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Evaluation of Precast Exterior Panel Walls (Used in Tunnel Formwork Applications) in Terms of Environmental Quality

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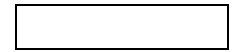
Abstract:

The scope of this work is the research of the positive esthetical effect of precast panel walls used in residence buildings' facades that are built in the system of tunnel formworks. The target of the work is the determination of the effect of this usage to environmental quality. Tunnel formwork systems are being preferred because of fast and economical production despite the housing shortage in Turkey. Moreover, these systems contain durability, quality and esthetic in its structure. During the tunnel formwork system execution precast panel walls usage, accelerate the production. In addition to this it provides advantages in the aspects color, pattern and solid. Panel walls and balcony parapet walls are produced in either factory or in situ. Then these walls are being integrated to the system gaps that have already being left for them. These pre-produced panel walls do not need any additional effort for the integration except painting and reduce the monotony of the tunnel formworks. In the extension of this work, the visual quality that gained from the usage of panel walls and balcony parapet walls has been observed. These tunnel formwork examples contain both panel exterior walls and non-panel exterior walls. Finally, the positive effects of using precast panel wall in tunnel formworks to the environmental quality and city silhouette are exhibited.

Keywords:

Tunnel formwork, precast facade panel, environmental quality

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1. Introduction:

Rapidly growing population, developing technology and exigency to use limited investment resources rationally have uncovered different insights in residence building production. Increase in residence building needs have generated rapid and economic residence building production and these needs have been tried to be met by industrialized production systems [1]. In Turkey, instead of industrialized production methods having high pre-investment costs, tunnel formwork technology is being used in a wide spread manner. It has been accepted as the most ideal denouement recently in terms of being compliance for earthquake conditions by dint of being a monolithic (single-piece) and reinforced-concrete structure. This system used commonly in residence building applications in Turkey; besides rapidity and economy, is also seen as one of the construction technologies embodying strength, quality and aesthetic [2].

“Tunnel formwork is a cast in-situ technique of industrialized construction techniques and is a production system that formworks made of three-dimensional steel can be removed by getting them move transversely and longitudinally, and both vertical and horizontal structure elements can be poured at the same time” [3].

This system, enabling cast in-situ of bearing walls and floors bodily and with single operation, is similar to traditional production system in this regard. However, it is accepted as a semi-preconstruction system with usages of prefabricated construction elements in the way of qualifications of the system. In this system, construction elements like facade elements, stairs, landings, partition walls, chimneys etc. are produced as preconstruction materials and combined with the main structure poured in-place [4].

Since necessary strength is given to concrete via curing in tunnel formwork system, removing the formwork at once and re-pouring concrete in short time, then starting production in top elevation is possible. As in traditional production systems, despite the fact that the process of gaining enough strength of concrete is 21 days under normal conditions; in tunnel formwork systems, concrete can gain enough strength in a short span of 24 hours with curing. In the course that concrete takes its setting in short time and of implementation of the system, taking the advantage of precast structural elements forces the pace of production [4]. By force of clean and smooth formworks used in this system, concrete surfaces become flat and thereby time and cost savings are provided during the painting on account of surface smoothness and cleanliness [3].

Besides the fact that traditional systems can be used in tunnel formwork systems while shell structures are being constructed, precast building elements which integrate with the structure are used as well. And this is the demonstration of the fact that mass-production can be used not only in load-bearing system but also in building elements.

2. Precast Exterior Panel Walls Used in Tunnel Formwork Systems

Precast elements accepted to be preconstruction system are divided into three as bearing, self-bearing and beared systems. Preconstruction elements used in tunnel formwork systems are in self-bearing and beared groups. Panel walls, balcony parapet walls and roof parapet walls can be exemplified in this group [5]. Prefabricated building elements in the production of which; concrete, light concrete and steel structural materials are used, can be produced both in factories (Photo 1) and in-situ (Photo 2).



Photo 1. Factory in which precast building elements are produced [Archive of Korur]



Photo 2. Casting precast element atelier established in-situ [Archive of Korur]

Precast panel walls are produced on the vibratory tables prepared for them. Along with pouring additive concrete on the reinforcement placed into the table appropriate for the project, they are also exposed to vibration (Photo 3). A homogenous dispersion of concrete is provided thanks to the vibration which makes the concrete get into the reinforcement adequately. Then the concrete delivered to curing process by closing its upper panel is removed out of formwork after reaching enough strength.

Panel walls that can be produced in factories or in-situ are levered by cranes to floor on which assemble will be performed (Photo 4). In response to elements already placed to precast panel walls, there are lamas and profiles to catch the same axis on shear wall and floor slab. After completing the connection of precast panel wall to profile on shear wall, the same process is applied to all floors. After all precasts are got to plummets by performing all adjusts from sub floor, they are welded to lamas present on the floor [7].



Photo 3. Production of precast panel wall on vibratory table
[Archive of Korur]



Photo 4. Carrying the precast panel wall to its place
[Archive of Korur]

2.1. Precast Panel Walls

Panel walls used in residence buildings built with tunnel formwork technique is the leading of building elements quickening the production in the course of application and gains advantages in terms of design flexibility, configuration, massive, aesthetic and economy. In addition to these features;

- Structural adequateness,
- In terms of shell structure,
 - Providing thermal comfort,
 - Providing noise control,
 - Resistance to fire,
 - Long resistance and service life,
 - Simplicity of maintenance and repair,
 - Gaining visuality to building,
- In terms of scale of production,
 - Providing time saving on account of the pace brought to production,
 - And advantage of providing saving of labor force can also be counted [6].

Precast panel walls' surface that can be produced in desired color and texture, can also be produced without texture and with texture discretionally. Panel walls which are ready to be painted and require no extra labor thanks to patterns processed to surfaces in the course of production reduce the monotonousness of the tunnel formwork on a vast scale which is a repetitive system [2].

Connection type of precast panel walls to the systems during assemble and cavities occurring between the shear wall and the panel create problems as thermal and visual. This problem is solved by wick and acrylic based sealant paste in the applications which

keep the costs at the forefront. As to some applications, user comfort is kept at the forefront by means of using quality impermeable materials and creating details on the precast panel walls in some applications. In addition to this, staining occurs in time in consequence of the fact that surfaces of the precast panel walls were produced with texture. For cleaning this staining, extra cost and labor are necessary.

In the situations that external insulation would be difficult to be made for precast panel walls with single layer (high buildings, cold climate regions), using sandwich panels can be looked as a solution. Sandwich panels are produced by placing heat insulation material between two concretes (Photo 5). While external panel provides aesthetic and insulation, inner panel acts as a bearing performing assemble to shear wall and floor (Photo 6).



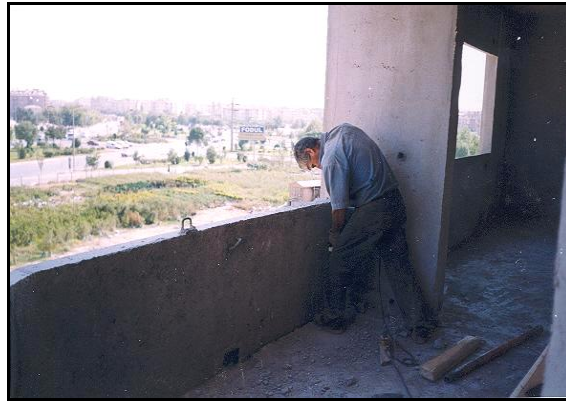
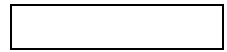
Photo 5. Sandwich panels having heat insulation material in the midst
[Archive of Korur]



Photo 6. Application of Sandwich panel walls
[Archive of Korur]

2.2. Precast Balcony Parapet Walls

Balcony in tunnel formwork systems is accomplished by using precast balcony parapet walls on the consoles ascended with floor slab or by traditional materials without pre-production. Balcony parapet walls produced as prefabricated are carried via cranes and ascended to floor level to be assembled. The precast panel placed on the floor is balanced considering floor concrete and shear walls. Thereafter, assemble to its place is performed by welding lamas one another that were placed to the parapets and the shear walls in the course of production (Photo 7).



Resim 7. Assemble of precast balcony parapet walls in situ
[Archive of Korur]

3. Effects of Precast Panel Walls to Environmental Quality

Artifactual interventions to the nature generate built environment. As for the most significant elements of the built environment are buildings. And residence buildings have the most common production percent among buildings. Nominative qualities of the elements creating the built environment militate environmental quality in all. For that reason, facades that are environmental faces of buildings are the main factors affecting this quality. Increasing the qualities of residence buildings' facades add up to increase in environmental quality. In the context of this pursuit, different solutions are applied in housing blocks produced with tunnel formwork systems. Because formwork elements used in this system and having long service life, are used for the nth time in different projects. Having deficiency of design flexibility and being iterant in tunnel formwork system, housing blocks resembling each other a lot emerge. Wherefore, precast panel walls and balcony parapet walls are used with the intent of increasing aesthetic quality on building facades. Precast panel wall (a) and brick laid wall (b) are seen on two different residence buildings' facades produced with tunnel formwork in Photo 8. Aesthetical diversity of the facade which was built by textured precast panel wall is perceived in comparison to the facade which was built as brick laid wall.



(a)



(b)

Photo 8. Precast and brick facade details [Archive of Sayın]

And in Photo 9, two different residence buildings' facades produced with tunnel formwork system are shown. Visual diversity that precast panel wall (a) and brick laid wall generate, is perceived when facade of the building is looked bodily in vertical. Plain facades are preferred since applications enabling aesthetic values (joint gap, doorjambs etc.) require extra cost and labor for brick laid wall facades (b). Therefore precast panel walls in tunnel formwork systems are used widely.



(a)



(b)

Photo 9. View of precast and brick facades [Archive of Sayın]

Balconies used in residence buildings' facades produced with tunnel formwork system can be precast panels as well as being metal profiles placed on concrete floor, aluminum - glass profiles or vertical and horizontal metal profiles on semi-parapet walls. Balcony details belonging two different buildings produced with tunnel formwork system are seen in Photo 10. Massive of balcony with precast panel comprises more positive effect visually comparing with traditional balcony characteristic.



(a)



(b)

Photo 10. Details of precast and traditional balconies [Archive of Sayın]

The effect of balconies with precast panel (a) and with semi-metal balusters (b) on iteration in vertical and building facade is compared in Photo 11. User interventions which are performed for the purposes of safety, confidentiality and functionality for balconies with semi metal-glass balusters are much more conspicuous compared with balconies with precast panels, and impinge on environmental quality in negative way.



(a)



(b)

Photo 11. Facades with precast parapet wall balcony and metal balusters balcony [Archive of Sayın]

Aesthetic value composed on residential building facade by the usage of textured precast balcony panels in tunnel formwork system together with metal profiles and color-texture differences made in patches impinge on environmental quality in positive way (Photo 12-a). As to the residential buildings for which balconies with traditional elements and brick laid walls are used, monotony occurs in terms of visual side and an unexpressive facade characteristic emerges comparing with precast panel facade (Photo 12-b).



(a)



(b)

Photo 12. Harmony of balcony and wall elements on the facade [Archive of Sayın]

Besides the fact that the service life of formwork elements used in tunnel formwork systems is long and since the costs of pre-production are high, they are generally used in mass housing applications. This feature of the system provides the occurrence of building blocks having the same character instead of wards having different characters. Facade characters of these wards which create a significant part of city pattern affect city silhouette. Wards that are generated by residential buildings, which precast panels are used (a) and unused (b) are seen in Photo 13. Dynamism performed for precast panels by different shape, texture and color reflects on the facade and environmental quality is increased by providing visual richness instead of monotonous iteration.



(a)



(b)

Photo 13. Housing blocks produced with tunnel formwork system
[Archive of Sayın]

4. Conclusions:

Due to the continuous increase in human population, it is necessary to produce housings having eligibility to be able to meet requirements as soon as possible. In the context of this pursuit, tunnel formwork systems are used especially in housing productions widely. Being a monolithic structure into the bargain; tunnel formwork system also enables resistance for earthquake and fire, and a rapid production owing to precast building elements, assemble of which is provided in-place by pre-production. In spite of having expensive pre-investment cost, this cost decreases substantially thanks to being applicable many times and on condition that accurate planning is performed.

Besides the fact that the usage of precast panel walls and precast balcony parapet walls decreases the cost and quickens the production, they also offer a visual richness for facades of buildings. And the usage of precast panels produced with texture, instead of brick materials, gains aesthetic quality for facades. As to the usage of precast balcony parapet walls seems more monolithic in visual and massive aspects comparing with applications of metal or semi-metal parapets. Since the usage of precast panel walls

increases the aesthetic levels of buildings, they offer positive effects for city silhouette and environmental quality in general point of view.

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