MODERN STEEL STRUCTURES FOR BUS STATIONS
SAVREMENE ČELIČNE KONSTRUKCIJE KOD AUTOBUSKIH STANICA

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ABSTRACT:

Bus Stations are public buildings with landmark character that are the first line for leaving the impression for tourists or every day experience for frequent users. Public buildings such these are also leaving great freedom for their design that is caused by the nature of its function. Two bus stations - Aarau Bus Station and Gare do Oriente are analyzed in order to identify the important common characteristics related to the structural design. These case studies are analyzed through desk top analysis of existing documents about each of them. The research considers a detailed analysis of every station with a focus on how does the steel structural system affects general architectural design and what are the outcomes of that symbiosis. It is also highlighted relationship between steel structures for bus stations and benefits of their use, taking in consideration technological aspects as well.

Ključne riječi: Autobuska stanica, Čelična konstrukcija, Arhitektonski izraz

SAŽETAK:

Autobuske stanice su javni objekti gdje turisti stiču prve utiske o gradu ali istovremeno predstavljaju i svakodnevno iskustvo za česte korisnike. Ovi javni objekti predstavljaju projektantski izazov na koji utiče priroda funkcionalnosti takvih objekata. U radu se razmatraju dvije autobuske stanice i to autobuska stanica Aarau i čvorište Gare do Oriente u cilju identificiranja karakteristika nosivih čeličnih konstrukcija. Analiza je napravljena na osnovu raspoložive tehničke dokumentacije kojima su autori raspolagali. Istraživanje razmatra detaljnu analizu svake stanice ponaosob s fokusom na to kako općenito čelična konstrukcija utiče na arhitektonski projekat i koji su ishodi te simbioze. Također se naglašava odnos između čeličnih konstrukcija za autobuske stanice i prednosti njihove upotrebe uzimajući u obzir i tehnološke aspekte.

1. UVOD

Transportation architecture is dominated by the concrete and steel as any other architectural facility today. What is characteristic to stations and other transportation facilities are specific spans necessary for the vehicle approaches and open space architecture for the buildings. Selection of material is conditioned mostly by the required spans and aesthetical approach of the designer. Every transportation facility has two structural parts that are most often independently built; stations building and canopy for the platforms. Depending of architectural design, the use of material for structural system may vary. More requiring structural design is most likely to use the steel as a material. Lately, canopies are built

separately of the building. During mid of 20th century, the canopies were not aesthetical element such as it is a case today. Platforms were sheltered usually by overhanging beams that were forming kind of balconies or terraces over the platforms. Built as reinforced concrete structures, those canopies were sheltering only front entrance to the bus station, or only passengers waiting in front of the bus. Today, bus shelters are often designed as a canopies independent of the building. Spans are varying of the type of platforms and distance between two parked busses. Steel columns are most flexible for achieving the creative and innovative design, and it can be combined with different materials for the roofing. Tensile structures are offering variety of possibilities for using a structure as an aesthetical feature. With its wide spans, they are enabling different platform arrangements underneath. The relationship between arch

2. AARAU BUS STATION

New railway station in the Aarau was redesigned by Theo Hotz. The following forecourt where passengers arrive with buses and other means of transport with rising number of users was not responding to the needs. The design request was given to Vehovar and Jauslin Architects, and it considered few different problem solutions. Bahnhof platz, situated between the railway station and Bahnhof strasse was cut off the surroundings because of insufficient and inappropriate pedestrian connections within the area. Vehovar & Jauslin submitted a design consisting of four areas: 1. the underground Einstein Passage, 2. the adjacent Hächler Hall, 3. the train station forecourt and 4. the bus station with its impressive canopy which is the subject of the research. Mateja Vehovar and Stefan Jauslin created organically shaped air – cushioned canopy with curved opening in the middle, that covers Bahnhofplaz platforms and waiting areas for passengers. Roof seems like almost hovering above the platforms with its very light, reflective and semi–translucent covering and completely reflects architects idea of creating “a haven of calm between the busy Bahnhofstrasse and the new railway station”. [1] Opening in the middle is following general organic shape of the roof, and even more emphasizes the feeling of lightness. Structural system is not an enabler of design, but also a part of overall architectural design with its light interpretation. The external canopy dimensions are 39 m x 42 m and height is 7 m, while depth of the canopy is 1.3 - 3.2 m. [2] There are eleven slightly inclined columns with diameter of 298.5 mm. Steel columns are unobtrusively set in irregular layout, and contain all necessary infrastructure such as carrying water, air, electrical and sensor technology for the station. The supports with their slight lean merge with cushion almost imperceptibly and carry the structure hidden within the cushion. Space between two membranes which form the cushion is hiding structural elements which support steel cables and other infrastructural elements. The choice of ETFE material for a membrane, gave the infinite options for shaping it in a specific form, lightness for simpler structural system and grid, durability, weather resistance and self-cleaning. Freeform steel structure is support for steel cables which are giving the form to membrane and make cushion shape together. Steel cables crossing the membrane material gave the structure.

Figure 1: Aarau Bus Station Canopy and Membrane [1, 6]

“If get off at the train station, you should realize immediately that you're in Aarau. The generous, open and urban station square is a comfortable, light space for all, structured by light islands and unique

materials.“ [6] Use of translucent ETFE foil as a membrane contributes to overall impression of lightness. Stefan Jauslin and Paolo Monaco, as membrane designers, choose completely translucent lower membrane and transparent light blue for upper part of membrane. The choice arise from the idea for creating new sky for passengers. Taking in consideration weather conditions in Aarau, foggy and cloudy weather most of the time, the choice of light blue membrane would remind people of bright blue sky when they look up. Varying distance between membranes brings even more the impression of sky for the observer with its randomness.

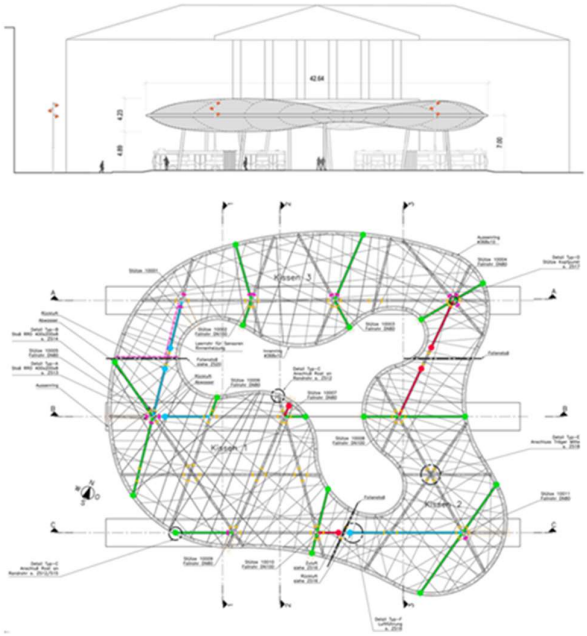

Figure 2: Aarau Bus Station – Structural Plan [7]

There are 1070 m² of roof covered area and a total volume of 1810 m³. For air supply of this, world’s largest single chamber membrane roof, there are four 120 meter long polyethylene tubes under the road that supply the roof with recirculated, dry air and four more for inversed process. Small structure, street furniture, and following facilities that were developed during the time without idea about the bigger picture and design that would answer to passenger needs, were the reasons why the square was barely perceived as open space before the intervention. Aarau Bahnhof becomes recognizable for all the passengers with this unique, bright roof structure and open urban space underneath. Aarau Bus Station with its canopy design provided an excellent landmark for the city and extraordinary experience for the new visitors arriving to the city.

Figure 3: Aarau Bus Station – Canopy Steel Structure [7]

Dynamic canopy with its solid – void composition and transparent skin provided new experience for all users. Mastering the design of seamlessly light structure, designers provided us one of the best blobitecture structures. Seamlessly random arrangement of columns and beams provided more pleasant feeling for users. Space is activated with aesthetically pleasing contemporary canopy structure that mesmerizes passengers, but the use of space remained the same. [3] The Bahnhof Platz, now renovated

into new modern bus station remains used only as a bus platform. Even though the designers provided inviting and appealing look, incorporated urban furniture that became recognizable for this project, the use is limited with its limited space and surrounding facilities. With its height, solid/void play and openness, the canopy provides limited protection from precipitation and wind for large number of passengers standing on platforms. Innovative approach to the canopy design and introducing a non-conventional structural system enabled use of EFTE foil in a more creative way, producing a real landmark for the Aarau. [4]

3. GARE DO ORIENTE

Gare do Oriente interchange was built in 1997 in order to serve the Expo 1998. Taking in consideration that this is not only station but a landmark for the city and first impression for tourists visiting expo, the only choice for this assignment was Santiago Calatrava.

Facility is placed on 6 levels in total. First two levels (underground) are occupied by metro station and basic services related to metro operations. Third and fourth level are occupied by bus station and commercial spaces for all three means of transport. Ground floor, as a third level, is entering level for all stations and it is accommodating feeder zone. Top two levels are made for railway station which is elevated above all other and was the only existing structure on the area before the interchange is built.

Concrete and steel are two materials used in construction of Gare do Oriente interchange. The building is built in concrete, while all platforms and canopies are built in steel. Even though built in different materials, form elements are translated from one material into another. Canopies are covered with double layered glass allowing natural enlightening wherever it is possible. Famous for its sculptural structures and expression, Calatrava once again designed structure that is inspired by human and animal anatomy.

The building, like all the others designed by Calatrava, do not differentiate structural from non-structural elements. Concrete structure has been used as a structural system for the interchange building, and for the platforms structure is made of steel overhanging beams that form canopies. Non-conventional arch shape of columns is defining the form of the building. The load has been transmitted through the concrete arches formed of beams and columns to the ground while the angle of the columns is used for communications. Angles are used as an angle for vertical communication within the building, and horizontal communications are elevated and leaning on arch shaped columns. All load bearing elements for roof and primary structure are used both for communications and even partitions for spaces. Ground level accommodates entrances to the building and bus station that share the same form of canopies. Main entrance canopy is made of overhanging steel beams arranged in leaf shape. The canopy covers main entrance and large area of the public space in front of the building. The entrance is emphasized with pedestrian bridges from the right and left side that connect the interchange with the shopping center.

Figure 4: Gare do Oriente – Canopy Steel Structure [8]

Tree like structure for railway tracks and platforms are indicating different use. Railway station is covered with steel canopy resembling a tree. The canopy lies on 4 rows of steel columns.
Bus platforms are located at north side of interchange building. The only access for the platforms is elevated, enabling unobstructed pedestrian traffic flow above the bus traffic. Central access bridge branches into six segments on left and six segments on right side where all 12 bridges vertically communicate with bus platform or taxi stop underneath.

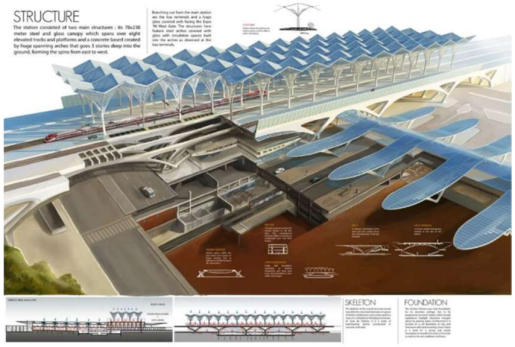

Figure 5: Gare Do Oriente - 3D Section through the Interchange [9]

Park des Nacoes (Park of Nationalities) changed its purpose after the closing of Expo 1998 into multipurpose social area. Today it is one of the most attractive places for recreation of Lisbon and wider area. Gare do Oriente is connecting this area to the wider context, and is enabler of reactivation and connection with city center. Calatrava used different forms of steel structure for every different level, and symmetry as one of his main motives. The symmetry can be observed mostly through the top view, where canopies give the best insight into it. With this concept of approach to platform, the effectiveness is increased for the bus movement to the maximum. Aesthetically it is the trademark for the architect, landmark for the city but at the same time very unusual without belonging identity. What cannot be discussed as a flow is the (re)usage of space. While most of the Expo sites remain left, this station remained the same and provided the life for remaining Expo sites. [3][4]

4. CONCLUSION

Bus stations were not build only for a present time but to serve for many years after building. Even though the emphasis was on a functional features, the aesthetical elements were not neglected at all. Structural elements that are integral part of aesthetical expression[1] of the design are still remarkable elements of these transportation buildings. Today, architecture of transportation facilities is trying to achieve many goals at once. One of them is also making the station place a landmark and increasing the public space use. Many of the station sites are not able to provide spaces large enough for a public activities and proper access for all users at the same time. Aarau Bus Station and Gare do Oriente are the best examples where steel structural system is at the same time architecture, where architectural expression is communicated through the approach to the structure. Exposing the building structure, the architects communicated the architectural expression clearly.

[1] *„Architectural expression is a wide term covering not only the outward manifestation of the inner purpose of a building or a group of buildings, i.e., an expression and indication of the total building programme, but also the close education of the human ego with the materials and mode of construction, which contribute to aesthetic sensation. Architectural achievement thus becomes a landmark of the pattern of society indicating resources, spiritual and material, as well as economic and technical limitations.“* [10]

Creative and innovative form has honest approach to the steel structural system and steel as a material, they are the same element without any hidden structure. Where structure and architecture are one, the landmark is inevitable result. If followed by clear function and unobstructed use, stations are succeeding in their role completely. Bus stations are more than transportation buildings, and it is proven that they are only one part of the infrastructure serving for the transport. Bus stations where the attention is put not only onto building itself but on a whole experience, including bus shelters, public space, entrances, feeder area and all other, are the ones that have positive effect on all users.

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