Slipform Construction of High-rise Building Cores

This post provides a quick overview about construction of service cores of tall buildings using slipform construction technique.

Slipform construction technique has been gaining a lot of popularity over the years in the construction of mid to high-rise buildings because of the many advantages it has to offer, especially for buildings having about ten storeys or more. For low-rises however, this approach is economically not viable. In previous posts, use of this technique for other tall structures like chimneys, silos, cooling towers etc. was briefly discussed. In case of these structures a non-stop concrete pouring schedule is normally adopted in order to impart monolithic attributes to the structures by keeping joints, voids, discontinuities etc. in the structures to the bare minimum. The same is however not a basic necessity for buildings and hence around the clock concreting too is not a must in the case of slipform construction method for highrises. A day-time-only kind of construction schedule is not uncommon in such projects. Nevertheless, if situation permits, an around-the-clock schedule would always result not only in higher progress but also in higher economy. Quality of the product is also quite superior.

There are several reasons of slipform construction being economical for tall buildings or structures. The key reason is the repetitive nature of the method itself. Once installed, the formwork need not be dismantled and reinstalled again for further use. The same setting continues till the job, in this case the core structure of a high-rise, is complete. Even in the case of a very tall building where the core is sometimes reduced abruptly at certain elevations for various reasons, change in settings of the slipform structure need to be done only at those few particular elevations. This results in saving a great deal of time, manpower as well as materials and thus becomes more economic than conventional methods. The method of construction requires a much smaller group of highly skilled workers as compared to other usual methods including jump-form method. It also needs lesser quantity of forms.

Slipform construction technique is normally adopted for the centrally located service core of a highrise. The service core or simply core of a high-rise building is normally located at the central portion of the building which hosts facilities not meant for dwelling or renting purposes but for common uses of all the occupants or users of the building and are integral parts of any such building. These include the elevator shafts, public restrooms or toilets, ventillation & electrical shafts, stairwells etc.

The foundation of the building core along with starter walls of height 1.5m to 2m are constructed precisely as per drawings to start with. The starter walls, meant for commencing installation of slipforms, must have all the necessary

embedments/provisions including the jack-rods on which the entire slipform unit would climb up. The walls also must have all the vertical reinforcing steel bars with adequate projections.

This entire unit consisting of the slip-forms, cross-beams, platforms etc. are raised in synchronisation along the jack rods by means of hydraulic jacks of suitable capacities. The jack rods, which are usually embedded in the concrete walls of the core itself, can be either sacrificed or removed later on if so planned. For a mid-rise building these can also be suspended from a crane in stead of embedding in concrete walls. Besides fixing re-bars, these platforms are also used for fixing doors and window frames, inserts/embedments, keeping provisions for supports and other openings and so on. Lowermost platform is used mostly for quality related purposes such as monitoring concrete quality, continuous surface finishing of freshly stripped concrete surfaces, curing, rectification of shortcomings, if any, and so on.

The rate of lifting of forms primarily depends upon the rate of setting of the poured concrete. The lowermost portion of the poured concrete inside the slipform must set sufficiently in order to gain enough strength to support itself as well as the layers above it (upto the top of forms) without getting deformed/damaged while the forms are slipped up. At the same time, it should not set too hard and thus resulting in excessive friction between the forms and the concrete surface. That could lead to difficulities in lifting the forms which in turn could damage the still-fresh surface of the concrete as well.

A 300mm lift per hour is common in this method. However, this speed can be somewhat lesser or more as well depending on actual conditions or requirements etc. Proper monitoring of setting characteristics of concrete is hence important in this method. Concrete is continuously poured in layers of suitable thickness and by the time the pour reaches almost top of the slipform the lowermost portion, as mentioned already, must set adequately. Hence, rate of pouring too needs to be pre-planned and monitored accordingly. The forms are normally lifted in a series of small crawls of about 1 inch or so in order to achieve the planned speed of 300 mm per hour or whatever. This process of concrete pouring and lifting progresses continuously without any break unless absolutely necessary or the pour plan demands it. The progress achieved in this method is substantially higher than that of any other conventional method. Typically, one storey height of core can be completed in 2 to 4 days. If round the clock construction with proper planning is carried out, a progress rate of one storey per day too is not impossible.

Highly skilled supervision is necessary for slipform construction of highrise building cores or any other tall structure for that matter. The slipform unit is carefully designed and once accepted, no change should be made in it during construction unless well-examined and approved by the designer. If a crane too is tied to the structure for various purposes such as lifting of steel reinforcement, inserts, frames etc., then the impact of the same on the structure is also considered in the design of the core. Steel re-bars are usually handled by guides which are attached to the

slipform unit itself. Sometimes, ordinary hoists are also deployed in stead of a crane for lifting rebars, inserts etc. from the ground, especially for mid-rises.

Similarly, adequate provision for smooth movements of workers from ground to the slipform structure and vice versa must be in place. The slipform structure itself should have sufficient working space for these movements as well as for working with long re-bars.

Slipform construction, by it's nature, is most convenient for continuous walls with virtually no or minimum joints or projections. However, that is not the case in a building whether it is a concrete-framed or a steel-framed one. Good number of connections such as, connections for slabs, beams etc. are bound to be there which need to be meticulously addressed to right from the beginning stage. Proper pre-planning and adequate care during execution are of utmost importance, especially in the case of pull-out bars for in concrete-framed buildings or steel inserts in steel-framed ones.

As discussed in an earlier post, verticality of any tall structure including building is of extreme importance as any negligence on that could result in development of eccentricities in the structure which is utterly unwanted. Tolerance limit for verticality must be well stipulated for any highrise. Usually, the same for lift shafts are stipulated by the lift manufacturing or installing agencies themselves. Effective mechanism for monitoring verticality of the structure right from the beginning must be in place in order to avoid deviations at any stage of construction. Verticality at no point of time during the entire construction period should go beyond the prescribed tolerance limit.

An efficient communication system, good co-ordination, high safety standards are some other basic requirements of successful implementation of slipform construction of high-rise Buildings.

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