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Repairing and Extending the Lifespan of Chimney under Severe Conditions

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Summary

The main chimney of the one and only heat-generating plant located on the island at the seaside was erected with initial faults of concrete shell. During the period of over 20 years the structure has been examined several times. As a result of specific localisation the chimney was exposed to severe conditions of wind, moisture, and salt attack. First time, after several years of use the emergency repair works were necessary, and in the next few years other serious repairs have been applied. Finally, the problem of radical strengthening appeared in 1997, as the existing plant must work for the next five years, at least. Description of diagnosis, recent repair methods, and final strengthening are presented in the report.

Keywords: concrete structures, concrete chimneys, extending the lifespan of structures, repair and reconstruction, strengthening of structures.

1. Description of the structure and recent repairs

The cylindrical reinforced-concrete chimney 80.5 m high, with internal duct diameter of about 3.20 m, was built by means of original method of double slip-form. The idea of the method was to erect the external shell from ordinary concrete, 0.22 m thick, and simultaneously, the internal shell from refractory concrete, 0.14 m thick. Between these two shells the insulation 0.12 m layer from granulated slag was provided.

The results of the experimental use of double-slip-form were rather poor. Serious faults on the surface of external shell, as well as on the internal surface of lining were noticed very soon after erection. After seven years of chimney use the first repair was undertaken. The vertical cracks up to 3 mm width were recorded in the lower part of external shell. To strengthen the chimney, particularly around the flue openings, the steel hoops along the whole lower half of the origin shell were introduced from outside. Epoxy resin was used for injection filling of main cracks.

Five years later, much worse situation was observed during inspection. The vertical cracks in the lower part exceeded in some places 20 mm, and the length of cracks was 15 m or more. It was the result of thermal influences due to destruction of internal lining and insulation layer, as well as external action of severe atmospheric influences on cracked concrete surfaces.
The strengthening of the chimney up to the level of 35 m (in form of R.C. shell, 0.12 m thick), new lining at the bottom part, and extension of hoops up the top of chimney were introduced. Such a kind of strengthening was possible because the foundation slab was relatively strong and supported by 39 piles 12.0 m long. The additional mass of concrete in the lower part of structure was advantageous for the improvement of dynamic response of the structure.

2. Present reconstruction

As the heating plant have to be in use for about five years (prior to erection of new one in another place) two possibilities about the chimney have been taken into account. First one was demolishing of the structure and erection of new multi-channel steel chimney on the former foundation. The second one was to extend the lifespan of the existing structure by means of strengthening of its upper part. On the basis of the feasibility study, considering the economical aspects, the second way was decided. The strengthening of structure should not increase significantly the weight of total chimney. Therefore, the most popular method of introduction of the new outer shell was not useful in this case. On the other side, the real time of suitable assembling of strengthening members was up to half a year due to climatic conditions.

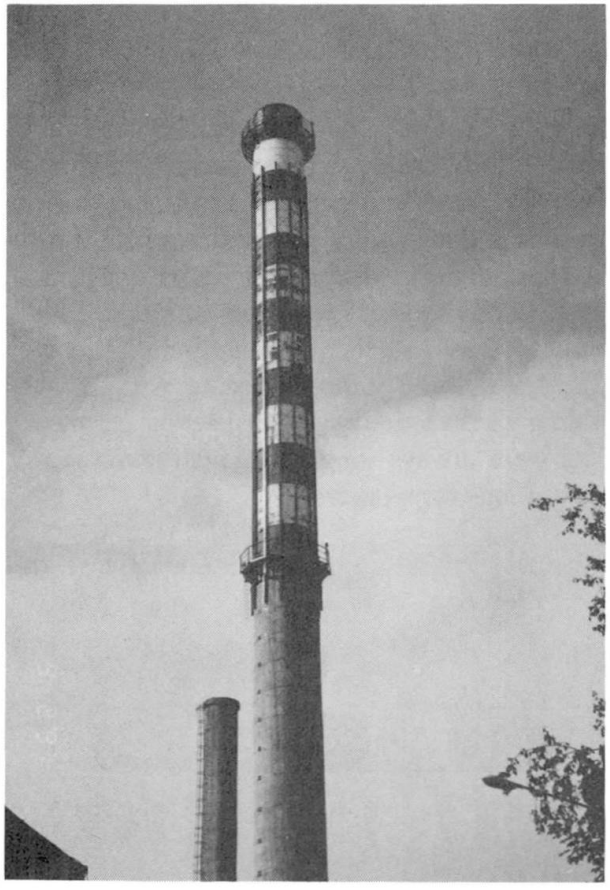

Fig.1: Overall-view of strengthened chimney

Finally, the steel external structure consisting of 12 columns and system of crossing tie-bars was designed. The vertical columns were fixed in the reinforced concrete shell of the lower part, made from the strong concrete. It created the kind of braid which was matched exactly to the real shape of structure. To ensure the possibility of simple and safe work, without heavy cranes, the elements of columns were divided into segments about 4.0 m long. All the assembly connections were bolted. High strength friction grip bolts were used in joints. The base of the braid was provided in form of strong ring with twelve arms anchored in the lower concrete part. Before fixing the anchors the layer of epoxy mortar was used to adjust the rigid ring to the existing concrete set-off. It was the only "wet" work during assembly. After preparation of steel members and trial assembly in the workshop, all the strengthening structure was erected in about six weeks with few breaks according to weather conditions. Another four weeks took the finishing of the surfaces of concrete and final painting.In this particular case the method of strengthening was assessed as over two times cheaper than the new external concrete shell.

Building Construction and Maintenance in Croatia

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Summary

In the first part of the paper, there is the description of the pre - transition situation with the analysis of construction, maintenance and the conditions of using the apartment buildings data. The property structure is also analysed as well as the space owner's attitude towards the rent payment and building maintenance. In the second part of the paper, there is a short survey of the housing fund demolition during the war in the Republic of Croatia. The third part of the paper gives the analyses of the privatisation conditions as well as their influence on the building infrastructure which has already been constructed. In this part, there are some information about the model and the structure of the privatised apartment buildings. The authors mentioned some law changes and the new model of maintenance building infrastructure.

1.Pre-Transition Period

During this period construction of new buildings had to symbolise the advancement of society, for which the ruling political party took credit. Housing buildings in particular played a key role in the philosophy which stated "every worker has to have a flat". Every year waiting lists were created and workers were ranked according to their employment and social status and then money for purchasing flats or crediting was distributed accordingly. It was common practice for companies and organisations in large cities to purchase flats and then to distribute them to employed personnel and their families with lifetime rights for usage of the real estate, with only a minimum charge of 10-30 DEM / month / flat. Building construction was consistently oriented on multi storey city housing buildings. Waiting lists were always long and construction was never able to keep up with the necessary demand for dwellings for workers.

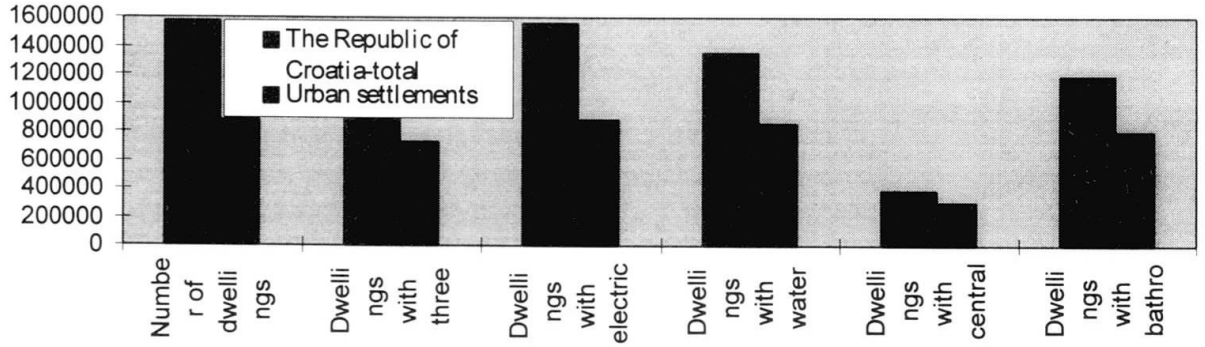

Figure 1 Housing fund according to number of rooms, installations and the other rooms-1991 census