# FORMWORK FOR TOOLED CONCRETE

*Some design and construction considerations*

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The term tooling refers to several kinds of mechanical fracturing used to achieve a particular visual effect by removing part of the concrete surface. Methods of tooling include abrasive blasting, bushhammering, use of scaling hammers or point tools, and grinding and polishing. Usually the equipment can be powered by small compressors and generators, although an occasional job may be done manually.

Tooling can enhance the color of the concrete by varying the degree of aggregate exposure. Tooling also aids in promotion of good weathering and long-term appearance because it removes the surface skin, paste, or laitance from the concrete. If not removed, this cement-rich skin frequently crazes and exhibits micro-cracking. Pollutants in the atmosphere penetrate the cracks and detract from the otherwise interesting concrete surface.

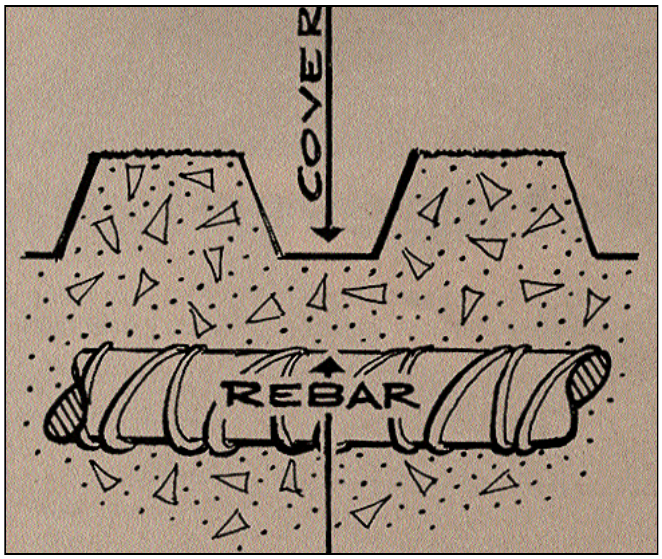
The process of producing tooled surfaces commences weeks or even months before the casting operation. The success of the whole process depends on the achievement of a level of consistency in all stages—commencing with the establishment of standards and proceeding through batching, mixing, handling, placement, compaction and curing, on down to the eventual operation of putting the tool to concrete. Of utmost importance is the initial achievement of sound, well compacted concrete. The removal of the surface of the concrete can accentuate blemishes or inconsistencies. Although with skill and careful selection of tools the effect of such blemishes can be minimized, pockets of bad compaction, areas of form leakage, and batches of concrete of differing mix proportions and flow characteristics should all be guarded against.

## THE DESIGNER'S RESPONSIBILITY

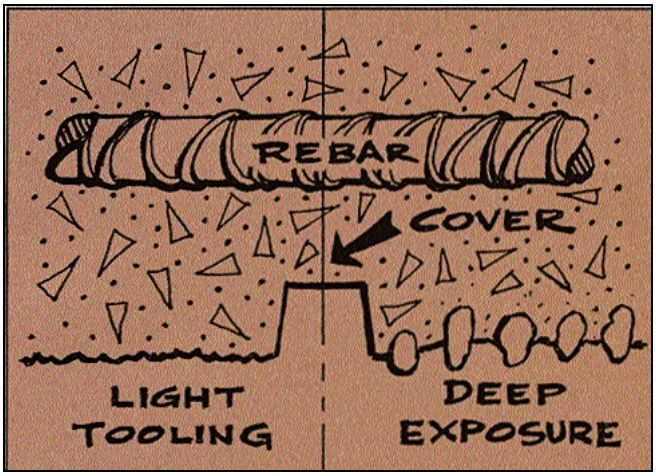
Tooled concrete offers immense scope in surface profile and texture. It can be used in slender sections or in massive forms, sculptured and featured to enhance the play of light on the surface. The range of aggregates readily available in all countries of the world allows the display of exotic colors, while at the same time profile can be planned to give the weathering characteristics which will ensure that the building envelope is practical with low maintenance costs—as well as aesthetically pleasing.

However, the architect or designer must realize that concrete, being a mixture of natural materials, exhibits the variability which would be expected of a raw material in nature. With considerable effort in all stages of production, this variability can be to some extent controlled. The best that even the most conscientious contractor can achieve, however, is some degree of consistency. Absolute uniformity of surface finish is impossible to achieve and much of the skill in design for appearance and weathering depends on the architect's ability to devise profiles and detail which mask irregularities.

Special attention is needed in the detailing stage, at the drawing board where such matters as profile, joint




**To maintain proper cover over reinforcing steel, the designer must allow for the thickness of concrete which is to be removed during tooling. If the surface is ribbed or fluted, remember that the grooves will also reduce protective concrete cover over the steel.**




**A formed groove allows the constructor to get a neat detail at points where finishes change. If grooves are added, be sure they do not reduce cover over reinforcement below the specified minimum.**

location and treatment, rustication, striation, and texture are determined.

## Maintaining cover for reinforcing steel

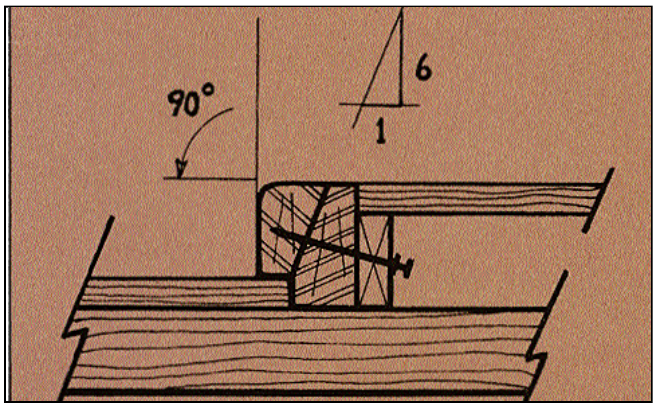
A most important consideration for the designer is that all tooling techniques result in the removal of some quantity of the concrete. This results in a reduction of the specified and valuable cover of concrete over the reinforcing steel, which is so essential to the long-term durability of the structure. *Allowance must be made in detail to compensate for the depth of concrete which will be removed by the tooling process.* Failure to make this adjustment will make the steel reinforcement more vulnerable to attack from moisture and vapor passing through the resulting areas of reduced cover.

## Attention to scale

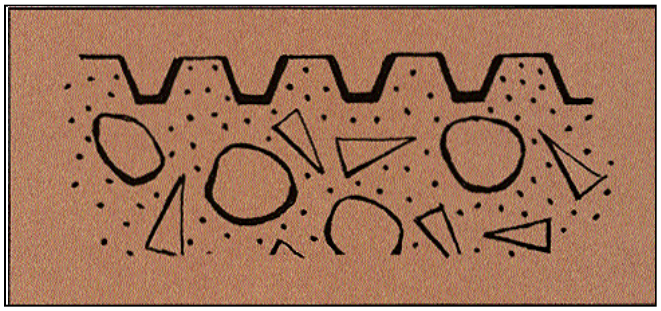
The scale of grooves, ribs, projections, and bands or borders must be in harmony with the overall scale of the structure. Details such as fins, grooves, and the sharpness of projecting members must also be related to aggregate size. There is little point in detailing a sharp corner when it is:

- Likely to be damaged or removed in the tooling process
- Unlikely to be filled by the complete concrete mix, rather only by the sand and cement which comprise the matrix

Where ribbed or striated concrete is being tooled, the so-called "split face" technique, then the designer must make sure that the individual ribs are sufficiently substantial to withstand the forces imposed without shearing at the root. In this context it may be of interest to the designer to consider the formalization of the tooling technique as distinct from the random treatments usually applied (the latter technique not always being as random as the designer would choose).




**Where the design calls for 90-degree angles on projections, a wrecking strip or fillet can be used to provide the desirable draft for the main form. The fillet stays in place, preserving the 90-degree corner, while the main form is stripped.**



**Keep details such as fins and grooves in scale with aggregate size as well as overall scale of structure. There is little point in providing sharp detail which can only be filled by the sand and cement matrix.**

## Joints, grooves, margins

Margins should be left at any projecting corner which is to be maintained as a crisp sharp angle. Joints should be detailed such that the actual concrete join line is marked in shadow. Where there are changes in aggregate or changes in the depth of exposure, color, or texture of the surface these should be marked by a groove.

The designer should be aware that, where no margin is detailed and where tooling is taken to the edge of a panel, the process of tooling will result in a ragged edge or corner. Many designers find this ragged edge acceptable and it can be used to accentuate some feature or detail.

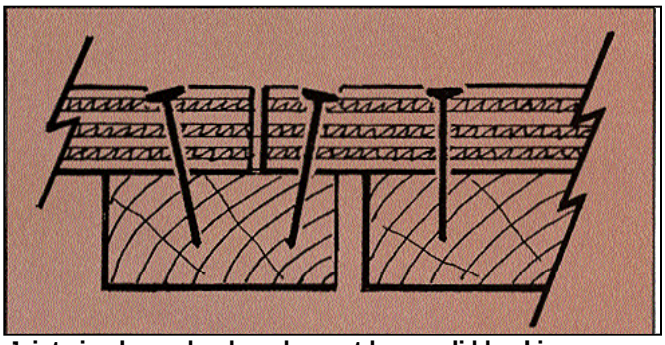
## Draft eases form stripping

Where a feature or panel is to be recessed, or where some feature is to project, a lead or draw should be allowed to facilitate form striking. The normal lead or draw allowed is a slope of 1 in 4, although l in 6 or 1 in 12 can be worked too. The removal of the form will be facilitated by careful application of release agent at site.

Where square-edged recesses are required these can be formed by the inclusion in the formwork of a suitable wrecking strip (see drawing).

## FORMWORK REQUIREMENTS

Formwork for the production of concrete which is to be tooled must be of good quality. The sheathing materials must be sound, close jointed and supported, not only to resist the normal deflections but also to avoid the



**Joints in plywood or boards must have solid backing. Otherwise, flutter or movement of the form face will tend to move large aggregate back into the mass of concrete and draw more fines to the face. Then even heavy tooling will not produce the desired display of coarse aggregate.**

incidence of "flutter"—the vibration of a sheathing face which develops in sympathy with the applied compactive effort. Flutter, particularly at sheathing joints, results in a high intensity of fines at the concrete face. Instances have been observed where, under the influence of external vibration, flutter at plywood joints results in a clearly defined line of fines (with a depth of up to 2 inches) being apparent at the time of tooling. The solution to the problem is to take special care with sheathing attachment to the extent of special fastenings or even the incorporation of loose tongues.

Foam seals and gaskets, required in formwork for as-cast concrete, also have their place in forms for tooled concrete. Wherever water or grout leaks from a form there will be darkening and a loss of fines, causing a blemish which can mar the appearance.

### Placement and consolidation

Where extremely deep lifts of visual concrete are to be cast it is essential that access doors be provided in the back face of the form for concrete placement and the introduction of the vibrator. This can often be arranged by constructing the form such that the back panels are inserted as concreting proceeds. The use of access traps should be limited to the back or non-visual face, as it is virtually impossible to ensure grout tightness or consistency of deflection.

Key points in these situations are:

- The placement of concrete in small batches and the avoidance of dumping
- The introduction of the concrete, as nearly as possible, into its final location in the structure
- Controlled use of vibration whether with pokers or external vibrators
- Sealed sheathing joints and the provision of access for concrete, especially where deep lifts are cast

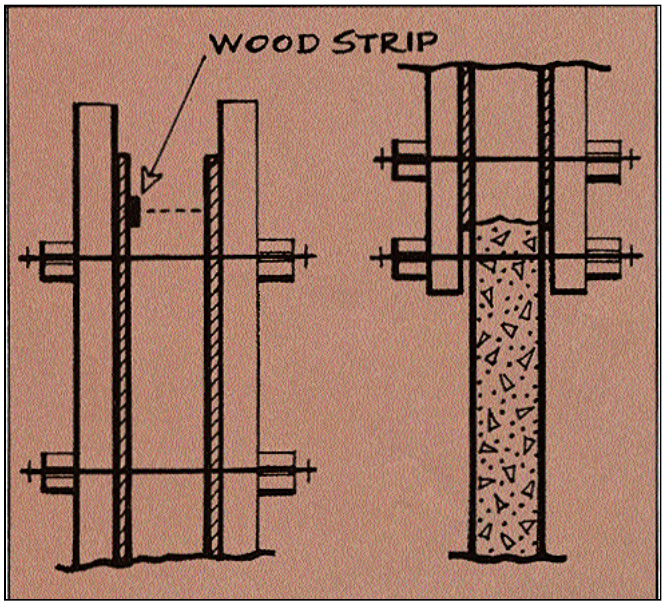
### Joint treatment

Joints in both the form material and the concrete require careful execution to avoid defects in appearance and in performance. Grooved joints, recessed in smooth concrete, ensure that any slight appearance defect is masked in shadow. Where grooves cannot be used, joint rules or strips will maintain a straight-line joint between two lifts or two adjacent bays (see drawing).

The details traditional to natural masonry, grooves between different finishes and the use of raised and fielded paneling, are easily produced by the incorporation of battens at the form face and serve to improve the visual effect.

## CONCLUSION

Tooled concrete offers the architect and designer a means of introducing color and texture into his structure. Generally tooling improves the weathering characteristics of the concrete. Formwork details as well as site control of operations must be appropriate to the required standards of finish if the work is to reflect the extra effort involved in design and detail.




**Where grooves are not feasible at construction joints, a narrow strip (about 1x2 inches) tacked to the outside form can be used to keep the joint line straight. Bulges and offsets can be avoided by keeping ties close to the joint. A closed-cell compressible gasket installed in the second stage between sheathing and hardened concrete will**