# The fire characteristics of the Municipal noise absorbing screen

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**Abstract**. This article deals with the fire resistance of an innovative noise protection – so called the *Municipal noise absorbing screen* and its resistance in other dangerous situations with the occurrence of fire. The article briefly describes the characteristics of the noise absorbing screen‘s element which is made mostly of the cemented rubber granulate. Due to its geometrical, spatial and material solution the Municipal noise absorbing screen innovatively extends technical opportunities in the field of noise reduction from the rail transport, especially in the urbanized areas. This article also covers the problems of possible causes of fire considering the real installation of the element into the tramway track. The main focus of the article lies in the selection of possible dangerous fire situations. In connection with this, within the experimental part there were carried out reaction to fire tests according to the arranged fire scenarios. There were realized three basic tests in total and their several modifications. In order to that the article describes the effects of the flame on the noise absorbing screen's element and its damage. Final part is dedicated to the summary of all results from the previous experiments and their comparison. Last but not least there are designed future construction improvements of the element.

## 1. Introduction

Traffic is an integral part of our everyday life whether it is road or rail traffic. According to the increasing requirements for the quality of life as well as health of population we have to deal with constant tightening of limits for the noise emission from traffic, especially in built-up areas.

Noise reduction of railroads focuses mostly on tram tracks which are unlike the rapid transit (the underground/subway) usually run on the surface and often directly through the residential area. Higher traffic intensities can lead to the noise level's maximum or worse – they can be exceeded. [1][2] Currently, an effort is made in developing various low noise protection screens which are, in cities, much better alternative than classic noise barriers limiting view from vehicles. [2][3] As the low noise protections are considered constructions with their height above the terrain not exceeding 1.5 m [1].

An example of the new noise protections of this kind is so called Municipal noise absorbing screen developed by the Department of Railway Structures, Faculty of Civil Engineering, CTU in cooperation with MONTSTAV CZ Ltd. From the acoustic point of view the choice of the screen's material is crucial as well as its shape and the future location. The Municipal noise absorbing screen uses a rubber granulate as a material with great noise absorption. [1][2][4] The following text is dealing with the element of the municipal noise absorbing screen, the description of possible fire hazard and the design of appropriate tests.

## 2. The Municipal noise absorbing screen

The Municipal noise absorbing screen (“MNAS”, in Czech “Městská protihluková clona – MPHC”) is a passive noise protection for the noise attenuation particularly from tram traffic. The screen is designed for the urban setting although not to interfere with the view of a driver or passengers and not to disturb the city panorama. “MNAS” is typical for its low height – only 300 mm above the top of a rail. [1][2] In compliance with technical regulations and rolling-stock, the screen is placed as close as possible to the structure gauge where it effectively absorbs noise coming from the wheel-rail contact. The principal of the attenuation is visible below (Figure 1).

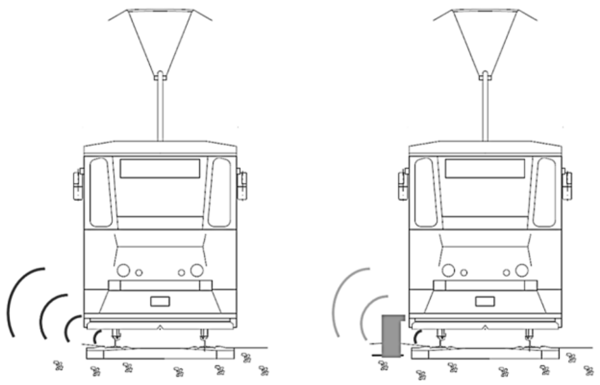

**Figure 1.** The principal of the noise attenuation with “MNAS“ [4].

**Figure 2.** The Municipal noise absorbing screen in Prague – Braník.

Thanks to its shape and material used the screen acts like an absorptive element and intercepts the noise at the source. On top of that, thanks to the screen’s small dimensions and the whole construction it is easily dismountable. That is a great benefit beside the concrete elements in the case of an accident or in the need of intervention of the integrated rescue system. [1]

The main material component of the Municipal noise absorbing screen is a cemented rubber granulate emerging from recycling of eliminated tyres. Within the recycling process the tyres are freed from bead wires, other metals and textile. [1] [4] The final product – granulate of a given grain size is then bonded with high-molecular-weight polyurethane adhesive and placed into individual manufacturing forms. These forms are adjustable so various surface finishes can be achieved (e.g. waves, pyramids, etc.). These surface finishes help to a better acoustic absorption of the screen. [4] Figure 2 shows the design used in the test section in Prague – Hloubětín which was realized in 2018.

In connection with the construction of the second test section of the Municipal noise absorbing screen in Prague - Hloubětín (June 2018) there was made a request to verify other qualities of this element. In terms of the overall safety emerged the need to verify its reaction to fire and the risk of fire itself.

These real requirements inspired performing tests described in this article. The aim of this article is to experimentally assess the extent of fire risks in several considered situations which can occur during the screen’s lifetime.

## 3. Experimental part

### *3.1. Initiation sources*

Within the realization of the second Municipal noise absorbing screen test section in Prague – Hloubětín it was decided to approach the verification of the screen’s reaction to fire and its behaviour during the contact with fire or another initiation source. [5] Critical situation with emergence of fire can occur near the tram track due to several causes – natural causes, technical problems and failures or intentional damages by vandals.

In the category of natural causes the risk of fire is mostly related to **the fire of adjacent greenery**. In case of fire in the track surroundings the fundamental test is the Fire resistance of shrubs described

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in ČSN EN 1794-2 [6] and ČSN EN ISO 11925-2 [7]. Considering the placement of the screen between both tracks and considering the already taken test on the similar element [8], this test with burning shrubs wasn't performed. The results are assumed as very similar.

A big problem lies in the screen's fire resistance to a **burning vehicle or its part**. The Faculty of Civil Engineering, CTU, isn't at this moment capable of providing the right conditions for the experiment simulating this situation. That is why this test isn't included here. Even though fires of vehicles, especially in the chassis area, are very rare, it is crucial to be concerned with this danger in the case of future boom of the screen.

Among others, risk of fire can occur within construction or maintenance work, specifically in the process of **rail welding** or **rail grinding**. During rail welding there is a prominent local increase of rail's temperature. This operation is done by qualified workers, the work takes place under a technical supervision and the workers have ordinarily a fire extinguisher at hand, so the fire risk is to a considerable extent eliminated. Similar conditions apply to the rail grinding as well.

By a long shot the most problematic situations are caused by **vandalism**. The main risk lies in early (on time) detection of hazards or arising danger and control over the area. There are several fire scenarios that come to consideration and are described in section 3.2.

### *3.2. Proposal of tests*

For the purposes of this article there were considered tests simulating rail grinding and vandalism. In total there were realized three types of tests which are described in detail in the following subsections.

Trial sample – one segment of the Municipal noise absorbing screen consists of two separate parts. The lower rectangular part is 600 mm long, 400 mm high and 250 mm wide. The side adjacent to the track has a wave-like surface but the others have a plain surface. The upper part of the segment is also rectangular but with a quadrant cut out. It is 100 mm high, 250 mm wide at its bottom and 330 mm wide on the top. The segment was kept for more than 48 hours before the start of testing in a space with constant temperature 20°C ± 3°C and humidity 50% ± 10%.

The experiment was carried out in exterior. The segment was placed in the lee in the distance of 1 m in front of a barrier. Placement of the segment didn't prevented wind flowing. During the tests every now and then occurred a light breeze reaching the speed of max. 2 m/s. Temperature of air in the testing area moved around 19°C. Air humidity was around 60%.

*3.2.1. Test 1 – Effect of fly away sparks simulating rail grinding.* The aim of this test was a determination of segment's reaction on effect of sparks as a simulation of rail grinding. There were two takes within this test where a tube from cast iron was placed on a metal frame in two different distances from the segment. The first distance represented the actual distance from the screen's face to the track, or more precisely to the outer rail. The second configuration should provide bigger amount of fly away sparks coming to a more concentrated area on the face of the screen. The entire construction was secured against shifting. The tube was cut with an angle grinder so that the sparks flew away to the face of the screen (Figure 3). These sparks should simulate the state during rail grinding. In both cases, the segment was exposed to the sparks for 30 s. Results from this test can be seen in Table 1.

**Table 1**. Results of the Test 1.

| Measurement | Distance of the tube from the segment (mm) | Temperature before (°C) | Temperature after (°C) |
|---|---|---|---|
| 1. | 670 | 18.2 | 21.5 |
| 2. | 280 | 18.8 | 30.1 |

**Figure 3.** Test 1 - simulating rail grinding.

**Conclusion:** The risk of a flare from the fly away sparks is negligible. The effect of the fly away sparks caused a local increase of temperature by approximately 10°C. During rail grinding the screen is under supervision when the workers can immediately intervene in the case of potentially problematic situation (e.g. occurrence of fire or its expansion).

*3.2.2. Test 2 – Effect of a burning match and cigarette.* The aim of this test was to expose the screen's segment to possible vandal activity. The meaning lied in placing a burning cigarette on the segment and observing its behaviour as well as behaviour of the cigarette (3$^{rd}$ measurement). The same way the test with a match was run (4$^{th}$ measurement). Furthermore, it was necessary to measure the time using the stopwatches and to observe changes in behaviour.

Within the third measurement the cigarette was lit and dragged for a good incandescence Then it was placed on top of the segment and after that it wasn't manipulated with anymore. During the test there wasn't noticeable any reaction of the segment on the burning cigarette. Cigarette itself extinguished after 12 minutes and 28 seconds after burning about 2/3 of its length (Figure 4).

The fourth measurement went similar to the previous one. After lighting a fireplace match, it was immediately placed on top of the segment and observed. Likewise the take with the cigarette, there wasn't spotted any reaction of the segment to the burning match. The match itself extinguished after 55 seconds in about a half of its length (Figure 4). Results from this test can be seen in the Table 2.

**Table 2.** Results of the Test 2.

| | Temperature before (°C) | Temperature after (°C) | Time of burning (min) |
|---|---|---|---|
| **Cigarette** | 19.7 | 29.8 | 12:28 |
| **Match** | 19.9 | 49.8 | 00:55 |

**Conclusion:** The risk of a flare from both - the burning cigarette and the match is very low. As a result of the burning of the cigarette local temperature rose and there was a slight disruption of the surface appearance. However, the flash point wasn't reached in this fire scenario.

In the case of the burning match the local temperature was risen approximately about 30°C, but still the temperature was below the flash point. In addition, in the experiment was used a large fireplace match which has in comparison to an ordinary sized match bigger energy.

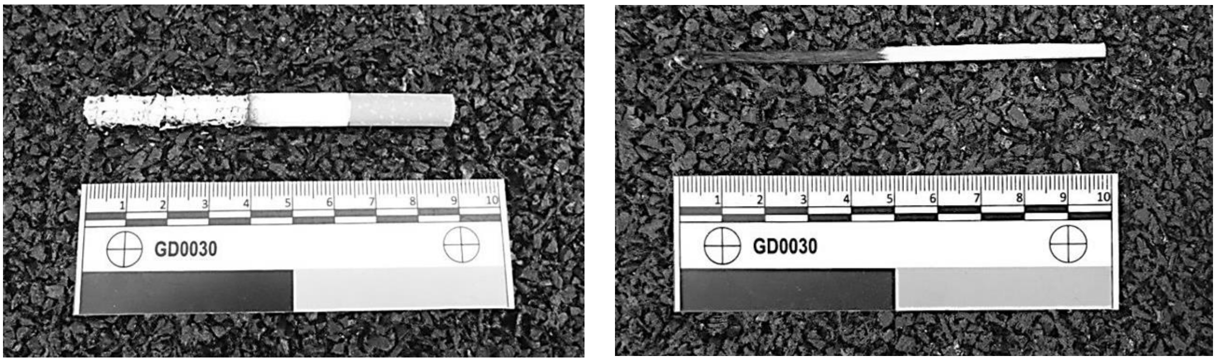


**Figure 4.** Test 2 - exposing the segment to vandalism – cigarette (left), match (right).

3.2.3. *Test 3 – Small fire attack.* The last test consisted of an intentional ignition of the screen's segment. The segment was exposed to a small fire attack using a kitchen lighter with 45 mm high flame for three intervals: 15 s, 30 s and 60 s. The ignition was performed on two different areas – the narrowest edge of the segment's upper part ($5^{th}$, $7^{th}$ and $8^{th}$ measurement) and on the flat back side of the segment ($6^{th}$ measurement).

As the first testing area was chosen the narrowest front edge of the upper part of the segment. The lighter was placed under the edge into the cut out section and there the small fire attacked the segment for 60 s (Figure 5). After about 8 s a flare of the segment occurred and during the next 22 s the flame spread significantly. After 60 s the lighter was switched off and then the burning progress and its extent were observed. After another 5 min and 5 s the fire spontaneously extinguished.

The second testing area was the back side of the segment where the small fire attacked a flat surface, not an actual edge. Again the flame attacked the segment for 60 s 50 mm below the top edge of the segment. After 8 s a flare occurred and then the flame gradually spread towards the upper edge (Figure 5). After 60 s the lighter was switched off and then the burning progress and its extent were observed. After another 5 min and 26 s the fire completely extinguished.

Within the last two measurements the segment was exposed to the small fire attack for shorter time periods. In the first case ($7^{th}$ measurement) the small fire attacked the front thin edge for 15 s, however, no flare was observed. Within the very last - $8^{th}$ measurement the same edge was exposed to the small fire attack, this time for 30 s. After about 6 s a flare of the segment occurred and after another 3 min and 44 s the flame completely extinguished.

**Table 3.** Results of the Test 3.

| Measurement | Time of the small fire attack (s) | Flare time (min) | Extinguishing (min) |
|---|---|---|---|
| 5. | 60 | 0:08 | 5:05 |
| 6. | 60 | 0:08 | 5:26 |
| 7. | 15 | - | - |
| 8. | 30 | 0:06 | 3:44 |

**Conclusion:** The risk of flare of the segment when using the kitchen lighter is needed to take seriously. Even with the use of an ordinary pocket lighter there is a possibility of a local igniting of the screen. The flame doesn't spread rapidly over the screen's surface and it has self-extinguishing properties. The problem can be a long-term continuation of this vandal activity which could lead to a larger fire of the element. The risk of fire rises with longer transport intervals (in the daytime – about 8 min, at night – about 30 min) when there can develop a time gap between starting a fire and its spotting. However, it is possible to say that even after the continuous small fire attack for 60 s, the element spontaneously extinguish within about 6 min.

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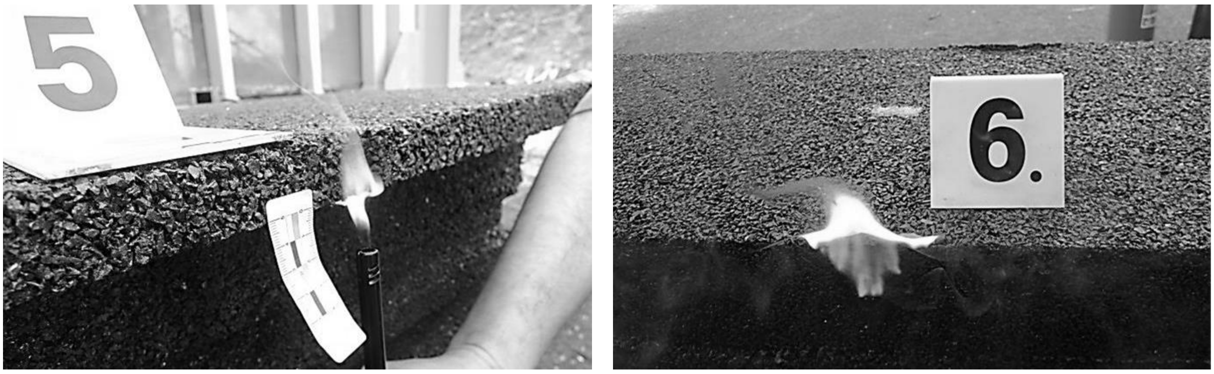


**Figure 5.** Test 3 – small fire attack.

## 4. Overall conclusion

Based on the performed experiments it is possible to state that the element of the Municipal noise absorbing screen has a good resistance against the considered initiation sources in the fire scenarios set above. Several types of tests have been performed as to simulate real situations which the screen may be exposed to. All tests were carried out on dried element. Under operation though, the element will be affected by weather so it is assumed to have higher moisture content.

Within the test simulating construction or maintenance work (such as rail grinding) there was only an insignificant local increase in temperature so the risk of flare of the element is minimal. A similarly low risk arises when putting down a burning cigarette or a match. Potentially most risky appears to be a targeted vandal activity with the aim of damaging, or more precisely igniting an element of the MNAS- e.g. with a lighter. In these scenarios a local flare of the segment occurred and the flame then spread to the near vicinity of the segment’s surface. However, in all cases, the flame spontaneously extinguished within a few minutes and the damage of the element was only local. The risk of an intentional vandalism rises especially with longer transport intervals when there can arise a time gap between starting and spotting the fire and thus also endangering the traffic.

Needed to say, this series of tests serves only as a primary insight into this issue and the identification of the greatest risks that can be used to design and perform other fire tests in the future.

## 5. References

[1] Bret O and Čížková P. 2017 Development of the Municipal Noise-Absorbing Screen and test section construction technology. Acta Polytecnica CTU Proceedings. p: 6-11. ISBN: 978-80-01-06297-5
[2] Čížková P and Bret O 2017 Městská protihluková clona v Praze Modřanech Akustika 28 p 3-12. ISSN: 1801-9064
[3] Čížková P and Lomoz L 2014 Comparison of efficacy of low and high acoustic screens Akustika 22 p 28-36. ISSN: 1801-9064
[4] Lidmila M, Krejčiříková H et al. Protihlukové prvky z drcené gumy Týden výzkumu a inovací pro praxi Hustopeče 2014 ISBN 978-80-85990-25-6
[5] ČSN EN 13501-1+A1: Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests ÚNMZ 02/2010
[6] ČSN EN 1794-2: Road traffic noise reducing devices – Non acoustic performance – Part 2: General safety and environmental requirements ÚNMZ 08/2011
[7] ČSN EN ISO 11925-2: Reaction to fire tests – Ignitability of building products subjected to direct impingement of flame – Part 2: Single-flame source test ÚNMZ 07/2004
[8] Burning shrubs test of multifunctional gabion element record. Provided by Monstav CZ Ltd.

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