasonable and achievable in the quest for zero defect.

11. Recognition

Active recognition and support to those staff members who actively try to improve the quality of their work must be encouraged. When the targets that were set have been achieved there must be some form of recognition in order to motivate others within the contracting organisation to put every effort into improved quality.

Successful handover

Striving to improve the quality of work, ensuring that work complies with the specifications and good building practice will ensure that the successful handover of the contractor's project on completion is a happy and satisfactory one rather than one that ends up in a dispute.

Contractors that do not get their quality right and continually go into disputes with clients will soon go out of business because no one will want to use them on their projects.

Section 3.8: Managing resources

Supervision

Resources are a core element of the contractor. These constitute materials, labour, plant, equipment and, of course, the management skills to be able to coordinate them all in order to produce a finished product.

Supervisors on site have the responsibility to ensure that the resources available on site are coordinated in an efficient manner so that production on site as a whole is optimised. It will not benefit the project as a whole if the single tower crane on site is being used to support a single shutter for oiling if the bricklayers have insufficient bricks available to lay on the sixth storey or they are out of mortar to lay them.

Supervisors, from the Contracts Manager through Site Agent, General Foreman, Charge Hand and Gang Boss need to understand that they need to work together as a team to plan their resource requirements well ahead of time. Poor supervision can mean that the project makes a loss, and can even cause the contractor to go insolvent through penalties for not completing the work on time or to the required standard.

Supervision on site is the key to optimising the production on site. Supervisors are required to plan ahead and order materials required for the works well ahead of time to ensure that the work does not stop whilst waiting for delivery. They also need to ensure that workers know exactly what they are required to do and in what sequence. Supervisors must also be able to motivate their workers to improve their productivity and complete the work to the required standard in the available time.

Problem solving

Every site will encounter problems. These come from unexpected events or conditions and a solution needs to be found to minimise the risk or to proceed with the works.

When problems arise, these tend to cause production to stop or at best slow down. It is best to try to anticipate problems and put measures in place to avoid them but not everything can be foreseen. When problems do arise there needs to be a standard procedure for notifying the responsible person of the problem and asking for guidance on how to address the problem. If there is a clear line of communication, then this process can be made very quick, easy and simple. The line of communication will go up the ladder to the point where the person who is able to resolves the problem.

Problems can be solved by amending the work methodology, the timing or sequence, the tools to be used or by stopping work until the problem goes away (e.g. when it rains). It must be remembered that at all times the best interests of the project must be considered when deciding what solution to choose.

Work methods

Different methods of working require different resources. As such, the work methods need to be matched with the resources available and the time that they are required to be completed in.

For example, excavation of a trench can be done in many different ways, each of which is best suited to the conditions. For very deep, narrow trenches, an excavator with a narrow bucket may be the correct and most efficient answer but the project safety requirements need to be taken into account. For a shallow trench it might be quicker, cheaper and more cost effective to excavate by hand.

Equipment comprises items that a contractor uses to construct the work.

Plant comprises apparatus, machinery and items which are incorporated into the works.

If labour and equipment are not managed correctly, a contractor will be paying more than they should for the value that they are getting. One can never get a "man hour" or an "equipment hour" back; it's like time, when it's gone, it's gone.

Labour intensive work is strongly promoted in the construction industry because there are many tasks that can be done by hand that are as efficient or cost effective as using heavy machinery.

Different sequences can greatly enhance the time of delivery. For example, it might be easier to dig out the material if it is wet but to transport it means that water contained in the soil is also transported. This can lead to overloading of trucks and the consequential loss of productivity due to the truck being stopped at a weigh bridge. Excavating the material dry and transporting it dry will take the load from the trucks and spread it more evenly but it may place more pressure on the excavator that digs it out of the ground. This can be optimised to suit the capability of the excavator and the number of trucks that are available to produce the best productivity at the least cost per cubic metre.

Incentive schemes

Financial incentive schemes may include:
- Profit share (payments on the basis of profit earned).
- Piecework (worker is paid a rate per unit of production).
- Task work (worker is paid for a task completed).
- Bonus for a team's productivity.

Motivation is a factor that can be easily influenced. There is always a cycle of motivation during a project. At the start, everyone is very excited about the new work and they are normally highly productive and keen to get the job underway. As the project progresses, however, motivation can flag dramatically due to problems encountered that hinder the team from achieving the allowables or the productivity goals that are set.

Another factor that works against construction projects is the fact that they are always a temporary job. When the project nears completion, motivation is normally at a low point, since those people employed for the project see the end of the project approaching and with it their having to look for a new job. This prospect of a possible lack of income at the end of a project can be a major factor in trying to extend the duration of the job by slowing down the productivity rate.

One way of improving motivation is to implement an incentive scheme of some kind. Different kinds of incentives can be implemented, depending on what will motivate the particular part of the workforce the best. **Incentives contain several elements:**

- a target;
- a timeframe; and
- a reward.

The most common incentive is a financial bonus if a specific productivity target or completion date is achieved. This addresses to some extent the "end of job" syndrome but cannot eliminate it completely. Time off or a special treat such as a braai with the site team on a Friday afternoon can also help to get the team motivated. Another method is to set specific tasks for the day that are to be achieved. If the target is set correctly it will stretch the worker to finish in the time initially planned but it may be quite easily achieved once they have worked out a system to optimise the activity. Letting people go home for the day once they have finished their task is also a good incentive.

Always communicate productivity targets to staff.

Incentive schemes are good motivators but they can also destroy morale entirely if the goals are not set appropriately. If a goal is set so high that it may never be achieved it will have the opposite effect and de - motivate the workers dramatically. Likewise, if the target is so easily achieved that the bonus is always paid out it will be considered a "right" by the workers. If the reward is not immediately available it can also lead to de-motivation and angry workers.

Take the example of a labourer who is employed for 10 days and is paid for 10 days. If he worked only 50% efficiently he will have been paid for 10 days and only produced 5 days value for the contractor. Increasing productivity will always be a cost saving to the contractor.

Maintenance of equipment

Equipment needs to be maintained to ensure that they are in good working order. Breakdowns have a negative impact on productivity. Heavy machinery comes with a recommended schedule for servicing and maintenance which should be adhered to, to ensure the long life of the machine and the proper production rates it should be capable of. It is also important to remember that smaller equipment also requires maintenance and servicing and if neglected can also break down and cause delays.

Some items will require daily servicing. These services should be scheduled for times of the day when the machines are not in use so that the servicing does not impact on productivity. Typically, machines are serviced overnight or during a break when the operators have lunch. This means that the productive times of the day for the operator are as long as possible.

If a critical piece of machinery, such as a grader, is damaged and needs serious repairs it can have a major impact on the works, since other pieces of equipment, operators and labour will be at a standstill while waiting for the grader to be put back into operation. It would be better to stop the grader for an hour or two to do repairs than to push on to try and achieve the day's production, with the result that the grader is out of action for two or three days whilst a special part is sourced and delivered to the site.

Maintenance of concrete shutters is another example where good care can extend the productive life of the shutters. Timber shutters are normally used only two or three times, however, if they are properly cared for it could be extended by properly oiling the boards before casting and ensuring proper handling of the shutters when stripping. The result is significant savings on the costs, time and material for building and making of shutters. The overall costs can be drastically reduced by spending a little time on maintaining them and taking care in the handling and storage of the shutters.

Simple things like cleaning shovels after casting concrete can also save time and money. Cleaning the shovel immediately after use means that the concrete residue can be easily washed off, leaving the shovel smooth. If it is not cleaned and the concrete residue is left to stick to the shovel it will make it very difficult to use again and will probably be thrown away. A little maintenance can go a long way.

Storage of materials

Some materials are regarded as consumables. For example, unlike bricks, cement in pockets or in silos can deteriorate over time and reach a point where it cannot be used. Careful management of these resources is therefore extremely important as materials that have deteriorated to an unacceptable state cannot be incorporated into the works and will have to be disposed of and replaced. Cement silos need to be in good condition before it can be used and time taken to prepare them will be well spent. Using materials after their **"expiry date"** may mean to break down what has been constructed and start again.

When resources (like bricks) are completely **"storable"** they need little management other than ensuring that they have been stored correctly and that they are secure from theft or damage by falling over. Plant and labour (including security) cannot be stored and therefore need full time on-site supervision and careful management.

Goods that can deteriorate need special attention. Typically these items have a shelf life and must be used within that time or will have to be thrown away. Once the expiry date has been reached the item will not perform as it should. An example of this is a chemical resin anchor that is used to set threaded studs into concrete or rock. These types of goods need to be managed on a first in, first out basis but will always have to be checked before use to see that the expiry date has not been reached.

Materials must not be temporarily stored adjacent to or within a structure or service in a manner which overloads the structure or service or any portion thereof.

When managing materials it is good to always consider the "storability" of materials.

Materials should be stored in accordance with the manufacturer's instructions and protected in such a manner that any deterioration, distortion, damage or contamination does not impair their performance when incorporated into the works.

Section 3.9: Finishing the project

What is completion?

Completion of the works generally occurs when the works reach a state of readiness for occupation of the whole works although some minor work may be outstanding. Completion of the contract occurs when all obligations have been discharged.

Completion of the works is usually followed by a defects liability period during which the contractor is obligated to make good any shortcomings in the materials and workmanship covered by the contract that are indicated by the employer or his representative (engineer, principal agent or project manager). The completion of the contract cannot take place before the expiry of the defects liability period.

Failure to follow procedures provided for in the contract can lead to:

- late payment;
- delays in the release of retention and performance bonds; and
- the employer applying the financial penalties provided for in the contract for late completion.

Completion of the works triggers the release of performance bonds and the reduction in retention monies. The completion date for a contract is usually linked to the completion of the works. Failure to do so may result in penalties (or liquidated damages). Consequently, it is in the contractor's interests to complete the works as soon as possible.

Each of the forms of contract supported by the cidb has different administrative procedures in bringing the works and the contract to completion. **It is very important that contractors familiarise themselves with the procedures that apply to their specific projects.** The diagrams at the end of this guideline illustrate the procedures that are provided for. Clause references are provided for ease of location of the detailed requirements.

Defects or "snag" lists

A defects or **"snag"** list is typically issued by the employer's representative around the time that completion of the works is certified. Such a list, depending on the form of contract that is used, will typically indicate what needs to be completed prior to certification of completion or what needs to be corrected during the defects liability or correction period.

Contractors will do well to prepare their own **"snag"** list prior to requesting the employer's representative to certify completion. This will minimise the risk of not obtaining a certificate as a result of defects found that prevent certification.

Each defect notified by the employer's representative during the defects liability or correction period should be added to the snag list. Defects that are rectified should be removed from the list.

A final walk through the works should be arranged for all the parties involved in the contract just prior to the end of the defects liability or correction period to confirm that all defects have been attended to.

The contractor should not accept the addition of defects to the list that have been caused by the employer's or client's use of the facility, and only accept defects relating to work not in accordance with the provisions of the contract.

Post works completion checklist

A post works completion list should include all items that need to be finalised before the end of the defects liability or correction period. Items to be checked include:

1. Site related issues:
   - Ensure that the site is cleared properly with no rubble, equipment or unused materials left lying around.
   - Ensure that temporary water, electrical, sewerage and telephone connections are disconnected and that the paper work for discontinuity of these services are completed.
   - Remove all contract-related signage.

2. Site administration:
   - Ensure that all files and paperwork are completed and in order, since there could be supplier and subcontractor invoices outstanding and the final accounts will not yet be completed for the project.
   - Ensure that all documentation is properly filed in a safe place. (It is advisable to keep all project information for a period of three years.)
   - Check that all subcontractors have submitted their final accounts and been paid accordingly.
   - Ensure that all hired equipment has been returned.
   - Close insurance cover for the works.
   - Close petty cash.

3. Contractual
   - Complete all items on defects list (snag list).
   - Request the return of performance bonds and securities, if any.
   - Request return of retention guarantee, if any.
   - Return subcontractor guarantees.
   - Obtain signed completion documentation as provided for in the contract.

4. Financial
   - Close financial accounts for the project for domestic subcontractors and nominated and selected subcontractors.
   - Recover deposits paid for temporary connections to services such as electricity, water, pavement deposits and pavement fees not used.

5. Feedback to estimating section:
   - Ensure that all information regarding costs on the project, particularly related to allowables, is provided to those people in the contractor's head office that are responsible for estimating and tendering for new work.

6. General

   Double check that all files are completed with respect to:
   - Drawings.
   - Site instructions.
   - Scope changes.
   - Confirmation of verbal instructions that have been obtained.
   - Programme and programme updates.
   - Budget and budget updates.
   - Minutes of meetings etc.

Record drawings and manuals

In terms of the contract the contractor is also required to provide as-built or record drawings, i.e. drawings that record construction works as completed. For example, where SANS 1921 - 1, Construction and management requirements for works contracts Part 1: General engineering and construction works, forms part of the scope of work, the contractor is required to provide within 40 working days of the works being completed, record drawings indicating all deviations from the construction drawings.

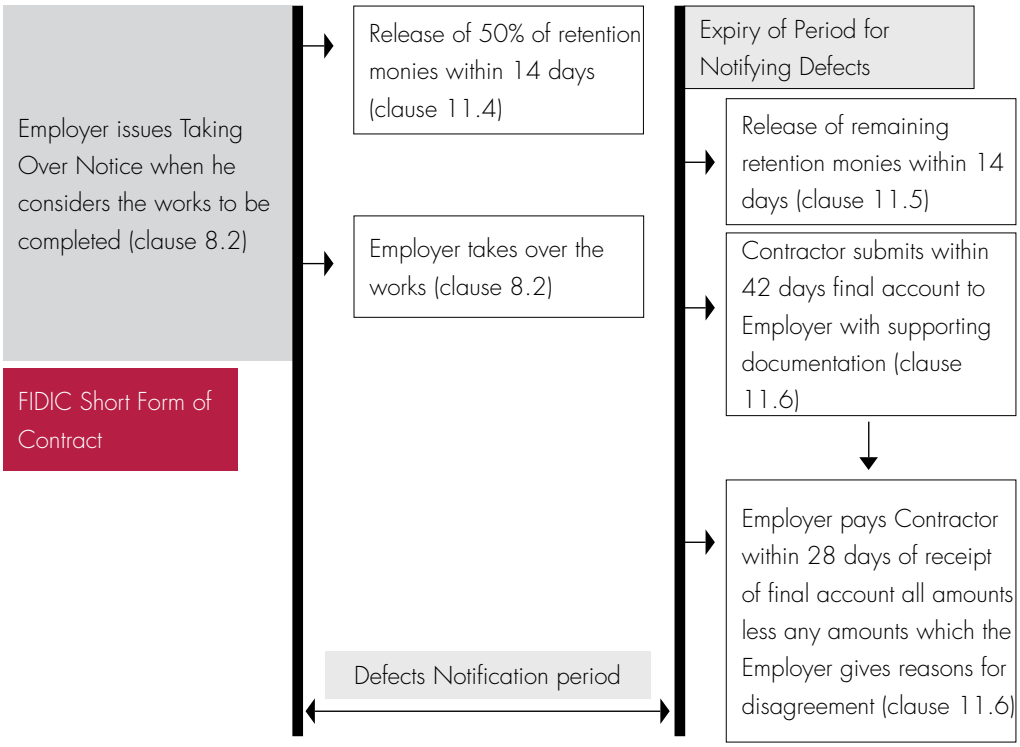
When work is planned and designed, many assumptions are made that may not be correct when it comes time to construct. As such the works may be constructed differently to what was originally designed. The employer must have these details correctly recorded for future maintenance and possible additions or alterations that may be needed later on.

The contractor is often required to provide this as-built information and annotated drawings to the employer or the engineer so that the final configuration can be recorded. This information is often in the form of marked-up construction drawings; however, additional data is sometimes also required such as the GPS coordinates of valves and fire hydrants that have been installed.

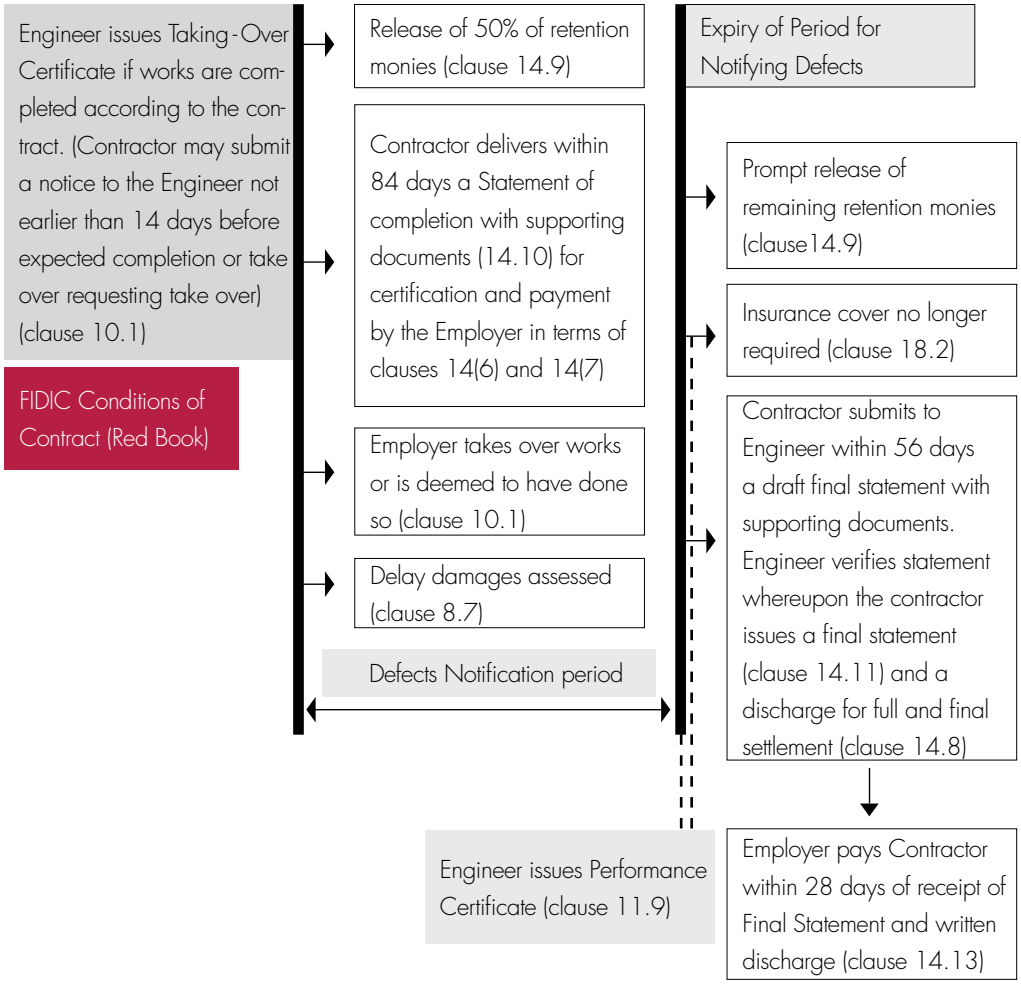
On some projects the contractor is required to hand over operation and maintenance manuals which enable the end user to operate the plant that is provided or to take care of and service such plant.

The contractor's work is not complete until he has provided all this information in the format that the client requires.

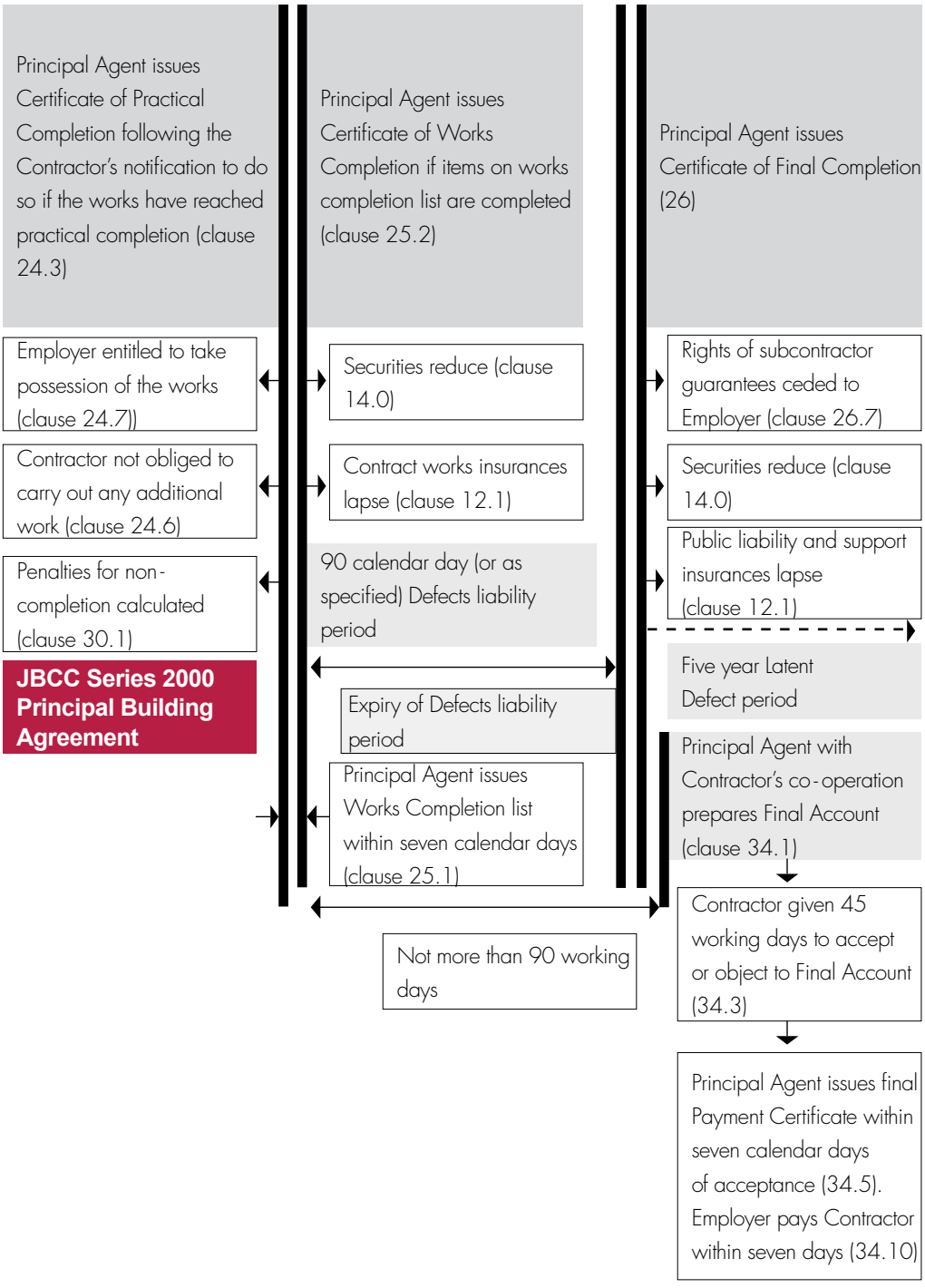
The following procedures are provided for in the FIDIC Short Form of Contract:



The following procedures are provided for in the FIDIC Conditions of Contract for Construction for building and engineering works designed by the employer (Red Book):

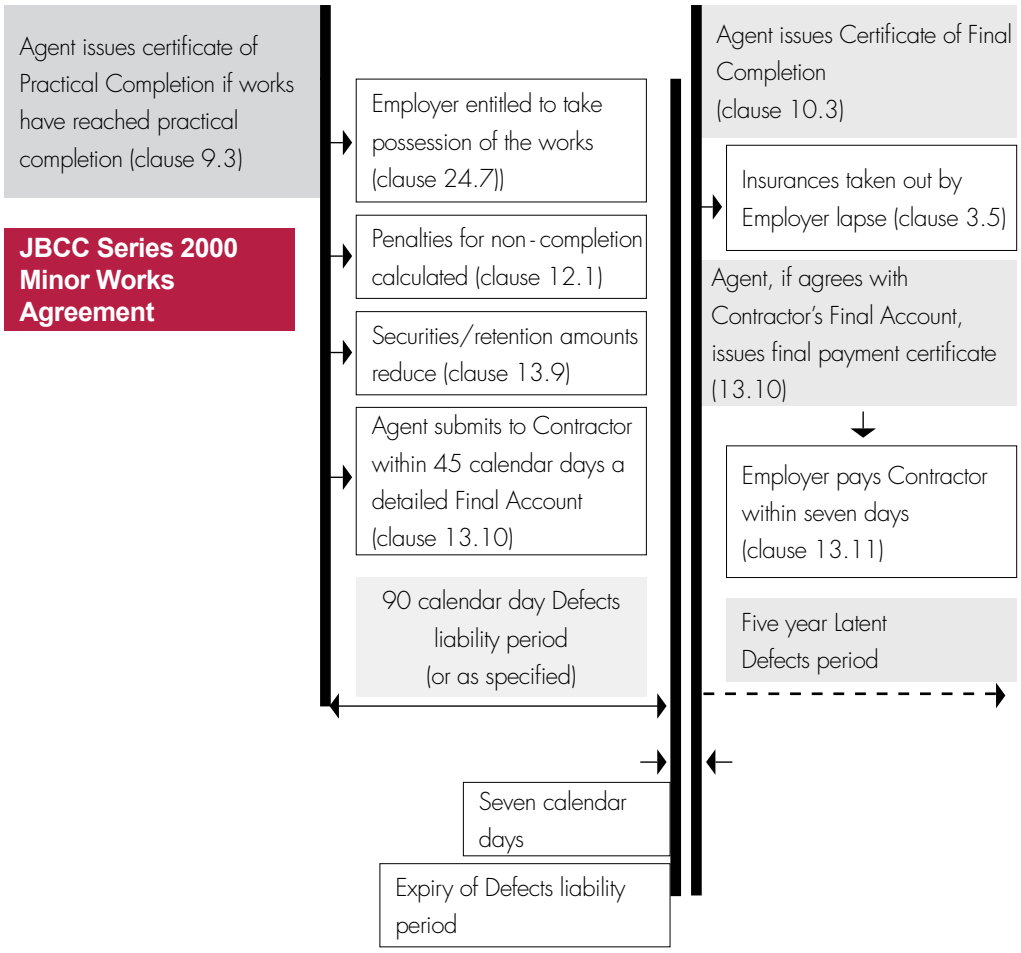


The following procedures are provided for in the JBCC Series 2000 Principal Building Agreement:

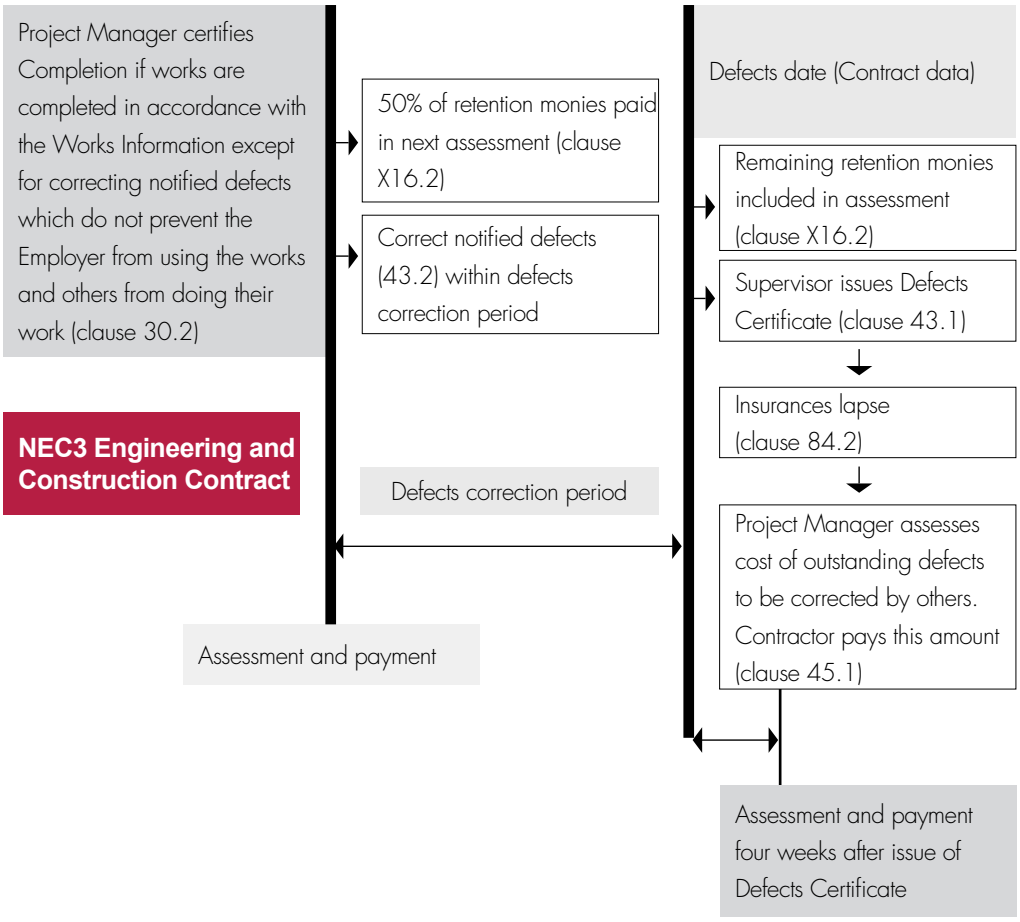


The following procedures are provided for in the JBCC Series 2000 Minor Works Agreement:

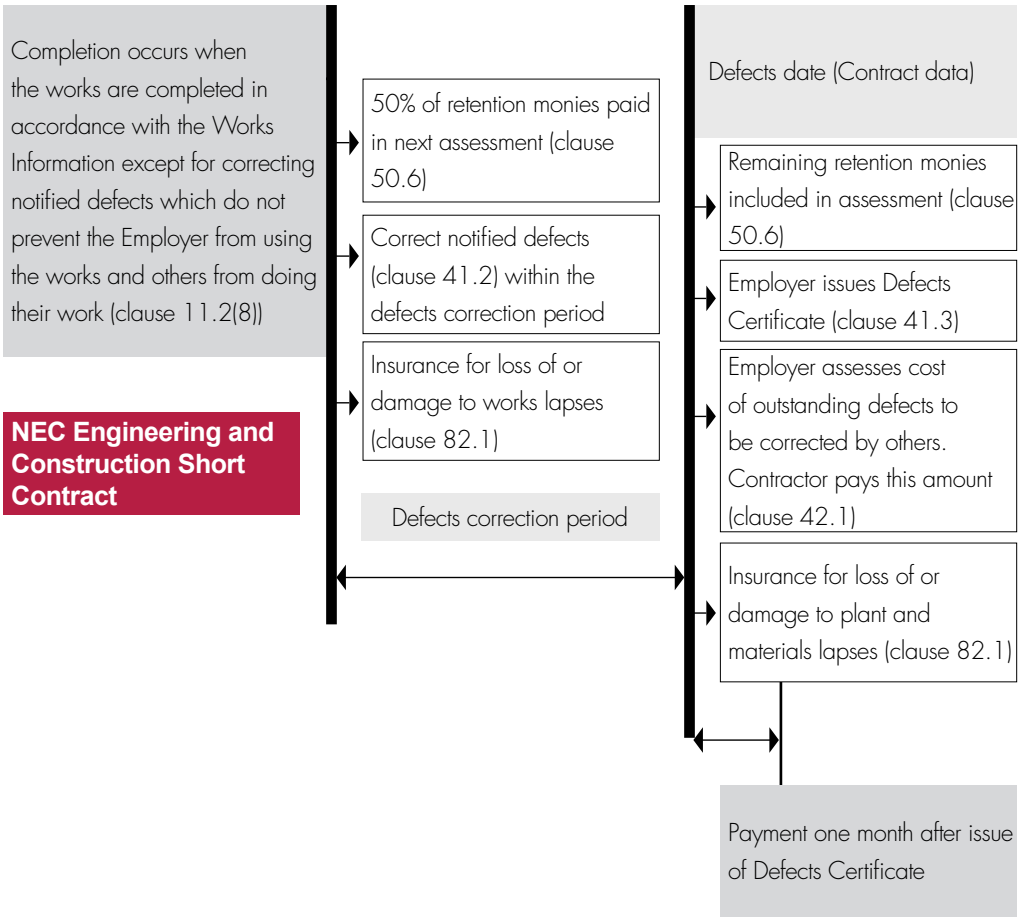
JBCC Series 2000 Minor Works Agreement



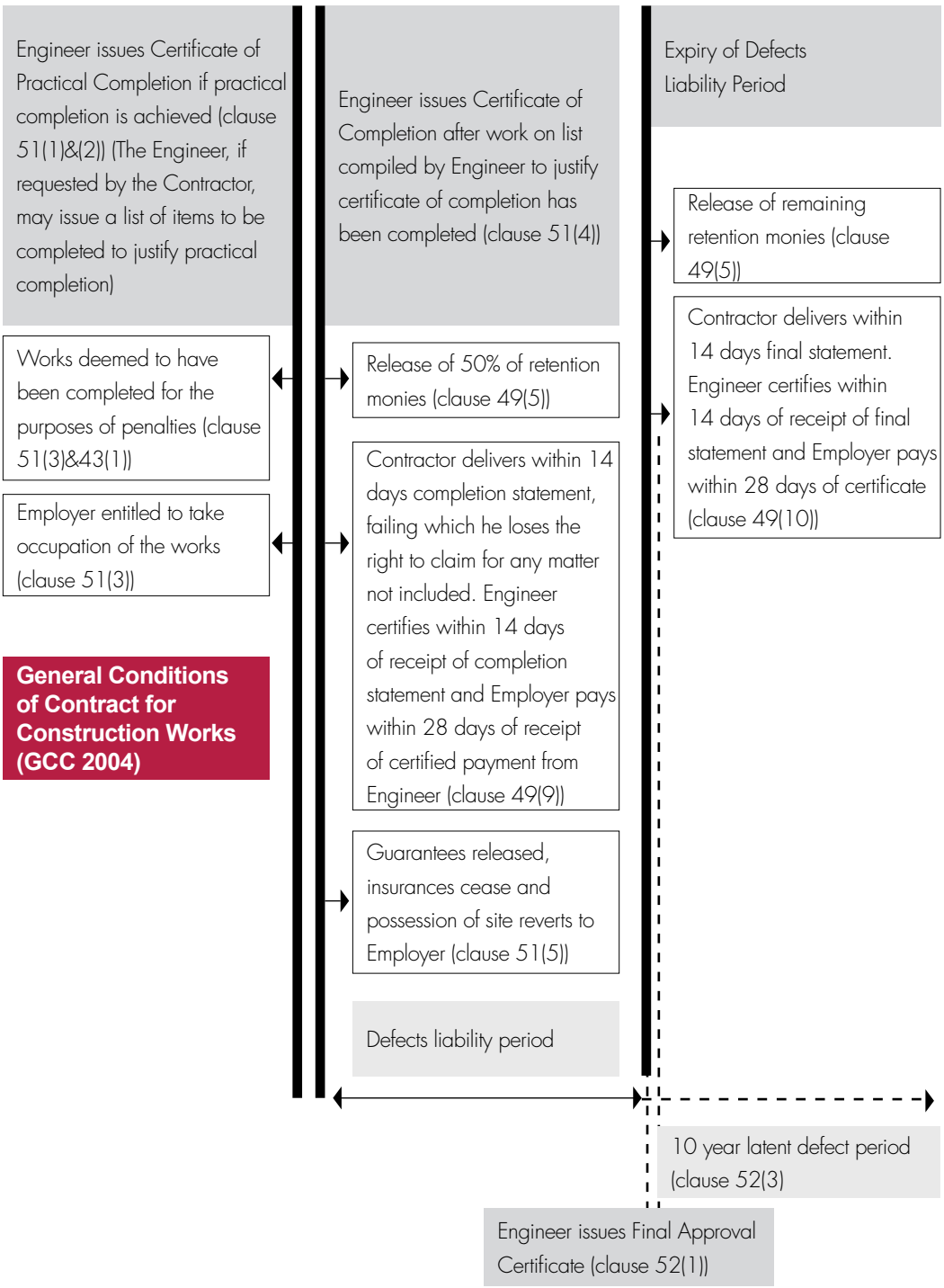
The following procedures are provided for in the NEC3 Engineering and Construction Contract:



The following procedures are provided for in the NEC3 Engineering and Construction Short Contract:



The following procedures are provided for in the General Conditions of Contract for Construction Works (GCC 2004)



Section 3.10: Controlling project risk

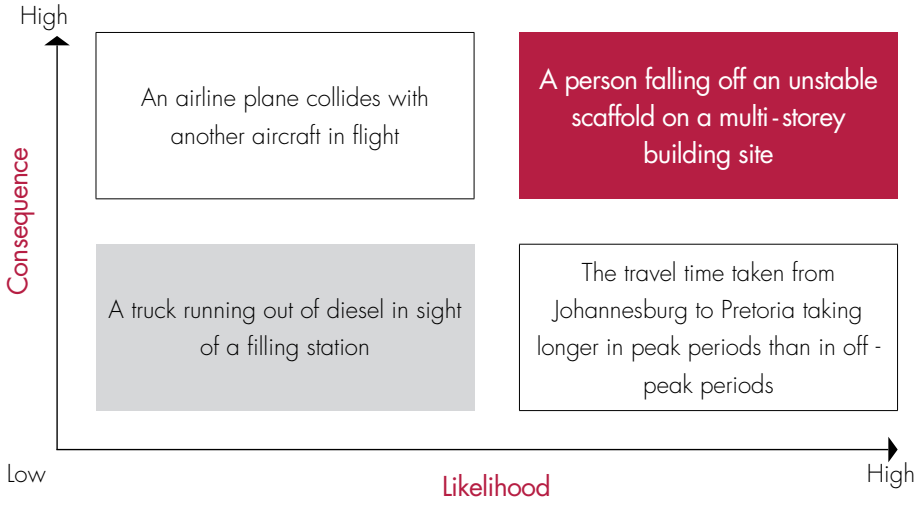
What is risk?

Risk is the chance of something happening that will have an impact upon a project's objectives.

Risk has two elements, namely:

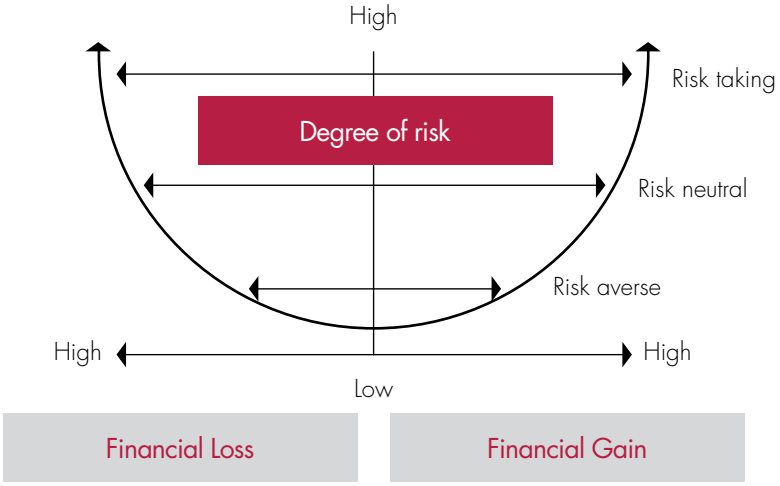
- The likelihood of an unwanted event.
- The consequences when it happens.

The likelihood and consequence of an event are combined to indicate the severity of the risk.



Risk and opportunity go hand in hand. A contractor may be described as being:

- Risk taking – high risks are taken that result in the reaping of higher than average rewards when things go well and huge loss of money when things go wrong.
- Risk neutral – only an average number of risks are taken that result in average financial rewards.
- Risk averse – risks are avoided that result in smaller but more consistent financial rewards.



No construction project is risk free. Risk has to be managed, shared, transferred or accepted. It cannot be ignored.

Risk may be transferred. Legal duties and responsibilities cannot be transferred.

Risk and opportunity go hand in hand. Measures taken to control risks may have a beneficial aspect on some other aspect of the work.

Possible risks that a contractor faces are:

- The tender price may be too low or the costs on site may increase.
- The work may be more difficult than realised and take longer to complete, resulting in penalties.
- The employer may not pay in time or at all.
- Subcontractors may not do their work properly.
- The agent may make changes which cause extra costs or delays.
- There may be delays caused by bad weather or strikes, or suppliers not delivering materials.
- The work may be defective because it is not according to the contract drawings or the specification and may have to be redone.
- Work done may be damaged or destroyed by external forces.

What are the common sources of risk on a construction project?

There are many sources of risk on a construction project which may be categorised as follows:

Source	Examples of risk
Client	The client delays payment or does not pay for work done
Commercial	The tendered amount is insufficient to cover costs
Community	The community is opposed to the project
Construction	Heavy rains delay the construction programme
Contractual	The inflation adjustments provided for in the contract are insufficient to cover the real cost of inflation
Environmental	Raw sewerage spills into the water course
Financial	Bank won't provide sufficient bridging finance
Labour	Labour strikes during the project
Market	The tender is awarded to another contractor due to high levels of competition in the market
Natural	The site is susceptible to flooding
Occupational health and safety	A worker is killed during construction
Quality	Labour is insufficiently skilled to achieve required quality
Safety	Criminal acts and acts of vandalism occur
Transport	Vehicles cannot access the site in the raining season

Measuring risk

Approximate scales may be used to measure the likelihood of a risk occurring based on judgment. The consequence may be measured in monetary terms, time delay and severity of accident or injury. Alternatively consequences may be measured on approximate scales.

The simplest scale is a three point system where the likelihood and consequence of the risk are assessed as being low, medium and high. The risks may be described as low, medium or high based on the scales for consequence and likelihood as follows:

		Likelihood		
		Low	Medium	High
Consequence	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Medium	High	High

If numerical values are assigned to both the consequence and the likelihood, the risk may be scored by multiplying the likelihood by the occurrence. For example, if low is assigned a value of 1, medium a value of 2 and high a value of 3, the risks may be assessed in terms of a number between 1 and 9. The scoring of risks allows risks to be ranked.

		Likelihood		
		Low (1)	Medium (2)	High (3)
Consequence	Low (1)	1	2	3
	Medium (2)	2	4	6
	High (3)	3	6	9

Risk management

Every person is involved in risk management on a daily basis. Decisions have to be made whether or not to cross a road, overtake another car or to deposit money in a particular bank. The risk management that is applied in daily life is usually instinctive and is as such managed by judgment and experience.

Construction projects are full of uncertainties. Risk needs to be managed in a systematic manner in order to improve the likelihood of projects being completed on time and within the tendered price. The identification of a risk ensures that a contractor is not caught by surprise. Management of the risk ensures that the impact of the risk is reduced.

Risk management is all about making informed decisions, minimising potential damage or loss and controlling uncertainties. Once a contractor is aware of the risks that a particular project or activity involves, informed decisions can be taken regarding different courses of action. It also focuses efforts and energies into dealing with the areas that might have the potential to cause time delays and cost overruns on a project. Consequently, risk management is also about opportunities for improving the way in which a contractor operates.

The main elements of the risk management process are:

1) Identify the objectives of the risk assessment for the project, activity or group of activities and define the criteria against which risk will be evaluated, e.g. to return a particular profit level on a project, to complete a project ahead of time, to complete a project without any major accidents, etc.

2) Identify the hazards (sources of potential harm or a situation with a potential to cause loss) i.e. what can happen and why can it happen.

3) Determine the existing control measures and analyse risks in terms of consequence and likelihood in the context of those controls.

4) Evaluate risks by comparing against the pre-established criteria.

5) Rank risks to identify priorities.

6) Treat risks by developing and implementing a specific management plan or accept risks and monitor low priority risks.

The performance of the risk management system should be monitored and reviewed at regular intervals to ensure that it reflects any changes which might affect it. Risk management is a continuous process.

Risk management may assist a contractor to:

- Save money and improve profitability.
- Reduce accidents.
- Deliver project on time.
- Reduce the chances of disputes arising.
- Enhance the reputation of the business.

Risk cannot be eradicated but can be managed. It is better to be proactive rather than reactive.

Working together reduces risks.

Risk management is an iterative process.

- Always expect the unexpected.
- Risk assessment does not need to be precise to be useful.
- Plan ahead.
- Plan for emergencies.
- Lack of communication is usually one of the biggest hazards.
- People are usually the most unpredictable hazard.

A risk management plan should be developed with inputs and discussions with the contractor's staff and where relevant the employer's staff and agents. This is essential to identify the hazards. Hazards can be identified through brainstorming with others, interviews of team members and reviews of similar projects.

Risk registers

A risk management system needs to be documented. A risk register is a tool for documenting the findings of the risk management process that is followed. The register needs to record at least the source, nature, existing controls, consequences, likelihood and initial risk rating for each risk identified.

There are a number of ways in which a register may be structured and presented. Some examples are:

Health and safety – objective is to complete a project without any major accidents

What are the hazards?	Who might be harmed and how?	What are the safe work procedures for the site?	What further action is necessary (monitoring and review)?	Action by whom	Action by when	Likelihood	Consequence	Risk rating
Collapse of scaffold	All operatives on scaffold may incur crush injuries or worse if the scaffold collapses on top of them.	Bricklayer supervisor to check with the site manager that the correct scaffold is provided and inspected.	Supervisor to keep a check to make sure that scaffold is not overloaded with materials.	LG	Before bricklaying starts.	Low	High	3

Construction – objective is to complete the project on time within allowables

Item no.	Area	Hazard	What can happen and why	Consequences of the hazard happening	Likelihood	Consequence	Risk rating	Control measures		
								Strategy	Owner of strategy	In place (Y/N)
1	Plant and material.	Availability of structural steel roof trusses.	Demand exceeds supply leading to shortage of materials.	Roof cannot be completed and building cannot be handed over to client. Delay will lead to penalties payable of R40k per day.	high	high	9	Order steel as soon as contract is awarded. Follow up order with fabricator on a fortnightly basis.	Site manager.	y

Section 3.11: Specifications

Specifying requirements for construction works

Specifications are required to:

- Describe the construction, the method of construction and the materials to be used.
- Establish the requirements for construction work to be carried out.
- Prescribe requirements to be fulfilled by a product, process or service.

Specifications communicate the client's requirements for construction works or aspects thereof and are usually put together by built environment professionals. Contractors are contractually bound to produce work that complies with the specifications.

The requirements for elements and components of construction works are frequently very similar from one contract to another. As a result, specifications can be standardised by clients or by national standardisation bodies such as the South African Bureau of Standards. South African national standards, which are published by Standards South Africa, (a division of the South African Bureau of Standards) establish commonly encountered requirements for a wide range of construction works and materials that are incorporated into construction works.

South African national standards are frequently referred to by their identification number in scopes of work, e.g. SANS 1215, SANS 50196-2/EN 196-2 or SANS 4427 ISO 4427. They are also commonly referenced in standardised specifications such as those developed by the National Department of Public Works e.g. *Specification of Materials and Methods to be Used (OW 371)* or the Committee of Land and Transport Officials e.g. *Standard Specification for Road and Bridge Works for State Authorities*.

In building and civil engineering works parts of the following national standards are referenced:

- SANS 2001, *Construction works*. This family of standards provides generic technical descriptions of the standard of materials and workmanship that will be used in the works that are executed or in the performance of the works when completed.

- SANS 1921, *Construction and management requirements for works contracts*. This family of standards establishes generic requirements relating to how the construction is to be executed and how construction is to be managed.

These standards are made contract specific though specification data or the construction drawings. For example, SANS 2001-CM1, *Masonry Walling*, covers the construction of masonry walling using bricks or blocks (masonry units) made from burnt clay, calcium silicate and concrete. The specification data or the construction drawings needs to state which type of units are required, whether or not they are to comply with the requirements of a South African National Standard and what the precise materials properties of the bricks or blocks are. The specification data or construction drawings will also need to state what type of masonry bond is required, what class of mortar is to be used, etc.

South African National Standards also specify requirements for construction materials, describe test methods and procedures and provide guidance on how to correctly perform various construction activities.

A tolerance is the range within which a dimension or position lies.

Tolerances

Inaccuracies in the dimensions of constructed items such as foundations, walls, columns, beams trusses, screeds, etc. occur as a result of:

- Human errors in setting out.
- The use of inappropriate, faulty measuring equipment in setting out.
- Poor workmanship.
- Deviations in manufactured articles that occur during the manufacturing process.
- The deflection or settlement of formwork.
- Wear in moulds.
- Erection and assembly procedures.

Specifications usually establish tolerances for constructed articles. The difference between the actual (i.e. measured) size or position and the specified size or position must lie within the limits of these tolerances. Components of the works that fall outside these tolerances may have to be demolished and reconstructed.

Compliance with requirements

Most specifications establish the means by which compliance with the requirements of the standards may be established. Typically this is achieved by:

- Measuring dimensions and positions and confirming that they are within the specified tolerances.
- Conducting specified tests.

The tests, depending upon their nature, can be conducted on site by the contractor itself or an accredited service provider. Sometimes, the contractor is required to take or make samples of materials incorporated into the construction works and forward them to accredited laboratories for testing.

The specifications also often specify the frequency of the tests.

Section 3.12: Concrete, mortar and plaster

What is cement?

Cement is generally defined as a binder, glue or adhesive. Cement in hardened concrete, mortar or plaster forms a matrix which binds aggregates (sand or stone, as relevant).

Common and masonry cements

Common cements are required by law to comply with the requirements of SANS 50197-1 EN 191-7, while masonry cements have to comply with the requirements of SANS 50413-1 EN 413-1. Masonry cements are designed for use in mortar and plaster but are not always suitable for use in concrete or plaster.

Portland cement is a hydraulic cement (clinker) as it sets and develops strength after being mixed with water at normal temperature and pressure and even under water. Extenders (materials which have cementing properties when used with Portland cement) in the form of ground granulated blast-furnace slag, fly ash, pozzalano silica fume, burnt shale or limestone may be added to the Portland cements. These extenders change the chemical properties of cement. Common cements may either be a pure Portland cement or a mixture of Portland cement and extenders.

The Minister of Trade and Industry has issued a compulsory standard for cement in terms of the Standards Act, 1993.

Effects of extenders on the properties of concrete (see Fulton's Concrete Technology)

Granulated blast-furnace slag	Fly ash	Silica fume
Fresh concrete • May improve workability slightly. • Retards setting slightly. **Hardened concrete** • Slows development of strength. • Increases later-age strength, e.g. at 90 days. • Refines pore structure and reduces permeability. • Increases rate of carbonation. • Prevents or retards alkali-silica reaction. • Binds chlorides and reduces the chloride induced corrosion of embedded steel. • Reduces rate of heat generation caused by cementing reactions.	**Fresh concrete** • Improve workability and reduces water requirement for a given slump. • Slightly retards setting. **Hardened concrete** • Slightly reduces rate of strength development. • Increases later-age strength, e.g. at 90 days. • Reduces the rate of chloride diffusion through concrete. • Refines pore structure and reduces permeability. • Prevents or retard alkali-silica reaction. • Improves sulphate resistance. • Reduces rate of heat generation caused by cementing reactions.	**Fresh concrete** • Reduces workability. • Increases cohesiveness. • Reduces bleeding significantly. **Hardened concrete** • Increases strength. • Reduces permeability and improves resistance to chemical attack.

Masonry cements are normally a blend of portland cements and finely ground limestone or hydrated lime. Some masonry cements contain air entrainment agents.

Each of these common cements result in concrete, mortar and plaster which have different properties.

Some common cements have particular applications e.g. to minimise cracking in thin concrete members.

Some common cement types are not suitable for use in plaster.

Further information on the use of different cement types may be obtained from the Cement and Concrete Institute.

Tel: 011 315 0300;
Fax: 011 315 0584
e - mail:
info@cnci.org.za

Masonry cements may only be used in mortar

A cement designation (type) and strength grade are by law required to be shown on the cement packets. The markings on a common cement bag are as follows:

Portland cement EN 197-1-CEM I 42,5 R

The first part of the designation refers to the common cement type and the second part refers to the class of standard strength. The common cement types are:

Main type	Common cement type		Percentage clinker (hydraulic cement) by mass
CEM I	Portland cement	CEM I	95 - 100
CEM II	Portland-slag cement	CEM II/A - S	80 - 94
		CEM II/B - S	65 - 79
	Portland-silica fume cement	CEM II/A - D	90 - 94
	Portland-pozzolana cement	CEM II/A - P	80 - 94
		CEM II/B - P	65 - 79
		CEM II/A - Q	80 - 94
		CEM II/B - Q	65 - 79
	Portland-fly ash cement	CEM II/A - V	80 - 94
		CEM II/B - V	65 - 79
		CEM II/A - W	80 - 94
		CEM II/B - W	65 - 79
	Portland-burnt shale cement	CEM II/A - T	80 - 94
		CEM II/B - T	65 - 79
	Portland-limestone cement	CEM II/A - L	80 - 94
		CEM II/B - L	65 - 79
		CEM II/A - LL	80 - 94
		CEM II/B - LL	65 - 79
	Portland-composite cement	CEM II/A - M	80 - 94
		CEM II/B - M	65 - 79
CEM III	Blast-furnace cement	CEM III/A	35 - 64
		CEM III/B	20 - 34
		CEM III/C	5 - 19
CEM IV	Pozzolanic cement	CEM IVI/A	65 - 89
		CEM IVI/B	45 - 64
CEM V	Composite cement	CEM V/A	40 - 64
		CEM V/B	20 - 38

The three classes of standard strength are 32, 42 and 52. This refers to the 28 day compressive strength of the cement. The letters N and R after the standard strength class indicate ordinary strength (N) and high early strength (R). The R cements have a very much higher two - day strength than N cements.

Cements with low - heat cement are identified by the addition of "-LH" to the cement designation.

The markings in a masonry cement bag are as follows:

Masonry cement EN 413-1 MC 12,5 X

Four types of masonry cements may be produced – MC 5; MC 12,5; MC 12,5X and MC 22,5X. The numbers 5, 12,5 and 22,5 relate to the minimum standard 28 day compressive strength of the cement. The MC 5 type has a substantially lower Portland cement clinker content than the other MC 12,5,

MC 12,5X and MC 22,5X types while the MC 5 and MC 12,5 have very much higher levels of air content than the MC 12,5X and MC 22,5X types.

Not all the cement types described in SANS 50197-1 EN 197-1 and SANS 50413-1 EN 413-1 are produced in South Africa.

Aggregates (sand and stone)

Both the coarse aggregate (stone) and the fine aggregate (sand) must comply with the relevant requirements of SANS 1083, Aggregates from natural sources – Aggregates for concrete. The coarse aggregate usually has a nominal size of 13 mm or 19 mm.

Sand for mortar and plaster is either required to comply with the requirements of SANS 1090, *Aggregates from natural sources – Fine aggregates for plaster and mortar,* for mortar sand (natural or manufactured) and plaster sand respectively, or all of the following requirements:

- Not contain any organic material (material produced by animal or plant activities).
- Not contain any particles which are retained on a sieve of nominal aperture size 5 mm.
- **Mortar:** when 2,5 kg of cement is mixed to 12,5 kg of air-dry sand, the mixture shall not require more than 3,0 litres of water to be added to reach a consistency suitable for laying of masonry units.
- **Plaster:** when 2,5 kg of cement is mixed with 12,5 kg of dry sand, no more than 2,7 litres of water is required to bring the mix to a plastering consistency.

Water

The water used must be fit for drinking.

Concrete mixes

Concrete is specified in terms of its grade i.e. an identifying number which is numerically equal to the characteristic strength of such concrete at 28 days, expressed in megapascals (MPa). For example, a grade 20 concrete is a concrete that has an average 28-day compressive strength in excess of 20 MPa.

The contractor may be made responsible for procuring or producing a concrete having a specified grade (i.e. strength), in which case samples of the mix are taken to confirm that the concrete will achieve the required strength (see SANS 2001-CC1, Concrete works (structural)). Usually, at least three concrete cubes are taken from each day's casting and from at least every 50 m^3 of concrete of each grade placed. These cubes are crushed at 28 days to determine the 28-day cube strength of the concrete. Concrete that does not achieve the required grade may have to be broken out and replaced, unless a structural engineer confirms the acceptability of the under-strength concrete.

Alternatively, the contractor may be required to use a prescribed-mix concrete i.e. a concrete for which mix proportions have been specified (see SANS 2001-CC2, Concrete works (minor works)). In this case, the contractor must ensure that the constituent materials are properly measured and mixed in accordance with prescribed requirements.

In prescribed - mix concrete, cement is measured in terms of its mass in kilograms and sand and stone aggregates are measured volumetrically in buckets or wheelbarrows of known volume, or in suitable measuring boxes. (It should be noted that a standard wheelbarrow for concrete (SANS 795 type 5 wheelbarrow) has a capacity of between 60 litres and 70 litres with no projection of material above the rim of the wheelbarrow.)

Sands for mortar and plaster can be tested using a kitchen scale and a measuring jug.

SANS 2001-CC1, Concrete works (structural), establishes requirements for strength concrete. This standard is used where the concrete work is designed by appropriately qualified engineers and technologists and the concrete work is carried out under the direction of appropriately qualified supervisors.

SANS 2001-CC2, Concrete works (minor works), establishes requirements for prescribed-mix concrete. This standard is used in concrete works such as foundations, slabs, stairways, masonry walls, pipelines, manholes, latrines, conservancy tanks, septic tanks and the like where the design and supervision of the concrete works are not necessarily under the direct control of appropriately qualified engineers and technologists and no special finishes to the concrete are required.

Only sufficient water should be added to produce a workable mix. The quantities of water specified in prescribed-mix concrete are for guidance only as the actual quantity required will depend on a number of factors including the moisture content and quality of the sand and the type of cement used.

Cement should not be measured by volume. A bag of common cement, depending on the quantity of extenders, has a mass of 50 kg and a volume of approximately 33 litres when packed under air pressure at the factory. Cement, however, fluffs up (bulks) when poured into a container with the result that 50 kg of cement cannot readily be contained in a box of 33 litres. The volume of a bag of loose (bulked) cement, depending upon its compaction, can be up to 20 % more than when in the bag. For this reason it is always preferable to use whole bags of cement when volume batching.

The concrete mix proportions for use with 19 mm and 13 mm aggregate specified in SANS 2001-CC2 are:

Grade of concrete	Common cement kg	Sand		Stone		Water L
		L	Wheelbarrows	L	Wheelbarrows	
Class 42,5 N or R cement, 19 mm stone (see permitted types)						
10	100 (2 bags)	290	4,5	290	4,5	72
15	100 (2 bags)	260	4,0	260	4,0	66
20	100 (2 bags)	230	3,5	230	3,5	Permitted types of common cements
CEM I (32,N or higher)						
CEM II A-L (32,N or higher)						
CEM II A-M (42,5 N or higher)						
CEM II A-S (32,N or higher)						
CEM II A-V or W (32,N or higher)						
CEM II B-S (32,N or higher)						
CEM II-B V or W (32,N or higher)						
CEM III A (32,N or higher)						
60						
25	100 (2 bags)	200	3,0	200	3,0	55
30	100 (2 bags)	160	2,5	160	2,5	51
Class 32,5 N or R cement, 19 mm stone (see permitted types)						
10	100 (2 bags)	260	4,0	260	4,0	67
15	100 (2 bags)	230	3,5	230	3,5	60
20	100 (2 bags)	200	3,0	200	3,0	54
25	100 (2 bags)	160	2,5	160	2,5	50
30	100 (2 bags)	130	2,0	130	2,0	46
Class 42,5 N or R cement, 13 mm stone (see permitted types)						
10	100 (2 bags)	330	5,0	230	3,5	71
15	100 (2 bags)	290	4,5	200	3,0	65
20	100 (2 bags)	230	3,5	200	3,0	60
25	100 (2 bags)	200	3,0	160	2,5	56
30	100 (2 bags)	145	2,0	130	2,5	52
Class 32,5 N or R cement, 13 mm stone (see permitted types)						
10	100 (2 bags)	290	4,5	200	3,0	66
15	100 (2 bags	260	4,0	160	2,5	59
20	100 (2 bags)	200	3,0	160	2,5	55
25	100 (2 bags)	160	2,5	130	2,0	51
30	100 (2 bags)	130	2,0	100	1,5	47

Permitted types of common cements

- CEM I (32,N or higher)
- CEM II A-L (32,N or higher)
- CEM II A-M (42,5 N or higher)
- CEM II A-S (32,N or higher)
- CEM II A-V or W (32,N or higher)
- CEM II B-S (32,N or higher)
- CEM II-B V or W (32,N or higher)
- CEM III A (32,N or higher)

No-fines concrete

No-fines concrete is a concrete made from stone aggregate, common cement and water. It is porous and is used in subsurface drains, weepholes or drainage layers.

The mix proportions of no-fines concrete are as follows:

Nominal size of stone aggregate	Common cement kg	Stone aggregate	
		L	Wheelbarrows
13	50	270	4
19	50	300	5
38	50	380	6

Not more than 20 L of water per 50 kg of cement is used.

Mortar mixes

As is the case with concrete, the contractor may be required to provide a strength mortar or a prescribed-mix mortar. Strength mortars are required in load bearing masonry applications e.g. multi-storey buildings that have no steel or concrete frames. Requirements for strength mortar are rare.

Cement is measured by mass and sand is measured volumetrically.

The prescribed-mix proportions for mortar specified in SANS 2001-CM1, *Masonry Walling*, are:

Cement type	Cement kg	Lime kg	Loose sand	
			L max.	Number of standard wheelbarrows
Class I mortar				
Common cement (any type)	50	0-10	130	2
Masonry cement MC 22,5 X, MC 12,5	50	Not permitted	80	1
Class II mortar				
Common cement (any type)	50	0-25	200	3
Masonry cement MC 22,5 X, MC 12,5	50	Not permitted	130	2

Plaster mixes

SANS 2001-EM1, *Cement Plaster*, requires that common cements be used, in the following mix proportions:

Type	Common cement kg	Lime kg	Masonry cement MC 22,5X or MC 12,5 kg	Masonry Cement MC 12,5X kg	Loose sand	
					L max	Number of standard wheelbarrows
External plaster	50	0 - 25	-	-	150	2,5
	-	-	50	-	130	2
Internal plaster	50	0 - 25	-	-	200	3
	-	-	50	-	150	2,5
	-	-	-	50	100	1,5

The addition of lime to common cements improves the consistency of the mix and is optional. Lime is not used to replace a portion of the cement in the mix. Lime must comply with the requirements of SANS 523 and be of the class A2P type.

Diameter, mm	Mass, Kg/m
8	0,395
10	0,617
12	0,888
16	1,580
20	2,470
25	3,850
32	6,310
40	9,860

Reinforcement

Concrete may be reinforced by means of bar reinforcement or fabric reinforcement. Bars need to be handled on site and it is for this reason useful to know the mass of bar reinforcement.

Fabric reinforcement is supplied in the following formats:

	FABRIC	MESH SIZE Nominal pitch of wires		WIRE SIZES		NOMINAL MASS/m²	
	Ref. No.	Main mm	Cross mm	Main mm	Cross mm	Kg	SUPPLIED IN
SQUARE MESH FABRIC	888	200	200	12	12	8,88	SHEETS ONLY 6 m x 2,4 m
	746	200	200	11	11	7,46	
	617	200	200	10	10	6,17	
	500	200	200	9	9	5,00	
	395	200	200	8	8	3,95	
	311	200	200	7,1	7,1	3,11	
	245	200	200	6,3	6,3	2,45	
	193	200	200	5,6	5,6	1,93	SHEETS OR ROLLS
	100	200	200	4,0	4,0	1,00	
DESIGN MESH FABRIC	1085	100	200	12	8	10,85	SHEETS ONLY 6 m x 2,4 m
	943	100	200	11	8	9,43	
	772	100	200	10	7,1	7,72	
	655	100	200	9	7,1	6,55	
	517	100	200	8	6,3	5,17	
	433	100	200	7,1	6,3	4,33	
	341	100	200	6,3	5,6	3,41	
	289	100	200	5,6	5,6	2,89	
LONGITUDINAL MESH FABRIC	278	100	300	6,3	4,0	2,78	SHEETS 6 m x 2,4 m OR ROLLS 60 m x 2,4 m
	226	100	300	5,6	4,0	2,26	
	133	100	300	4,0	4,0	1,33	
SPECIAL MESH	200	100	100	4,0	4,0	2,00	
	156	100	100	3,5	3,55	1,56	

Warning: brickforce having a diameter of less than 2,8 mm serves little or no purpose.

Bed joints reinforcement in brickwork permitted in terms of SANS 2001-CM1 may comprise:

- Brickforce comprising hard-drawn wires that consist of two main wires of diameter not less than 2,8 mm and not more than 3,55 mm spaced a constant distance apart, and 2,5 mm diameter cross wires spaced at longitudinal intervals that do not exceed 300 mm in ladder-type brickforce and at twice the distance between the longitudinal wires in truss-type reinforcement.
- Rod reinforcement comprising hard-drawn, pre-straightened wires (typically obtained from a fabric reinforcement manufacturers) that have a diameter of not less than 4,0 mm and not greater than 6,0 mm.

In some corrosive environments, the bed joint reinforcement may have to be galvanised.

SANS 2001-EM1 permits plaster to be reinforced with a pre-galvanised mild steel metal lath having an aperture of 6 mm, having a minimum strand thickness of 0,5 mm.