Architecture of Concrete Prefabricated Apartment Houses in Slovakia in Relation to the Nesting Habits of Delichon Urbicum

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Abstract. Czechoslovak Republic faced the serious need of dwellings for more numerous post-war generations in 50’s up to 70’s of the 20th century. New technology of the modular concrete high-rise apartment houses enabled an extensive mass construction. From 90’s of the 20th cent. increasingly more strict demands regarding thermal insulation properties were applied and the most frequently chosen technology to deal with them was ETICS added to concrete external walls. Interaction of various bird species and insulated façades, not limited to failure or damage, are interesting theme. This research deal with the nesting preferences of Delichon urbicum species in relation to the characteristics of architecture. The housing estate Solinky in Žilina in the northern Slovakia was a locality chosen for monitoring and analysis as housing estates belong to the important nesting/breeding grounds of the several bird species. In order to maintain ecological balance, necessary architectonical features should be provided as nesting sites in context of the topology of houses and paper identifies them. Future lies in solutions for coexistence of apartment dwellers and bird species in urban space.

1. Introduction
Czechoslovak Republic faced the serious question of inadequate quantity and quality of dwellings for more numerous post-war generations in 50’s up to 70’s of the 20th century. New technology of the panel – modular concrete high-rise apartment houses was the answer. The very first of this relatively cheap, quick to assemble prefabricated buildings was built in 1956 in Bratislava during 6 weeks and extensive mass construction soon followed in the whole republic. Such a massive activity had favourable conditions – many people in the active, young work force, new technologies, strong pressure of the state organized planning system and extensive areas of the state owned land at the outskirts of the rapidly spreading towns. Housing estates underwent another wave of building activities from 90’s when increasingly more strict demands regarding thermal insulation properties were applied. The most of the concrete sandwich panels of this apartment buildings got new added external insulation layers. The most frequently chosen technology is ETICS (External Thermal Insulation Composite System) using cheaper polystyrene boards or mineral wool boards with increasingly thicker layers applied straight on top surface, without ventilated gap. Wide variety of problems appear on the ETICS insulated façades – from construction failures to biotic damage (algae, fungi stains).[1] Interaction of various bird species and insulated façades, not limited to failure or damage, are interesting theme. Authors, who dealt with it, could be divided roughly into two categories. The first are building engineers concentrating on the construction or material issues mainly in the context of ecology and energy consumption. The second
group are specialists – ornithologists, dealing mainly with preserving endangered species of birds and bats, who are rapidly disappearing because renovations changed opportunities for nesting of this species. Usually both groups stand in the antagonist positions – one is defending building (maintenance, failures, damage) and the other is defending animals, disappearing also due changes in the housing politics and agricultural techniques.

Common ground is often limited to looking for means of how to incorporate artificial nests into the construction and application of protective measures like strengthening of ETICS surface or using mineral wool, that seems to be less attractive to species, usually nesting in the tree cavities. Ornithological associations (most often civic associations, e.g. SOS/BirdLife Slovensko) usually deal with mapping and identifying preferential sites of endangered and protected bird species, creating literature and guides, creating also the Atlas of Birds as a basis for land management and animal protection.[2]

No research (as far as it is known to the authors) has so far dealt with the breeding habits and nesting preferences of each species in relation to the characteristics of architecture such as dimensions, surface material and texture, the height of the building, the number of floors and the orientation of the building or the impact of the noise or nearby traffic on the number of nests. The article is one of the parts of the survey of the occurrence and nesting habits of several detected bird species. This paper is limited to the one of the bird species - the common house martin (*Delichon urbicum*), belorítka domová in Slovak. The one sample of the housing estates with prefabricated modular concrete apartment buildings was used (description follows) – housing estate Solinky in Žilina in the northern Slovakia.

2. *Delichon urbicum*

*Delichon* is a small genus of passerine birds of the swallow family, containing three species named as house martins. The common house martin (*Delichon urbicum*) is a migratory bird that breeds in Europe, North Africa and temperate Asia and migrates to winter in sub-Saharan Africa and tropical Asia. Birds use human-made structures for its closed cup nest from mud pellets, usually under eaves or door/window openings on buildings. Nests are often located at the junction of surfaces, so the structure is stabilised by attaching the nest to the both planes. *Delichon urbicum* uses more the outside of inhabited buildings.

![Figure 1. Delichon Urbicum at Solinky, Žilina, May 2018 - colony and nests building. Photo Grúňová.](image)

2.1. Nesting habits of the *Delichon urbicum*

*Delichons* build nests usually in colonies; nests may be built in contact with each other. It is much more urban than the barn swallow, and will nest even in city centers with cleaner air [3]. A colony size of less than 10 nests is typical, but there are records of colonies with thousands of nests. Four or five white eggs are usually laid. The female does most of the incubation (for 14–16 days). The newly hatched chicks after a further 22–32 days (depending on weather) leave the nest. The fledged young are fed by the parents for about a week after leaving the nest. Occasionally, first-year birds from the first brood will
assist in feeding the second brood. The nest being reused for the second brood, and repaired and used again in subsequent years if not removed from the building.[4]

2.2. Area and height of living, parasites and population numbers
This species hunts at an average height of 21 m (69 ft) during the breeding season, but lower in wet conditions. The height of 21 m is the height of 5th or 6th floor of the prefabricated concrete apartment houses, depending on the height of the ground floor with entrance and sometimes partially subterranean storage and technical rooms. The hunting grounds of the Delichon urbicum are typically within 450 m (1,480 ft) of the nest, with a preference for open ground or water. [5] It is parasitised externally by fleas and mites, e.g. Ceratophyllus hirundinis, and internally by endoparasites.[6] The nests typically contained more than 29 specimens of ectoparasite, with C. hirundinis and Oeciacus hirundinis the most abundant.[7,8] The common house martin has a large range (estimated global extent of 10,000,000 km²) and its population in Europe is estimated to be 20–48 million individuals. There is evidence of population fluctuations, however in Europe population numbers indicate a declining trend (poor weather, poisoning by agricultural pesticides, lack of mud for nest building due to warming of the climate etc.). Delichon urbicum is protected by Slovak law, the social value of this bird is set to 460€ per one bird.[9]

2.3. Problems and challenges
This species was chosen for its numerous occurrence in the monitored housing estate Solinky in Žilina (see Chapter 3). Delichon do not cause significantly direct damage to the insulation systems of the façades. The nests leave after their removal (or spontaneous fall in the winter) stains of mud that are difficult or impossible to remove entirely. During nesting they restrict the use of flats – often it is impossible to open window without destruction of the nest attached partly to it. They leave significant amounts of droppings on the window sills, which often fall over multiple floors and covers also surface of adjacent façade. The glass parts of the façade, which are difficult to reach for maintenance and cleaning - e.g. glass façades of staircases (fixed glazing, higher floors) are also polluted. Birds bring various insects as food, which sometimes escapes from the nest, or birds-transmitted parasites spread from the nests. Delichons could also be quite noisy during nesting.

How to provide this bird species with the possibility of nesting to ensure its survival and hassle-free living with residents remains a challenge for further research. The article is focused on the first stage - the identification of preferred nesting sites. Based on the conclusions, it is then possible to effectively define the range of possible design / architectural solutions and in particular, to justify the urgent need to address nesting possibilities of slowly vanishing bird species.

3. Žilina and its housing estates
Žilina is a seat of region (kraj) and district (okres), a town in northern Slovakia. It lies on the confluence of the rivers Váh, Kysuca and Rajčanka on the geographical coordinates 49° 13′24.39″ N 18° 44′21.58″ E. Its area is 80.03 km² and the altitude of the Marian Square (historical center) is 345 m. m. With about 81,000 inhabitants, it is the fourth largest city in Slovakia. It is the administrative, economic, transport and cultural center of northwestern Slovakia. The territory of the city of Žilina is divided into 20 city districts, of which 4 are housing estates composed mainly of prefabricated houses: Hliny, Vlčince, Solinky and Hájik. Hliny is the first and oldest settlement. It consists of 8 separate parts of Hliny I-VIII, associated in urban complexes Hliny I-IV and Hliny V-VIII. The construction took place between 1955 and 1977. The housing estate contains approximately 6,000 housing units - about 25,800 inhabitants live here.[10] Vlčince is the largest settlement in Žilina regarding its area, with about 20,000 inhabitants being the second largest regarding population. The settlement has 4 parts Vlčince I-IV., about 7,500 apartments in total. Construction took place in 1971-1982. Solinky, see figure 2, are the third housing estate with prefabricated houses built from 1981 to 1988. Two other dwelling houses (multifunctional and rented) were built later in the 1990s. There are about 4300 flats in Solinky and about 13 000
inhabitants. There are three primary schools, a post office, shops and a shopping centre with cinema halls, a gas station, garages and the Roman Catholic Church of the Good Shepherd sanctified in 1999. The names of the streets in the housing estate are named after trees: Osiková, Limbová, Platanová and Dubová. Chrast' Forest Park connects Solinky with Vlêince. [11] The last one is the Hájik housing estate, built on a raised terrain terrace west of the Žilina center. It has 2 parts Hájik I. and II. (1987-2007) and a smaller set of family houses Hájik-South. There are approximately 8200 inhabitants.[12]

4. Research

Research consisted of two phases. The 1st phase was done in-situ, counting bird activities, localities were marked on the map with detailed information about height (floor above ground) and type of activity: active nest, attempt to build a nest, fragments and marks left after nest removal, protective measures made by inhabitants of the apartments. Typical and unique activities were documented by series of photos (LUMIX FZ330 ultra zoom). All monitoring was repeatedly done in the area of whole housing estate Solinky during breeding/nesting season from May to July in 2018. Various bird species were recorded, Delichon urbicum was chosen as particular topic of this article. 2nd phase of research contained creation of 3D models, statistical and other analysis and conclusions done off site up to May 2019.

![Figure 2](image.png)

Figure 2. left: 3D model of housing estate Solinky; right: scheme of Žilina, Solinky housing estate is marked by dark grey, south of town centre. Schemes and model Grúňová, 2019.

Apartment houses of Solinky can be divided into 4 groups: 7-storey longitudinal concrete prefabricated houses (yellow on figure 2), 10-storey prefabricated high-rise houses (orange), 12-storey prefabricated high-rise houses (red) and other. 10-storey and 12-storey houses have the same construction, only different number of floors. Other group contains multifunctional house with shops on the ground floor and 7 floors of apartments above (magenta); 5-storey special apartment house (green); 4-storey rental apartment house with mansard roof (violet). Almost all types see figure 3.

Monitored number of 7-storey apartment houses was 48, they had total length of façades 7 776 m, total area was about 186 600 m². Two of 7-storey houses were in original state, without any added insulation (length 260m, area about 6200m²); one house had insulated only the short end façades without windows (uninsulated length 142 m, area about 3400m²). 16 of 12-storey apartment houses were monitored with total length of façades 1 280 m and area about 46 080 m². 5 of 10-storey apartment houses were monitored with total length of façades 400 m and area about 12 000 m², all with ETICS
insulated façades. In the other group were multifunctional house with 272 m² total length of façades and about 5700 m² (only 26 m of insulated façades, area about 545 m²); rental house – length of façades 96 m, area about 1152 m² (fully insulated); 5-storey special use apartment house – length of façades 132 m, area about 1980 m² in original state without added layers of insulation. Buildings with ground floor only (shops, technical equipment, schools, kindergarten and garages) were included – some of them provide nesting sites for other bird species, but not to *Delichon urbicum* – no nesting activities past or present were detected.

![Figure 3](image1.png)

**Figure 3.** Almost all types of concrete prefabricated houses of Solinky – from left: Multifunctional house with apartments and shops (1990s), red-white house with rental flats (1990s), high-rise 12-storey house in the centre and on the left; 7-storey longitudinal type of dwelling house.

5. **Distribution of nests by location**

In figure 4 was plotted the location of active nesting sites, as well as traces of discarded nests, unfinished nests and barriers placed by apartment dwellers.

![Figure 4](image2.png)

**Figure 4.** Left: Active nests, right: Barriers to nesting. Created by Holešová, Grúňová, 2019
The nesting sites are concentrated in three highly visible main foci on the streets Limbová, Borová and Platanová, confirming habit of nesting in colonies usually of more than 10 nests. It is evident, that even the various barriers or removals / natural fall-off of the nests do not completely discourage birds from setting up the new ones. Therefore, it is important to count on possible nesting places when designing the building so that the residents of the flats and birds can live in symbiosis with each other. For this reason, the behaviour of birds in housing estates should be repeatedly monitored.

6. **Height distribution of nests and location according to façade direction**

Monitoring of the active nests suggests that the most nesting sites are concentrated on the sixth floor (approximately height 20 m above ground), regardless of the height and number of floors in the building. The fourth and fifth floors are among the next critical floors in regard of nesting preference. This confirms correlation with the usual hunting height of 21 m, which corresponds to the fifth or sixth floors of the building, depending on the height of ground, technical floor with entrance. Therefore, these floors should contain built-in structural elements that allow birds to nest without negative influence on the apartment dwellers.
Analysis of nesting sites locations in context of the direction the façade containing nests is facing showed that *Delichon urbicum* prefer the north side. It is evident also from the figure 7. In addition to the northern side, the birds prefer also several nesting sites on the east and northeast facing façades. This can be largely related to the climatic conditions for nesting during the late spring and early summer (May until July), where birds choose the coldest side. Some south and other warmer directions façades were chosen probably also as the least preferred, but available places in the area of the colony.

![Figure 7. Number of active nests per floor in storey apartment houses, created by Holešová, 2019](image)

**Figure 7.** Number of active nests per floor in storey apartment houses, created by Holešová, 2019

7. **Comparison of noise level factor - noise façade versus quiet courtyard façade and greenery**

Research suggests that the number of nesting sites on the noisy side – façades facing the road is almost the same as the number of nests per side in relative silence. More interestingly, the greater part of the nests facing north, northeast and east is on the noisy side. Temperature factor was clearly chosen as a more important over lower exposure to noise. In case *Delichon urbicum* chose the south side, most of these nesting places are oriented towards the quieter part towards the courtyard and the greenery, but higher trees are not close to the façades. Also this nests on the warmer façades were facing to the colony focal point.
8. Conclusions

By joining the EU, Slovakia has committed itself to ensuring the necessary protection for all major European animal species. Birds and bats are of interest to international conventions, namely: the Bonn Convention (Convention for the Conservation of Migratory Species of Wild Animals) and the Berne Convention (Convention for the Protection of European Wildlife and Natural Habitats). In addition to the specific protection of animal species, Act no. 543/2002 Coll. defines also general protection of nature and landscape in § 3 Fundamental Rights and Obligations in General Protection of Nature and Landscape.

It is important that refurbishment work on dwelling houses is carried out outside the reproductive period of the birds and if it is necessary to remove the nest to give them a replacement nest. Based on the research, it could be established - if the birds of the Delichon urbicum species were interested in nesting in particular location, they would try to return and restore the colony even after the nest was removed. It is possible that, in addition to returning older birds that remember the place and nest, the young hatched in the colony are also returning.

Replacement nests should be created in such places, or structural elements that allow nesting should be incorporated architecturally into the building facade. Based on research and monitoring of housing estates could be effectively determined where the nesting grounds should be preferably located after the reconstruction. Common house martins prefer the fifth and sixth floors of apartment houses and colder facades facing north, northeast, north-west regardless of the total height of the building and environmental noise level (transport) near to the façade. The second factor is enough to have a free space to hunt and fly, so the tall growing trees in the courtyards are an obstacle rather than an advantage when choosing a nesting site.

Figure 8. Dividing the number of active nests with regard to the level of environmental noise, created by Holešová, 2019.
In order to preserve the environment and maintain balance, as housing estates belong to the important nesting/breeding grounds of common house martins, necessary architectonical features have to be provided as a nesting sites. Such a designated place could be for example a set of artificial nests, placed into window openings of the staircases. In these localities, nesting activities will not limit apartment dwellers by noise and birds will not be disturbed. Provided space should be designed for easy maintenance during autumn / winter. Staircase is a space usually directed to north or other colder directions with no need of direct sunlight - which is also an important preferred factor for *Delichon urbicum* nesting. Future lies not in building barriers to "noisy and unwanted" bird activities, but to find solutions for coexistence.

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