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DEGREE OF DETERIORATION DUE TO FIRE IN LARGE CONCRETE HALLS

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Abstract

Present paper deals with the engineering consequences of the fire attack in three halls in Budapest, Hungary. Material and structural behaviour are analysed under high temperature, which is reached even 800°C in some cases. These fire attacks were again lessons, which are important to be analysed.

Keywords: fire, deterioration, temperature dependent material properties.

1. Introduction

During engineering design it is very important that incidentally unexpected events have also to be taken into consideration. In this article we intend to draw attention to fire, as well as to its impact on structural elements, as fire has been known since ancient times as one of mankind's greatest enemies. During design, in several cases the fact is ignored that a building may also be exposed to the effect of high temperature, when the properties and the bearing capacity of materials also change. Therefore it is very important to get acquainted with the behaviour of the different materials under high temperature, as a consequence of which a building may also collapse. Of course, it has also to be taken into account, that if the structure's bearing capacity on a certain point is lost, then its static system may change as well. As the analysis of past fire cases can result in immense experience, we would like to present hereby the behaviour under high temperature of three halls of reinforced concrete structure.

2. Influence of Fire on Structural Materials

2.1. Steel

Steel is not an inflammable material; nevertheless it needs fire protection, because its mechanical properties change unfavourably under fire. Consequently, steel pillars are set in brickwork, concrete or coated with heat resistant paint in order to protect them against fire [1].

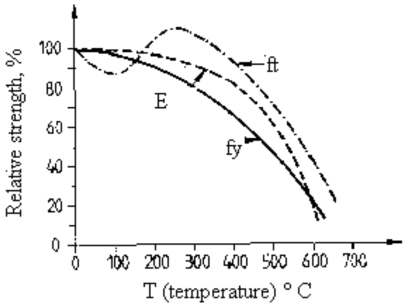

Fig. 1.

Over 400°C the tensile strength, the liquid limit of steels already decrease considerably *(Fig. 1)*, consequently the load-bearing steel structures are not necessarily capable to carry the designed stress, and they will have permanent deformations. In steels with carbon content exceeding 0.2%, the effect of long lasting heat above 500°C could cause considerable decarbonisation. Exposure to heat above 800°C, combined with incidental fast cooling, causes surface-incrustation, or embrittlement.

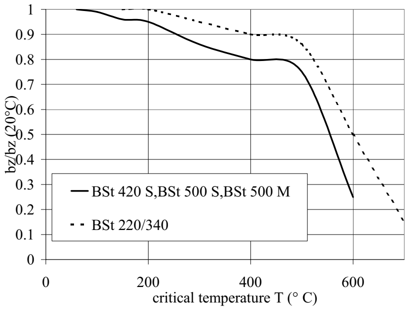

Fig. 2. Changing of the tensile strength of hot rolled concrete steels in function of temperature [2]

In the case of load to 80% of a limiting stress, the traditional, hot rolled concrete-steels and the cold-worked bowstrings will loose their load-bearing capacity, on 480-500°C *(Fig. 2)* and 380-400°C *(Fig. 3)*, respectively. The hot rolled concrete steels may almost entirely regain their original properties. On the other hand, the cold-worked bowstrings lose their properties gained through heat treatment and strain hardening. The grade of strength decreasing depends on the measure

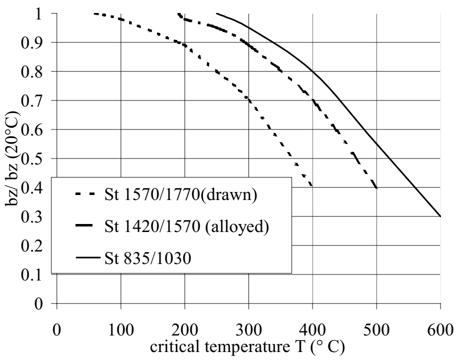

Fig. 3. Changing of the tensile strength of strain hardened tensioning cables in function of temperature [2]

of heating up and the speed of cooling down.

2.2. *Concrete*

In concrete the stress generated under the effect of considerable heating is due to the fact that eventually the expansion of the cement and aggregates is different. Therefore, it is an essential requirement for the aggregate to have equal thermal expansion coefficient with the cement. At high temperatures, in comparison with concretes to quartz aggregates the behaviour of concretes with limestone content are more favourable [2].

Under the influence of heat, initially, the concrete's fabric structure undergoes only a gradual deformation. At high temperature the differently bound water ensuring the setting of the cement, strips of the silicate shell, and evaporates. However the damage caused to the concrete at 100-130°C is not considerable yet. Between 130 and 150°C a major quantity of the adsorptive water escapes what influences the strength of the cement. The chemically bound water evaporates at 200-220°C, which already causes strength degradation. The portlandite ensuring the stability of the cement stone at a temperature between 450 and 480° C will get dehydrated. The explosion like damage of the concrete will start at 570° C due to the transformation of its quartz particles. The reasons of the behaviour of the concrete can be searched for in the changes taking place in the cement stone. Between 200 and 900° C, transformation of the components sets in. At 400-500° C the calcium hydroxide ($Ca(OH)_2$) breaks up resulting in calcium oxide (CaO) and water (H_2O). Up to 600° C the calcium-silicate-hydrates (Ca_2Si_2H, Ca_3Si_2H) in course of a reversible process begin to lose their hydrate water and calcium-silicate is formed. Calcium carbonate breaks up at about 700° C [3].

2.3. Reinforced Concrete

In reinforced concrete structures, due to the different thermal expansion of the steel and the concrete, especially if the concrete cover is thin, spalling of concrete cover is possible. Concrete coating should be appropriately chosen, because the strength of the steel rapidly decreases at higher temperature. Pollutants getting into the concrete are playing an important role in the deterioration of the reinforced concrete structures. (Most often, these materials are chlorides and sulphates). These materials could cause the corrosion of the reinforcement [4].

3. Case Study: Budapest Sports Hall

3.1. A Brief History of the Budapest Sports Hall

Fig. 4. The Budapest Sports Hall under construction (1981) (`www.index.hu`.)

The Budapest Sports Hall was designed in the period from 1974 to 78. Based on economic and technological arguments, a political decision was made: for the roofing of the Sports Hall a cable covering technique should be used that was developed and proved suitable in the Soviet Union. A political decision was taken supported by economical reasoning. As a consequence, functional analysis played a second role in the course of designing. No in-depth analysis was carried out on the most appropriate relationship between the spatial effects and the main functions prescribed by Budapest [5]. The geometrical shape of the Russian circle roof construction was given beforehand. The construction of the roof was a rather complicated process. The tension generated in the cables was to be equal, and besides, of a specified level. The tensioning cables threaded in between the suspension cables ensured the rigidity of the roof. Tension in the tensioning cables could not fall under a certain limit, as the structure had to remain rigid enough. One of the most important and most complicated operations of the construction of the roof was the straining of the cables [6].

The Sports Hall was constructed between 1 March 1978 and 12 February 1982 *(Fig. 4).* The opening ceremony was held on the 12 February 1982.

Finishing the construction operations, Hungary's first sports hall of real international level was inaugurated [7]. The new Sports Hall was linked to one of the most prominent transport network systems of Budapest, as it was built nearby the 'Népstadion' metro-station. The diameter and the height of the two-walled cylindrical hall were 120 and 26 meter, respectively. The training halls were located in the rectangular jetty attached to the main building, [6]. The Sports Hall was appropriate for the organization of any room-sports events. Competitions in figure skating, short ring speed skating; ice hockey matches could also be held here. Organization of many, high-graded international contests were possible. In the course of years, the Budapest Sports Hall because of economic reasons became also the site of concerts and mass programmes. Programmes, which did not belong to the originally designed functions, such as exhibitions and fairs, were also held. The Hall was supplied with installations required for television broadcasting, telephone lines, and boxes needed for the press. As of 1989 the Hall made a home for holding masses and conferences of different religious denominations. Since 1991 Christmas-fairs have also been held here. The Budapest Sports Hall became a favourite venue of business seminars, and general meetings of banks and share companies [7].

Not only the inflammable materials were destroyed or damaged by the fire of 15 December 1999, but also the bearing structure suffered a permanent deformation and a structural damage in the materials, and therefore the pulling-down of the Sports Hall was decided [4].

3.2. Structure of the Sports-Hall

The hall's structural system was mainly composed of two parts: the circularly positioned rows of pillars bearing the purely steel structure cable suspension roof and the steelwork supporting the upper floors of the ring-shaped building, moreover the reinforced concrete structure grandstand encircling the arena, as well as the connected 1st and 2nd floor ceiling-elements. In general, the bearing structural elements of the building were of reinforced concrete *(Fig. 5).*

3.2.1. The Structural Elements of Reinforced Concrete

The structural parts of reinforced concrete were independent of the steelwork from the aspect of transmitting the vertical loads. In supporting the horizontal loads the

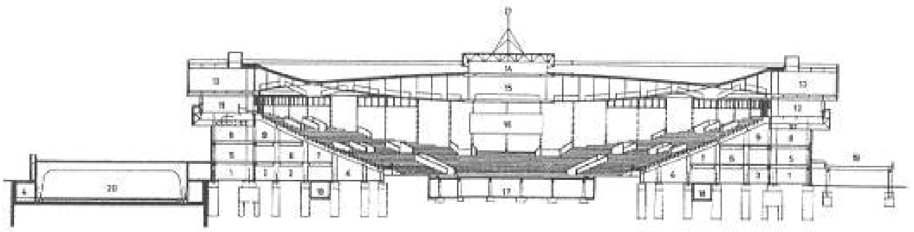

Fig. 5. CROSS-SECTION OF THE BUDAPEST SPORTS-HALL Ground-floor circular gallery, level for competitors, contributors; 2. Changing rooms, showers; 3. Offices; 4. Ventilating engine compartment; 5. 1st floor circular gallery, arena's chief entrance level; 6. Cloak-rooms; 7. Toilets; 8. 2nd floor circular gallery, arena's entrance level; 9. Vending machines, toilets; 10. Ring ducts in the ceiling; 11. Box of honour and parlour; 12. Pressroom, press-boxes; 13. Level for machines; 14. Opeion (fanlight in the roof); 15. Loft for cables; 16. Score-board; 17. Store under the arena; 18. Engineering tube tunnel; 19. Cloister; 20. Ice rink for training and hall; 21.TV antenna

two structural parts formed an integral unit as the principal steel posts were fitted continuously to the reinforced concrete structure.

A major parts of the reinforced concrete structural elements were prefabricated. The ceiling-elements of the two lower floors of the ring-shaped building consisted of radially positioned prefabricated T-slabs. The supporting elements of the grandstands, and the hollow or pre-stressed SD type slabs of the internal dividing ceiling-elements were also prefabricated.

The ceiling elements of the ring-shaped building's 1st and 2nd floor could also be considered as a reinforced concrete structure, which was constructed by concreting the trapezoidal slabs coating joined to the radial principal posts and laid on cross girders. The span of the fields between the cross girders was 2.0-2.5 m and functioned as a multi-span slab. The ribbed slab was 100 mm thick [4].

3.2.2. Steel Structural Elements

The steel bearing structural elements divided the circular ground plan into 48 equal segments.

The section I the welded main posts were placed along a circle's diameter.

The main bearing structural elements of the suspended roof consisted of suspension and bracing cables joined to the inside and outside rings and of in-between struts (ribbed slats) *(Fig. 6)*.

Cable heads in the anchorage chamber were lead cast. With the help of the long course, which was at the end of the anchorage head at the middle ring of the

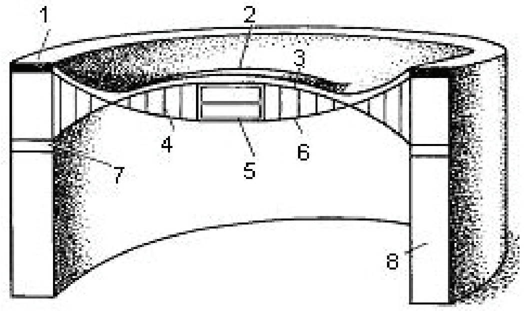

Fig. 6. Location of the cables [6] 1. Reinforced concrete ring 2. Roof covering, 3. Bracing cable, 4. Braces, 5. Cylinder, 6. Suspension cable, 7. Steel ring, 8. Internal cylindrical wall.

stabilizing cables, after tensioning, the cables could be fastened along the desired length. The changing distance between the cable supports was bridged on the drawn part by suspension cables, and on the compression section by ribbed slats made of steel plate.

From the aspect of the spatial rigidity of the roof, the longitudinal steel settings at *R*=20 m, and *R*=35 m, and the four reinforced concrete diaphragms, as well as the front reinforced concrete panels had important roles [4].

3.3. What Happened to the Structural Elements of the Sports Hall?

The intensity of the fire can be judged from its long duration (3 hours), and from the extent of the damage caused to the different structures. On the basis of the damages caused by this particular fire case, the general conclusion may be drawn that the large part of the structures were exposed to a long lasting, high temperature (800-900° C, or incidentally even higher) effect.

The most intensive fire effect was experienced at the arena's roof, which tumbled thereupon. Presumable reason of tumbling was the relatively fast melting of the lead cast at the cable heads *(Fig. 7)*. In case of appropriate technological solution the tumbling would probably have happened much later.

The fire intensively attacked the building's 3rd floor, which was separated from the arena almost everywhere only by a space limiting structure, glassed, and without fireproofing. The structural elements not exposed, or exposed only to a small extent to direct fire effect, were not , or were just slightly damaged by the fire.

Fig. 7. Destroyed cable heads [4]

The fire damage on the 4th floor was not remarkable either, because here in-between the steel posts traditional (primarily brickwork) space limiting was constructed from the arena's side, providing fireproofing for 3-4 hours [4].

3.3.1. Steel Structures

The steel structure sections, slabs, with the exception of secondary beams, from the aspect of dimensioning, belonged to type 37 steel. After the fire, from the steel structures, the material of the steel posts and radial main supports could be characterized with the original strength properties. The effect of the high heat and subsequent quick cooling usually caused only on the margins crystalline structural change. The properties of the outer layer of at most 2 mm thickness were similar as what of the 'transitional area' experienced at welding. The steel did not change in its basic structure, only normalized.

Statically, the welded joints, except at the secondary beams, had the appropriate values.

Bolted connections on the 3rd floor were in hardened, rigid state, therefore their strength was considered uncertain.

Because of considerable, long time heat exposure, the original strength of the materials of the stabilizing ring, of the connecting cantilevers of the steel post, and of the cable head supports decreased (new strength value: S 185) [4].

3.3.2. Reinforced Concrete Structures

The anchorage elements of the cable heads transmitted the high temperature inside the reinforced concrete structures. Fixation of the tails implied uncertain locations, this was also indicated by cracks seen around anchorages.

The concrete shell of the internal, steel main posts on the 3rd floor was completely destroyed, damages could be noticed on the 4th floor.

According to strength analysis, the concrete of the external posts showed different values. (Some weak values referred to construction deficiencies). On the 1st floor the SD 27 floor slabs above the cloakroom were destroyed. On several places, the concrete coating peeled off the bottom of the elements; the tensioning cable strands were damaged too. It would have been necessary to explore the upper head-plate of the SD elements but the analysis was not carried out.

The structural elements of the cellar of the arena were not damaged. The concrete of the floorboard covering the ceiling structure suffered permanent deformation due to the fire and the falling structures thereon. To some extent, the surface of the concrete got cracked and burnt. Because of the intensive effect of fire and fume, a large quantity of chloride and sulphate got into the upper zones of the concrete structures.

3.3.3. Geometric Data

Under the influence of the fire the geometric shape of the upper reinforced concrete flange did not change. In the case of the lower steel ring, a deformation of several cm-s could be measured. The inside steel pillars remained almost vertical [4] *(Fig. 8)*.

Fig. 8. The steel rings deformed [4]

3.3.4. Bearing Structures

Fire damages in the ground level were of such an extent, especially in the area close to the arena, that deformations locally endangering the stability of the bearing structures of the building could be observed [4].

There were cracks on the purely reinforced concrete ceiling structures of the 1st and 2nd floors, however these did not influence considerably the bearing capacity and stability of it. On the 1st floor 25%, while on the 2nd floor 10-15% of the bearing structures deteriorated to such an extent that measures had to be taken.

The 3rd floor could be declared as completely destroyed. The steel structures were not appropriate for further use. The diaphragms and also the suspended ceilings got totally damaged.

The 4th floor of the ring-shaped building was mainly exposed to underneath thermal load. The floor structure of the ceiling, which confined this level from beneath, suffered major damage. The covering ceiling and the other bearing structures remained sound. In case of a reconstruction, the cover floor and the attic panels were to be pulled down. Position of the upper attic panels changed due to thermal movement of the two joining steel frame floors. As a consequence, vertical planes tilted and the joint gaps opened in a different extent.

3.3.5. Corrosion State

In the damaging process of the reinforced concrete structures a considerable role is played by polluting materials, which get into the concrete. These are mostly chlorides. Chlorides cause corrosion holes by diffusing in the reinforcement. The sulphate ion is the other damaging material. Sulphates enter into reaction with the aluminium-hydrates contained by cements and a tricalcium-aluminate based strongly swelling product (ettringit) is created.

Subsequent to fire cases the carbonized depth must be analysed, if concrete steel is reached then corrosion can be reckoned with. In the case of the Sports Hall the thickness of the carbonized surfaces endangered on some places the concrete steel or the I supports. The quantity of chloride ions in several cases reached in the vicinity of the steel reinforcement also the value considered as dangerous. The corrosion of sulphates was not to be afraid of. The value of concrete coating was very different, therefore it is probable that the steel reinforcements were situated in the polluted outer layer and they might have corroded.

3.3.6. Systems of Sanitary Engineering

The fact that the replacement of almost all sanitary engineering installations was necessary contributed substantially to the decision of pulling down the Budapest Sports Hall. The fire attacked only to a small extent the air engineering installations, however they were completely outdated units of inefficient operation. Electric cabling should have been almost totally replaced due to probable high cable cleaning and checking costs. Otherwise, the complete replacement of the systems of water supply, canalisation and heating had already been timely [4].

4. Case Study: Industrial Halls

4.1. The MASPED Depot in Csepel

The MASPED depot on Budapest-Csepel island consists of prefabricated posts, main beams and pre-stressed reinforced concrete roof-panels with 24 m span.

The fire (1984) of several hours damaged the monolith stiffening-core in the middle of the hall's structure, and the two adjacent westward-located stores. Concrete coating could be removed easily by hand or a hammer from the damaged elements. Because of the softening of the bracing cables of the pre-stressed ceiling slabs considerable permanent deformations happened. Joints of the cross-wall westward of the monolith core burned off and the bricks partly got damaged, therefore the wall had to be exchanged.

Fig. 9. Angular displacement of the tail of the principal beam

In the western part the edge beams of the ground floor ceiling got severely damaged. The short cantilevers of the two middle main beams on the supporting points of the roof slabs were cracked and their inclination exceeded by 1-2 cm that of the undamaged beams. In the main beam a spatial torsion deflection was also experienced besides the strength decrease of the concrete *(Fig. 9)*. The cracks setting off in an angle of 45° downward from the fork-formed stanchion referred to torsion. The two extreme main beams, apart from the necessary surface repairing, did not require any strengthening.

Damage of the separating walls could be observed on the first stock. The separating walls lost their stability as a result of the burning off of the joints, the decreased strength of the bricks, and the huge cracks in the staircase.

The administrative block had a shed-system roof. On the various sections of the roof the elements got differently damaged. Near the seat of the fire, with the exception of two lateralmost elements, all the other roofing elements had to be reconstructed or changed. The concrete in the thin slab of the six shed fanlights on the northern part of the building suffered considerable strength decrease, therefore as a result of lost stability it was necessary to pull down these elements. At the four fanlights on the southern side of the building the change of the reinforced concrete frame of the windows and the masking of the damages on the beams were necessary, the shed-slabs could be maintained. The roof-approach got severely damaged.

The nests of bases and the floor covering got damaged to a small extent only.

The concrete in the pillars directly exposed to the fire got burnt more deeply than the line of the main reinforcement; it could be separated by hand. The corners of the pillars supporting the main beam were cracked off.

Fig. 10. Burnt pillar

The ceiling slabs are pre-stressed beams with great span. The fire caused great damage in the beams. In the tension zone, on the lower half of the compressed plate, and in the section near to the lantern fanlights the concrete had burnt, cracked, and lost its strength. On some places the concrete coating of the web plate peeled off and the bracing cables got free. At the supports, the web plate on many places got sheared and the end faces turned off considerably and permanently. Inclination in the middle of the spans of the beams was perceivable. Although the ceiling slabs got damaged considerably, they were not completely destroyed. The ceiling slabs displayed an upwards bending on the undamaged parts.

Nearby the fire the joints of the firewall burnt off and the bricks suffered severe strength decrease.

It is probable that the fire had spread through the roof insulation and the fanlight. It could have been proposed to prevent the spreading of the fire on the roof as well.

Well-considered designing of the dilatations can be proposed in the case of long buildings. In the building, subject of this analysis, movements resulting from the dilatation of the supporting structure could be experienced in 150 m from the seat of the fire [8].

4.2. The Storehouse in Óbuda

The building was made of prefabricated MEZŐPANEL type prefabricated frame structure. In the one-level storehouse the lattice main beams spanning 15 m were built in with 3 m spacing. For roofing the Y-13 marked reinforced concrete roof elements were used.

The high temperature and intensive fire effect lasted cca. 30-45 minutes.

Under the influence of the fire (2000), the lattice main beams and a large part of the roof elements got sooty. In the seat of the fire, the soot burnt off the surface of the roof elements well perceptibly. Disjoining, loosening of the concrete nowhere could be observed on the lattice main beams. However on the lower zone of the main beam microcracks occurred.

The roof structure of the building did not get damaged in such an extent that an exchange was necessary.

However, under the influence of high temperature, cracks appeared in the building which affected also the wall of the adjacent building [9].

5. Conclusions

5.1. Budapest Sports-Hall

No considerable damage could be observed by visual surveying of the bearing structures of the cellar. On some places the signs indicating dislocation or inside tension could be ascertained. The concrete fittings at the tails of the beams weighing on pillars partly broke off.

Fire damages caused in the ground level were of such a large scale – especially in the area close to the arena – that deformations could be noticed which endangered locally the stability of the building's bearing structures. The bounding reinforced concrete masonry of the arena was severely damaged by the fire, and a considerable part of its surface became cracked and broken. In some places the reinforced concrete beams and U-panels got broken and cracked, where the concrete was pink-tinted. 70-80% of the floor structure was also considerably cracked and broken.

There were cracks on the ceiling structures of the 1st and 2nd floors, however these did not influence considerably the bearing capacity and stability of the structure. On the 1st floor 25%, while on the 2nd floor 10-15% of the bearing structures deteriorated in such an extent that measures had to be taken.

The greatest strength and structural damages were observed in the materials of the area of the cloakroom on the 1st floor. Here, all concrete structures suffered strong or medium damages. The damages caused to the pillars were not significant, however the displacements and cracks implied structural movements.

On the basis of inspection it could be said that the 2nd floor suffered the lightest fire attack; here, damages of smaller extent of probably local character occurred.

The bearing structures suffered the most severe damages on the 3rd floor. The steel structures were inappropriate for any further use. Under the influence of the fire considerable deformations and permanent damages occurred, and the welded, bolted elements were destroyed. From the arena's side the concrete coating of the main steel pillars peeled off and on some places fell down, giving a hollow sound when hit. The steel ring fastening the bracing cables was deformed, the welded bonds destroyed, the glass structures from the arena's side, the diafragm toward the arena, the plasterboard completely damaged.

The 4th floor of the ring-shaped building was mainly exposed to underneath thermal load; therefore, the floor structure of the ceiling, which confined this level from beneath suffered major damage. The cover floor and the other bearing structures remained sound.

5.2. Two Storehouses of Reinforced Concrete Structure

As a consequence of the fire lasting for several hours, in the storehouse in Csepel the concrete cover could be separated by hand. The joints burnt out from the bricks of the masonry, and the bricks themselves got damaged; their replacement was necessary.

In the western part, the flange beams of the ground floor roofing got severely damaged. The short cantilevers of the two middle main beams on the supporting points of the roof slabs were cracked or deformed.

On some sections of the roof the elements got differently damaged. Near the seat of the fire, with the exception of two lateralmost elements, all the other roofing elements had to be renewed. The elements on the northern part of the building had to be pulled down. At the fanlights on the southern side of the building the reinforced concrete frame of the windows had to be changed, and the damaged beams covered, the shed-slabs could be maintained. The roof-approach got severely damaged.

The nests of bases and the floor covering got damaged to a small extent only. The concrete in the pillars directly exposed to the fire got burnt more deeply as the line of longitudinal reinforcement; it could be shred by hand. The corners of the pillars supporting the main beam were cracked off.

The ceiling slabs were pre-stressed beams with larget span, which were severely damaged by the fire. Inclination in the middle of the spans of the beams was perceivable. Although the ceiling slabs got damaged considerably, they were not completely deteriorated.

In the storehouse building in Óbuda under the influence of the fire (2000), a large part of the lattice main beams and of the roof elements got sooty. Disjoining, loosening of the concrete nowhere could be observed on the lattice main beams. However, on the lower zone of the main beam microcracks occurred.

The roof structure of the building did not get damaged to such an extent that a replacement would have been necessary.

5.3. General Lessons of the Three Fire-cases

Since the sensors of the fire detectors were too highly located, the alarming system of the Budapest Sports Hall did not warn in due time. The first warning reached the BS Reception, and not the Fire Department. Consequently, anyway, in such a large and important building, the installation of a fire-alarm and fire-extinguishing equipment is necessary. In the other two storehouses there were no fire-alarm devices. In the Csepel storehouse building the fire lasted for a relatively long period, therefore considerable damages could be observed. As in the Óbuda storehouse the fire extinction started relatively quickly, no remarkable fire damage occurred. This suggests that fire alarm devices, eventually extinguishing equipment are necessary in every case.

Presumably the roof of the BS crushed as a result of a contestable structural solution. Under high temperature, the cable heads, which were cast with lead in the foundation castings after the smelting of the lead slid out the castings. Presumably, in case of the appropriate technical solution, the crushing would have occurred much later. Lack of dilatation or its improper emplacement contributed largely to the damaging of the two other store-buildings. In the course of deciding upon the use of a certain structure, the possibility of the influence of an incidental fire should by all means be taken into consideration. Special attention must be paid to the selection of the appropriate materials and structures.

A relatively great damage could be noticed in the pressurized concrete structures. In the BS, the SD-27 roof slabs, and the roof slabs in the Csepel storehouse were destroyed, as well. Concrete coating in many places peeled off the bottom of the elements, and the bracing cable strands got damaged. Anyway, in the application of stressed reinforced concrete structures, the role of the statical, mechanical changes under the influence of high temperature should be considered carefully.

According to the formulation of the Mészáros' (1990) requirements:
'In case of fire the building structures must primarily:

- *delay, or prevent the spreading of the fire, as well as*
- *maintain the stability of the building (structure).'*

In the case of the BS, insufficiencies occurred in the accomplishment of both tasks. The roof crushed on the 3rd floor, and glassed structure limiting off the arena could not prevent fire spreading. The storehouses maintained their stability, but in the Csepel case the prevention of the spreading of the fire was not solved.

The importance of these two requirements is also highlighted by the extent of the damages caused to these buildings: the BS was attacked most seriously because here, none of the two conditions were ensured, while the Óbuda Hall, meeting both requirements was damaged least.

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