Practical Restoration Handbook

Concreting

by

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1. INTRODUCTION

1.1 Successful concreting relies on two things; firstly the concrete has to be the right specification for the job and secondly it has to be placed correctly. Handling concrete effectively and safely requires careful planning, preparation and, given the vagaries of weekend working in the British climate, not a little luck.

1.2 Concrete itself consists of a mixture of cement, large fines (usually 20mm aggregate but this is dependent on the application), small fines (usually building sand but this is also job specific) and water. The mix may have other admixtures added for special reasons (waterproofing, frost protection, colour, etc.).

1.3 A full analysis of the use of concrete would involve a complex mix of chemical, mechanical, structural and civil engineering and would certainly be beyond the scope of this document. This document aims to give advice to the Site leader to ensure that the issues associated with the handling of concrete on site are adequately addressed.

1.4 Particular reference is drawn to section 13 “Health and Safety issues”.

2. DESIGN OF MIX, REINFORCING, PLACEMENT, ETC.

2.1 Do not underestimate the importance of good design and specification of concrete structures. If at all possible seek advice from a suitable engineer (IWA has several Honorary Consultant Engineers who may be able to provide advice, contact IWA Head Office, 3 Norfolk Court, Norfolk Road, Rickmansworth, WD3 1LT for further details). On any project where there is input from a civil engineer or designer then the project plan should specify the mix and finish to be used (and probably its placement as well). These instructions should be followed and any deviations should be fully discussed with the engineer beforehand. Section 16 gives an example of the details given in a typical concrete structure design.

2.2 However, for simple jobs it is possible to select the appropriate mix to match the job requirements and site conditions by following a number of simple stages.

2.3 The overall job of describing what sort of concrete you want has been made easier by the introduction of designated mixes into the British Standard for concrete (BS 5328). Table 1 (page 6) gives illustrations of typical applications of designated mixes. In fact the job is often further simplified as these mixes are often further reduced to just a few standard mixes (page 6). However, it is important that a site leader can understand all the possible mixes he may be requested to work with and so the full details are given here.

2.4 To arrive at a specification for your mix a decision first has to be made as to which of the typical applications given matches your application and whether the concrete will be reinforced or not. Consideration must also be given to the ground conditions and the quality of the water the concrete will come into contact with. For most applications Ordinary Portland Cement (OPC) will be used however other cements exist for specialist applications such as high sulphate resistance (Sulfacrete), high initial strength (Ferrocrete), etc. Advice on a suitable choice can be obtained from the larger manufacturers of cements (Blue Circle, Rugby, etc.).

Table 1. (Standard mixes BS5328)		
TYPICAL APPLICATION	**DESIGNATION**	**SLUMP (mm)**
FOUNDATIONS		
Blinding and mass concrete fill	GEN 1	75
Wall footings (non-aggressive soils)	GEN 1	75
Mass concrete foundations (non-aggressive soils)	GEN 1	75
Reinforced foundations in Class 1 sulphate conditions	RC 35	75
Foundations in Class 2 sulphate conditions	FND2	75
Foundations in Class 3 sulphate conditions	FND3	75
Foundations in Class 4A sulphate conditions	FND4A	75
Foundations in Class 4B sulphate conditions	FND4B	75
GENERAL APPLICATIONS		
Coping stone bedding, etc.	GEN 0	V. low (nom. 10)
Backfill to wall cavities	GEN 1	125
Solid filling under steps, irregular, awkward pours, etc.	GEN 1	75
SLABS AND BASES		
Bases with no reinforcing	GEN 1	75
Bases with reinforcing	RC 30	50
PAVING AND GROUND COVER		
Domestic parking and external paving	PAV 1	75
Heavy duty external paving	PAV 2	50

Note that a “Non aggressive soil” is taken to be Class 1 Sulphate conditions.

The RC designation refers to Reinforced Concrete and the figure after the RC refers to its strength (measured in Newtons) after 28 days curing. RC figures are often abbreviated to just C figures (i.e. RC30 becomes C30). This is perhaps the most commonly used method of specifying concrete and frequently the other categories are “respecified” to these figures. This is obviously a potentially dangerous technique however a brief guide would be:

Table 2. Simplified mixes			
MIX	**APPLICATION**	**MATERIALS for 1m3**	**AKA**
C20	Blinding off, leanmix pours, etc.	250kg OPC, 0.5m3 Sand, 0.75m3 Agg.	
C30	Backfilling of walls and slabs with a high steel content.	300kg OPC, 0.5m3 Sand, 0.75m3 Agg.	6 to 1 mix
C35	Structural slabs still containing steel reinforcing	325kg OPC, 0.5m3, 0.75m3 Agg.	
C40	Concrete with a high resistance to ground conditions.	350kg OPC, 0.5m3 Sand, 0.75m3 Agg.	5 to 1 mix

Again, it cannot be stressed too highly that where a specification has been given it should not be adjusted or respecified without consulting the engineer.

3. READYMIX OR HANDMIX?

3.1 It may seem strange for a Canal Society to hand over its hard won cash to some other company to mix concrete when they can mix their own.

3.2 However the logic can be very persuasive: buying concrete readymixed may be more convenient, quicker and less wasteful (i.e. cheaper).

3.3 If you mix your own concrete, then you are responsible for ordering and storing the bulk ingredients (including clean water) and ensuring you have enough competent volunteers to mix AND place the concrete. By ordering from a readymix company the responsibility for all these factors rests with the company - often a definite advantage. There is, of course, an additional direct cost and a rough guide is that readymix usually costs about twice the price of the raw materials - but no split bags, expensive materials left over and far less mixing time meaning more time for your volunteers to spend on more skilled tasks such as bricklaying.

3.4 A logical extention of this argument may result in your project using precast concrete. Again this will have a financial penalty, however, for culverts and other such regular shaped constructions it is an option that is well worth considering. Companies such as FC Precast of Derby will give excellent advice and guidance in the installation techniques required.

3.5 If readymix is the chosen technique then the supplier should be given the mix designation, the required workability, the intended placement method and finish required. If the nominal maximum aggregate size is different from 20mm, this should be specified. Most readymix suppliers will give expert advice (and if they don't then don't use them). To make absolutely sure that the quality of concrete is going to be right, dealings should only be with suppliers who operate an independent assessed quality system, or from producers who hold third party product conformity certification. This will almost certainly remove the old requirement of having to provide a test cube (q.v.) when working with bodies such as British Waterways.

3.6 Remember that not all the responsibility would lie with the external company as you will still need to have an understanding of the stages involved, i.e. how to specify the mix required, accept delivery and work with the concrete.

3.7 "Handmix" is of course a red herring as, in the authors opinion, it is almost never sensible to mix without mechanical assistance. With the exception of a one off "emergency" mix to backfill a coping stone or similar it is just too tiring a process, quality control will be poor and your site will probably get very messy.

3.8 For the rest of this chapter it will be assumed that readymix is the chosen technique as it is here that most disasters occur, however most of the comments are equally relevant to handmixing.

4. PLANNING, PREPARATION AND TIMESCALES

4.1 It cannot be stressed too much that adequate preparation pays great dividends with concrete pours.

4.2 The first thing to realise is readymix manufacturers work an unfair system whereby you are charged for your mistakes but you have no comeback against their poor timekeeping. Once the load has arrived on site

you will be charged if you take more than 5 minutes (per cubic metre) to discharge it, however the wagon can turn up 2 hours late and you can claim nothing. Thus good planning and preparation is rewarded financially.

4.3 Well before the wagon turns up you should have checked you have an adequate supply of clean tools, tamping blocks, etc. Ensure that all sensitive areas (such as new or clean brickwork, scaffold clamps, etc.) are protected from splashes and that all barrow runs, etc. have been tested with a dummy load.

4.4 When planning the pour remember to allow time for cleaning up afterwards (especially easily forgotten items like wheelbarrow wheels). If using dumpers then be realistic about how long it's going to take to turn round each dumper run and warn the producer if it is going to be more than 20 minutes.

4.5 Always consider the whole curing time - if your pour is having fast running water kept off it by a pump then ensure that it will run until the concrete has gone off and that there is someone to keep an eye on it in case of blockage or breakdown. You may have sealed that underground spring but will the water pressure find another way out in the next 12 hours? (The answer to that one is "yes" and that's why it is always better to divert the water via a known route than try and stop it - contact your local WRG Smart Alec for further details.)

4.6 Unless you are absolutely sure you have the quantity of concrete exactly right always have a standby/overflow job to absorb any excess concrete delivered because if you send it back in the wagon then you will incur extra costs as they have to dispose of it. It is best to make it a simple job that will not absorb too many people or detract from the successful completion of the main job.

5. WORKABILITY OF CONCRETE

5.1 As soon as the concrete arrives on site, it needs to be inspected. Check the actual delivery ticket to ensure what has arrived is actually what you ordered (volume, grade, etc.). This is the only chance you get to send it back so it's worth doing no matter how much you trust the supplier. Having inspected the delivery ticket, you should then check the workability of the concrete to determine its suitability for placing. On an important job this would be a full slump test (q.v.), however on most sites it usually takes the form of a token load checked for "shovelability".

5.2 If testing indicates that the workability is below the lower limit, it is fine for the driver to add water to the load to increase the workability within specified tolerance, this is the usual case as the mix will leave the mixing plant a little drier than specified and water will be added by the driver on delivery.

5.3 However, if the concrete arrives and you find that its workability needs to be increased to assist placing then you can ask for water to be added. But note that if this is done then all liability for the properties of the concrete will be disclaimed by the producer.

5.4 If the concrete arrives and on site delays make it too stiff to use, then adding water is not the correct solution. A plasticiser admixture should be added for the concrete to reach its lowest possible water content, but still be suitable for placing.

5.5 Concrete can also arrive too wet due to excess water added at the mixing plant, though this is unusual. If this occurs, the concrete should not be used until the supplier has been contacted and the concrete's suitability has been checked.

6. ACCESS TO SITE

6.1 Always consider carefully the access and egress of the placement method. If it is to be directly unloaded from the wagon then check the wagon can safely and easily get into position. It is important to check the total weight and axle weight of the wagon against any site restrictions you may have. If it is to be transported by dumper then check the run is short enough to ensure the vibration does not segregate the mix. Equally important in poor weather or ground conditions is whether the dumper run will still be possible after the 7th pass. Some producers will offer a wagon with "conveyor belt delivery" as this "will allow easier placing of the mix" - the jury is still out on this option. Another option is the use of a concrete pump, though this too has generated some very fraught weekends. Pumping concrete is a very specialist technique that should be approved by the design engineer and the manufacturer should be made aware of the intention to pump as it will affect the mix required.

6.2 Don't forget that the wagon will be significantly lighter and therefore have much less traction over wet grass/mud on the way out. If it gets stuck on the way out they will still charge you waiting time. It's a bit touch and go as to whether you'll have to pay but seeing as it took you all week to track down a firm that would deliver on Saturday afternoon and would accept a Canal Society cheque can you really afford to upset them?

6.3 One final point regarding access; don't forget that you will need to finish off the surface. Wading through the concrete is not a safe option so always consider how your tamping crew will be able to get at the whole surface of the pour.

7. FORMWORK

7.1 All of the above will be of no consequence if the formwork itself is defective. This is the item most often hurried or bodged on a concrete pour as all too often the assumption is that shuttering (as formwork is more commonly known) can be knocked together from bits and pieces around the site. The main failing (literally) of concrete shuttering is not understanding just how much force a concrete pour hits the ground with or for that matter just how much weight is associated with a mix (especially if it is being vibrated). Remember that concrete weighs in at 2.4 tonnes per cubic metre and will be ejected from the back of the wagon at a height of 3 metres so it should not be too much of a shock that poorly erected shuttering often gets swept away. It's no use asking the wagon driver to go a bit slower - (s)he is in a hurry and is probably more worried about getting off site.

7.2 The second most common mistake is that not enough thought has been given to the removal of the shuttering. All too often people wedge shuttering against walls with bricks and then find it impossible to remove when the weight of the concrete pins the brick against the wall. Another common mistake is designing shuttering with lips, projections or nails that are then gripped by the concrete and become impossible to remove without damage to the face of the pour. Nails should always be on the outside of shuttering and should not be driven fully so that they can be removed easily.

7.3 You may wish to consider using a proper formwork system such as major contractors use - these are designed for large regular shaped pours. However it is much more likely that you will wish to get out your junior carpentry kit and customise an 8'x4' ply sheet.

7.4 Obviously the wood should be shuttering grade or better and it is strongly recommended that the internal faces of the shuttering are coated with a proprietary Mould Release Oil - this is good practice on simple shuttering and essential on any complex shuttering. Oiling the shuttering makes it easier to strike (with less chance of face damage), produces a better finish and allows the ply to be reused many times. It is possible to economise and use sunflower oil or similar but check that there will be no reaction with any admixtures in the mix. An alternative is covering the ply with visqueen sheeting but beware the effects of air bubbles and folds in the plastic getting caught in the pour and spoiling the face.

7.5 Any joints in the shuttering should be sealed otherwise the grout will leak out (especially if vibrated) leaving only the larger fines around the joint producing a distinctive honeycomb effect. This will result in weakness along an already vunerable edge. The traditional technique for sealing joints is to use strips of rolled up cement bag and if done carefully this can achieve acceptable results, however these days rolls of domestic draught excluder are cheap, easy to apply and produce much better results.

7.6 The finishing of faces is often specified in the design and is usually given a grade of either F1 and F2. Roughly speaking F1 is a smooth finish that is free of voids and air bubbles and it applies to exposed faces, etc. F2 corresponds to a rough trowelled or tamped finish suitable for laying bricks on. Other finishes are "brushed" and "wet brushed". The brush finish is used to provide a rough but regular surface whilst the wet brushed is a refinement of the technique whereby once the surface has undergone the first stages of curing a wet brush is used to wash away the surface grout leaving the larger fines exposed.

7.7 The final mistake made regarding shuttering is to strike it too early, if this is done then damage may occur not only as the shuttering is removed but also due to the concrete curing too quickly (see Section 9 Curing). The length of time that shuttering needs to be in place is obviously dependent on the mix and any admixtures but 18 hours should be viewed as a minimum for a normal mix.

8. PLACEMENT

8.1 If the ground you are placing the concrete on is at all boggy or you suspect it will move whilst the concrete goes off then it is usual to "blind off" the base of the pour. This means placing a supporting layer below the concrete that will support the concrete as it is placed, prevent loss of grout and also prevent contamination by ground conditions. To do this it must be stable and waterproof and this is usually achieved with a combination of these techniques:

- a geotextile layer (e.g. Bidim 444, Polyfelt 2000, Teram),
- a layer of hardcore, rubble, etc.,
- an initial pour of "leanmix" concrete that is poured and allowed to go off before the main pour.

8.2 The blinding should be included in the design specification as it is an important part of the pour and should be adhered to. Generally any blinding should be good enough to walk on, if not then it is not up to the job of supporting the pour.

8.3 Whether blinded off or not a concrete pour really does have to be a clean environment, when preparing an excavation always ensure that all edges and banks are stable and will not collapse during the placement. Ensure all organic matter is removed and any rubble, dust, etc. is removed.

8.4 Concrete needs to be placed so that it does not segregate and at a speed which allows it to be compacted properly. This is achieved through placing it in a series of layers. Then the concrete is vibrated to literally shake out the trapped air and encourage the mix to flow to all the extents of the formwork. The layers of concrete should not be too deep otherwise the weight of the material at the top makes it almost impossible, even with vibration, to compact the bottom layer. lf this happens, air will be trapped in the mix leaving voids and blow-holes that will result in surface blemishes and more importantly a loss of strength.

8.5 The maximum depth of these layers depends upon the method of compaction. Poker vibrators are the most suitable for canal restoration. The maximum depth of a layer should be 3-500mm dependent on the size of your poker head. Vibrating beams are an alternative but they are not as powerful and only good for regular shaped slab type pours (up to say 150mm.) The total lift height should not normally exceed 2m.

8.6 In all cases, a layer must be fully compacted before any more concrete is placed on top of it as voids in the lower concrete cannot be removed once the next layer is placed on top. However, the bottom layer still needs to be workable enough to respond to vibration so that the two layers can knit together without any joints, which is another reason for getting the material into position as quickly as possible.

8.7 The use of a vibrator will also allow the concrete to flow around coping stones or similar when backfilling thus providing a far better job. Petrol driven vibrators are undoubtedly the most popular but they are notoriously unreliable and it would be wise to ensure a second unit in reserve (or perhaps in a nearby hire shop), diesel models do exist which are slightly heavier and harder to start but more robust. It is also possible to get electric models which are much lighter but more susceptible to damage. Either way it is the poker head (a simple mechanical coupling and a Bowden cable that overheats) that is the unreliable part and this is unfortunately common to all of them.

8.8 Although a vibrator is always recommended, simple “non structural” pours can be placed without one simply by “chopping” along the pour with a shovel and working it in and out. This is much less effective than a vibrator - considerable and continuous effort is required but acceptable results can be acheived.

8.9 Always give considerable thought to how your reinforcing will be supported during the pour - steel rebar or mesh must be installed in accordance with the designers wishes. Chocking it up on half bricks and throwing the concrete around it is not really acceptable, various support systems exist for reinforcing and although they may seem more expensive than half bricks they will remove a common weak point in concrete pours - again, check with your designer.

8.10 Beware if you need to lay concrete to a slope - it is possible and depends on the workability of the concrete, however anything over 25 degrees from the horizontal is probably better built some other way.

8.11 Concrete can be placed under water but it must be done carefully to ensure that the fines are not washed away. Anything trickier than that (such as pouring a slab with water running across it) is in the realms of specialist professionals and you are probably trying to solve the problem the wrong way.

8.12 One final point - wetting down any handtools before and possibly during the pour will lead to an easier and cleaner pour - but don’t go over the top.

9. CURING

9.1 Curing is the last and one of the most important stages of concrete construction. The "curing" problem is caused by the concrete giving off heat and shedding water too quickly leading to cracking. If curing is not done properly, the concrete will not develop its full strength. Properly cured concrete is stronger, more resistant to chemical attack and erosion, and more watertight and frostproof.

9.2 The surface of the concrete is worst affected by poor curing, and it is this skin which gives concrete the ability to withstand wear and that protects both the reinforcement and the 'heart' of concrete. Therefore, if concrete is inadequately cured the effectiveness and the life-span of the concrete will be reduced.

9.3 It is, therefore, important for curing to take the proper time and this can be achieved in one of two ways:

- The first involves keeping the concrete moist by the use of ponding, spraying/sprinkling, damp sand or hessian.
- The second method prevents the loss of moisture from the concrete by covering it with polythene sheeting, spraying on a curing membrane or leaving the formwork in place.

9.4 The first methods are undoubtedly the more correct. However, they are expensive, labour intensive and time consuming. Moreover, if they are not carried out properly they may do more harm than good. The second group of methods, while not so efficient, are usually satisfactory for all except very special work and they can be carried out more easily.

9.5 Note that curing strengths given in specifications relate to the strength of the concrete after 28 days, recently "gone off" concrete (usually referred to as "green" concrete) may well be "crumbly" round the edges and care should be taken to protect it for at least several days after it has been poured.

10. EXTREMES OF TEMPERATURE

10.1 All of the above measures will ensure concrete reaches its full potential throughout much of the volunteers year (which is like a contractors year but longer and wetter!). However, modifications of concrete mix proportions and constituents may be required when concrete is to be placed in extremes of temperature. For cold weather the usual rule of thumb is only pour when it is over 4 degrees C on a rising thermometer. You also need to consider the fact that it gets colder a lot quicker towards the end of the day and protect the concrete from frost with additional cover whilst it goes off (you may wish to specify an accelerator in the mix to ensure the first stages of curing have occurred before it gets dark).

10.2 When placing concrete in summer months the usual limit is exposure to a temperature over 25 degrees C. Pay particular attention to the way that shadows move around during the day - the pour may be in the shade at 11am but will it be in the shade at 3pm? In both of these circumstances the producer will be able to offer advice regarding the suitability of the specified mix and relevant admixtures.

11. HANDMIXING

11.1 Many of the above considerations are valid for handmixing (or rather mixing using a concrete mixer), but in addition:

11.2 When planning a pour use a reasonable estimate of time per mix.

11.3 When using a mixer ensure that you add the materials in the right order as it takes ages to mix properly otherwise, the normal order is:

- 75% of the water
- 50% of the aggregate
- 100% of the cement
- 50% of the ballast
- final water to suit

but this can be varied to suit the materials (e.g. wet sand will require a lot less added water).

11.4 Generally you are doing something wrong if:

- you are getting splashed or,
- the back of the drum is getting caked with dry mix or,
- the mix is taking a long time (say more than 2 minutes from the addition of final water).

11.5 Ensure the water supply is adequate, clean and suitable. Ideally it should be mains water but if you must use canal water make sure it has no organic matter (weed, etc.) and is chemically suitable (pH neutral and saline free).

11.6 Pay careful attention to quality control when mixing by hand. Without doubt the best way to achieve consistent quality mixes is to use levelled buckets to measure out the materials rather than just shovels. Producing consistent mixes is a skill, though fortunately one that is fairly easily learnt.

11.7 When mixing by hand it is essential to keep up a steady rate of mixing so always ensure that you have the manpower to do the job and can supply the materials (including diesel and water) at a suitable rate - if not then make the job smaller. It is an unfortunate fact that nearly all possible contaminants will prevent concrete curing properly and so diesel spillages, etc. mean that materials must be discarded.

11.8 Ergonomics are very important when setting up a mixing site - Section 16 shows a well laid out site with some reasoning for the layout. One age old question that often holds up the start of a pour is whether it is better to set up the mixer by the materials and barrow the mixed concrete to the pour or set up the mixer by the pour and barrow the materials to it. It is an age old question because the right answer last time is rarely the right answer this time! In the author's experience it is usually more successful to keep the mixer near the materials and barrow the concrete but it really is site dependant.

11.9 Always clean the mixer immediately afterwards - a couple of shovels of clean, large ballast are more effective than the traditional half bricks. This is particularly important if your mixer is also being used to mix mortar for bricklayers. Equally important is to clean all splashes off the wheels and around the tipping area before they harden (unless it’s a security measure).

11.10 Your mixer may well have a starting cord (or at least a starting handle). The most common early morning game on site is "where's the ruddy starting cord?" - always keep the cord or handle in a known place. The

starting cord should be the proper article as a bit of old knotted string tied to a twig is a recipe for splinters, sprained wrists, etc.

11.11 You may wish to consider having a second mixer and/or vibrator on standby in case of machine failure.

11.12 If you are specifying a mixer then it is usually done in terms of the capacity of the mixer barrel, i.e. third of a cubic yard, etc. However, this is often corrupted into such descriptions as “half bag” mixers where this corresponds to the fact that the barrel can take half a bag of cement and enough aggregate to make up a standard C30 mix. They are also graded by their names; Baby Belle, Standard Belle, Liner Petter, etc. From experience when discussing the size of the mixer with a hire company it is most productive to try any or all of these techniques to narrow down exactly what they are delivering as many variations in nomenclature exist.

11.13 For the true masochists here is the guide to mixing by hand:

- Measure out the required aggregate onto a clean sheet of plywood,
- Form a crater in the top and add the measured amount of cement,
- Turn over until uniform in colour and texture,
- Form a crater and add the water slowly mixing as you go,
- Turn over (a lot!) until uniform in colour and texture and at the workability required.
- It’s just like making a cake.

12. MATERIALS AND STORAGE

12.1 Always store cement safely in the dry and ensure that stock is cycled i.e. that the bottom bag gets used. Note that cement will always go off, even when stored in the nominal dry conditions of a shed or store, only by totally surrounding the cement in airtight plastic can you extend its normal lifetime.

12.2 It is possible to get the aggregate and sand premixed before delivery and this can be a real boon in terms of storage and quality control - this is known as “all in concreting aggregate” but it is also called other things (see section 16). The ratio of large and small fines is important as it is this that determines the voids that can be filled (this is why it is best to use “all in concreting aggregate” as this ratio is already optimised).

12.3 Also beware the segregating effect of a long wagon journey - it may be necessary to remix the aggregate.

12.4 If you are doing a lot of pouring then it is well worth setting up a proper ballast store by laying a decent concrete base and setting up back and side walls (this will pay for itself in less wastage). Set it up so the delivery wagon can tip directly into it and also so the prevailing wind doesn’t blow ballast into the faces of the poor chaps shovelling it. An alternative is to use bagged supplies of sand and aggregate. This is generally more expensive but may well result in a higher level of quality control and less wastage and so be economic for small mixes on isolated parts of the site.

12.5 One final point, the whole world seems to think that volunteers spend their free time assembling neat, well ordered piles of sand and ballast just so their dog has somewhere to go to the toilet....beware.

13. HEALTH AND SAFETY ISSUES

13.1 No guidelines regarding the handling of concrete are complete without a mention of the safety issues involved. By educating everybody on site in the safe and correct use of concrete and what to do in the event of an accident, any problems can be minimised. It is essential that you have the COSHH hazard data sheet associated with the cement product and any other chemicals you are using - if you can't get these from your supplier then go direct to the manufacturer (Portland, Rugby etc.) and ask them.

13.2 Fresh concrete has a very powerful caustic effect on skin owing to the alkaline nature of cement. The abrasive effects of sand and aggregate in the concrete aggravate the condition and effects range from dry skin, irritant contact dermatitis, allergic contact dermatitis to severe burns. These burns can take several hours to occur and the author can confirm they can be very painful. Always ensure all those involved in the pour are aware of the dangers and have adequate protective clothing, such as overalls, gloves with close fitting cuffs, Wellington boots and safety helmets. Eye protection and eyewash are essential on any concrete pour. Any splashes should be removed immediately with lots of clean water. It is also essential to protect the public, not only from splashes during the pour but also from straying onto the pour whilst it goes off. (This will also result in less dogs called "Stumpy" and less paw prints in your carefully laid base.)

13.3 Your CDM plan may well require a Safe System of Work but even if it doesn't it is a good idea to have one anyway. In the case of concrete mixing and placement it really boils down to:

- how do I position everything so I can mix safely without getting everybody running into physical hazards (usually other volunteers and the public)?
- how can we place the concrete safely - i.e. sensible, tested barrow runs with different routes for empty and full barrows to avoid traffic jams, stop boards to tip against etc?
- are there any places or routes that are not safe for a concrete run and are they marked accordingly?
- have other requirements such as COSHH, First Aid, etc. been satisfied?
- has all of this been communicated to everyone involved?

13.4 It is also important that everyone involved in the pour is well briefed on lifting and handling techniques as considerable damage can be caused during the handling of materials - cement bag sizes have recently been halved to 25kg for this reason. Volunteers should be clearly instructed to look after their backs as they are often not used to such intensive effort - either the long, hard slog of a handmix or the frenetic intensity of a readymix pour.

13.5 Never start a mixer (or any other item of plant for that matter) unless you know how to stop it. You should store fuel safely away from the main work in clearly marked containers. Funnels are essential to avoid spills, if the mixer does have fuel spilled on it you must wait for the fuel to completely evaporate before re-starting the mixer. Other common hazards include exposed sharp reinforcing bars and lost limbs through reaching inside mixers whilst they are running - never do this.

13.6 Most incidents can however be avoided through education. It is worth noting that it is not simply altruistic motives that should guide your health and safety practices, one well known voluntary organisation ended up having to pay several thousands of pounds when a volunteer sustained cement burns on a work site.

14. FURTHER GUIDANCE

14.1 Further guidance on working with concrete can be found in the publications below:

The British Cement Association (01344 725704) produces a series of 11 booklets under the heading "Concrete On Site":

1. Readymixed concrete
2. Reinforcement
3. Formwork
4. Moving concrete
5. Placing & compacting
6. Curing
7. Construction joints
8. Making good & finishing
9. Sampling and testing fresh concrete
10. Making test cubes
11. Winter working.

The booklets can be purchased either as a set (£27.50 + p&p) or singly (£2.75 + p&p)

Readymixed Concrete Bureau (01344 725732) produce a series dealing with the handling of readymixed concrete called "The essential ingredient series":

1. Quality
2. Production and transport
3. Guidance on economic design, detailing and specification
4. Material
5. Concrete specification and mix design
6. Site practice
7. Testing
8. Making good
9. Today & tomorrow

RCB also produce:

"Concrete simplified" - a practical guide for site personnel.
"Site sampling and testing of concrete" - a site manager's guide

Blue Circle Cement (0800 236368) produce simple free leaflets.

Advice on Precast Concrete sections can be obtained from:
Culvert Box Association
60 Charles Street
Leicester, LE1 1FB Tel: 0116 253 6161

or

FC Precast Concrete
Alfreton Road
Derby, DE21 4BN Tel: 01332 364314

Advice on concrete paints and specialist finishes can be obtained from:
Keim Mineral Paints Ltd
Muckley Cross
Morville
Nr Bridgenorth
Shropshire
WV16 4RR Tel: 01746 714543

15. DEFINITIONS

15.1 **Ballast**: beware of local definitions; one site may refer to the sand/aggregate mix as ballast while another site refers to just the aggregate as ballast. Pay careful attention to the ratios of large and small fines as it is this mixture that ensures that all voids are filled (this is why it is best to use "all in concreting aggregate" as this is already optimised).

15.2 **Slump** is a not very subtle test to assess the workability of a mix. It involves filling a conical mould with the concrete to be tested and then inverting the mould. When the mould is removed the concrete naturally slumps under it's own weight. The distance from the top of the cone to the top of the concrete pile is the slump. The bigger the slump figure the more the concrete slumps under its own weight and hence the easier it is to move around. A standard mix (with 20mm aggregate) would have a slump of 50-75mm, this is easily shovelable (especially if vibrated).

15.3 **Test Cube** is a 150mm cubic mould filled with concrete taken at random from the pour. It is allowed to cure and can then taken away for testing at a lab. It is a way of proving to any third party that what was poured was within specification.

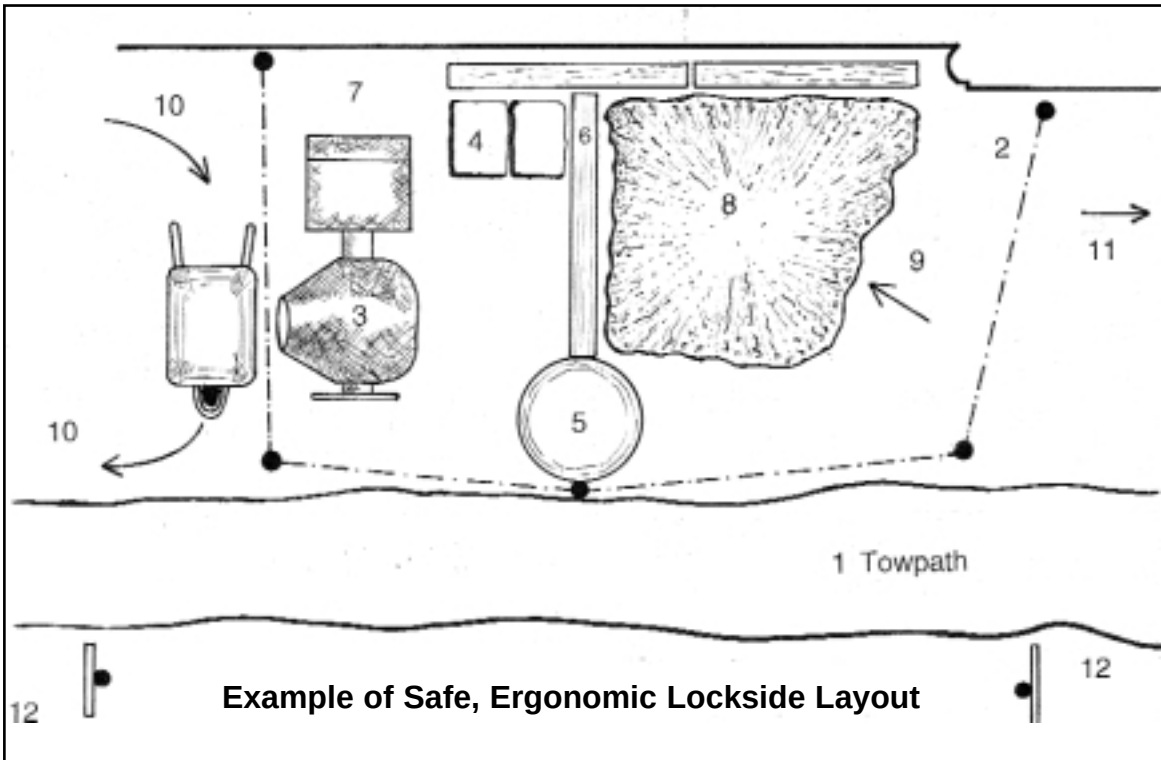
15.4 **Lean mix** is a concrete used for blinding off and it could be as low as C10 strength but is more usually C20.

15.5 **Grout** in this case refers to the suspension of cement and smaller fines in the water. It is important not to lose it as then only the larger fines will exist leading to honeycombing and a loss of density and strength.

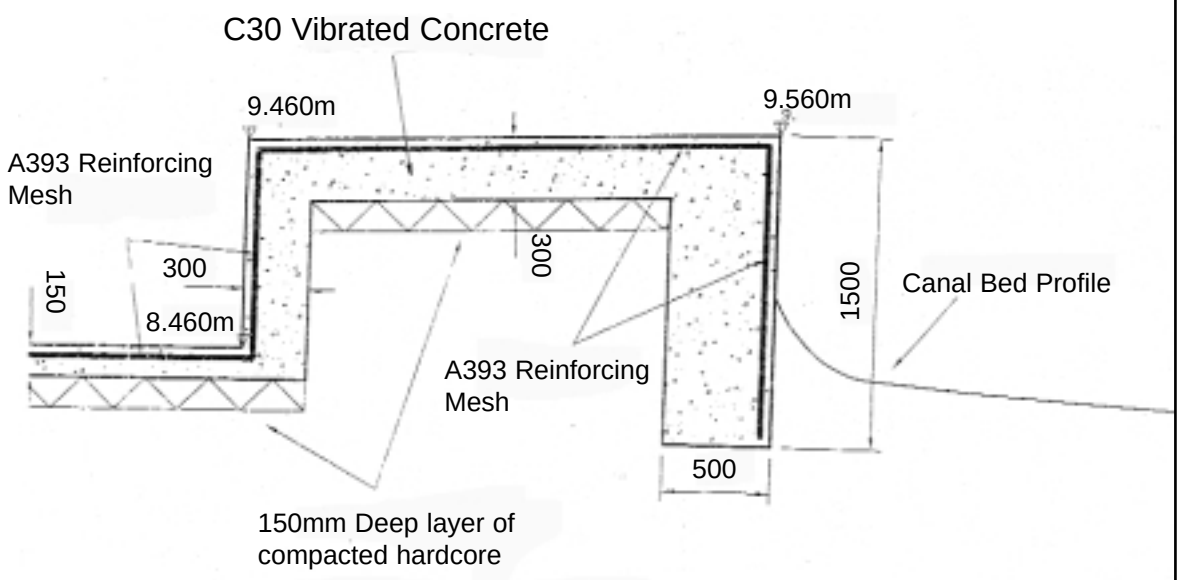
15.6 **Tamping** is the most common finishing technique. A straight, regular, smooth edge (usually a block of wood) is used to gently bounce off the concrete to vibrate the surface and produce a reasonably smooth and regular finish. The block should be raised no more than 50mm above the surface and brought down firmly so as to level out imperfections. Depending on the area of the pour the tamping block may be a small spirit level or a full length scaffold plank and may be worked solo or with a person on either end. Tamping is a skill and requires good coordination, particularly when two people are involved, as the block must move uniformly across the surface with the edge rising and falling onto the surface of the concrete evenly. It goes without saying that the block should be clean and free from splits, warps, etc. and should be cleaned off after use. Depending on the finish required the surface can then be trowelled, etc. if required or left as "tamped".

16. ATTACHED DRAWINGS

Key to Example of Safe Ergonomc Lockside Layout		
Key	**Item**	**Comment**
1	Towpath	Kept clear of materials, workers, debris etc.
2	Safety fence	Ready to be installed when work stops
3	Mixer	Positioned so that it can swing one way for loading and then over for unloading
4	Cement store	Safety stacked and cover over with plastic
5	Water butt	Alternative location would be near the mains water supply
6	Buffer beams	Railway sleepers (or similar) safely anchored to prevent spillage and waste of materials especially into lock chamber
7	Starting area	Enough room to safely start and stop the mixer
8	Ballast heap	Within easy shovelling of mixer and covered over when not in use to prevent contamination, ballast is tipped onto plywood sheets for ease of shovelling and minimum waste
9	Ballast heap	Safe direct tipping from dumper onto heap
10	Barrow run	There should be somewhere safe to hold barrows ready for use and a clear route that doesn't result in every body getting in each others way
11	Fuel store	Safely stored away from the main action
12	Warning signs	As appropriate to the work undertaken



Example of Safe, Ergonomic Lockside Layout



SECTION THROUGH WEIR CREST
1:20

Typical Concrete Structure Design