Traffic noise pollution in the city and some noise reducing measures

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Abstract:
Road traffic noise is only one type of noise that affects people, it is a concern for more specialists than any other individual source of noise. Traffic planning is an important tool in efforts to reduce noise from traffic. Speed limits for roads may reduce the level of noise in cities. Noise in urban areas can also be reduced by by-passes and traffic calming measures, in order to keep traffic out of residential areas.

1. Introduction

Noise has become a permanent component of our lives, especially in major cities. The various forms of activity in the compact area of a city (residential, commercial, transportation), almost inevitably lead to conflicts as to what is a reasonable or unreasonable level of noise. Transportation, and particularly the volume of vehicular traffic, is the main cause. During the past few years, the realization that noise is an increasingly serious ecological hazard has therefore gained ever wider acceptance. Noise can have direct or indirect effects on the well-being and even on the health of individuals. The results of noise-effect research indicate that at daytime evaluation levels of between 55 and 60 dB (A), the burdensomeness of traffic noise rises, that it increases substantially between 60 and 65 dB (A), and that health risks presumably start as of 65 dB (A); these are significantly substantiated at daytime levels over 70 dB (A) [1].

Described physically, sound is caused by vibrating bodies, by pressure variations within elastic media (gases, liquids, solid bodies). The pressure variations can be caused by impact, by friction, or by streaming gases. The range of pressure variations perceptible by the human ear (vibration amplitude or sound volume) is between 20 μPa (audio threshold) and 200,000,000μPa (pain threshold). The microPascal (μPa) is the unit of measurement for this pressure. To avoid having to deal with such huge numbers, a logarithmic unit of measurement has been introduced, the so-called decibel (dB) scale. In this case, 20 μPa, the audio threshold, equals 0 dB, and 200,000,000 μPa, the pain threshold, equals 140 dB [2] [4].

Environmental Noise Propagation:

Many factors affect the noise level, and measurement results can vary by tens of decibels for the very same noise source. To explain how this variation comes about, we need to consider how the noise is emitted from the source, how it travels through the air, and how it arrives at the receiver. The most important factors affecting noise propagation are: type of source (point or line), distance from source, atmospheric absorption, wind, temperature and temperature gradient, obstacles such as barriers and buildings, ground absorption, reflections, humidity and precipitation [2].

To arrive at a representative result for measurement or calculation, these factors must be taken into account. Regulations will often specify conditions for each factor.

Types of sources: point source and line source.

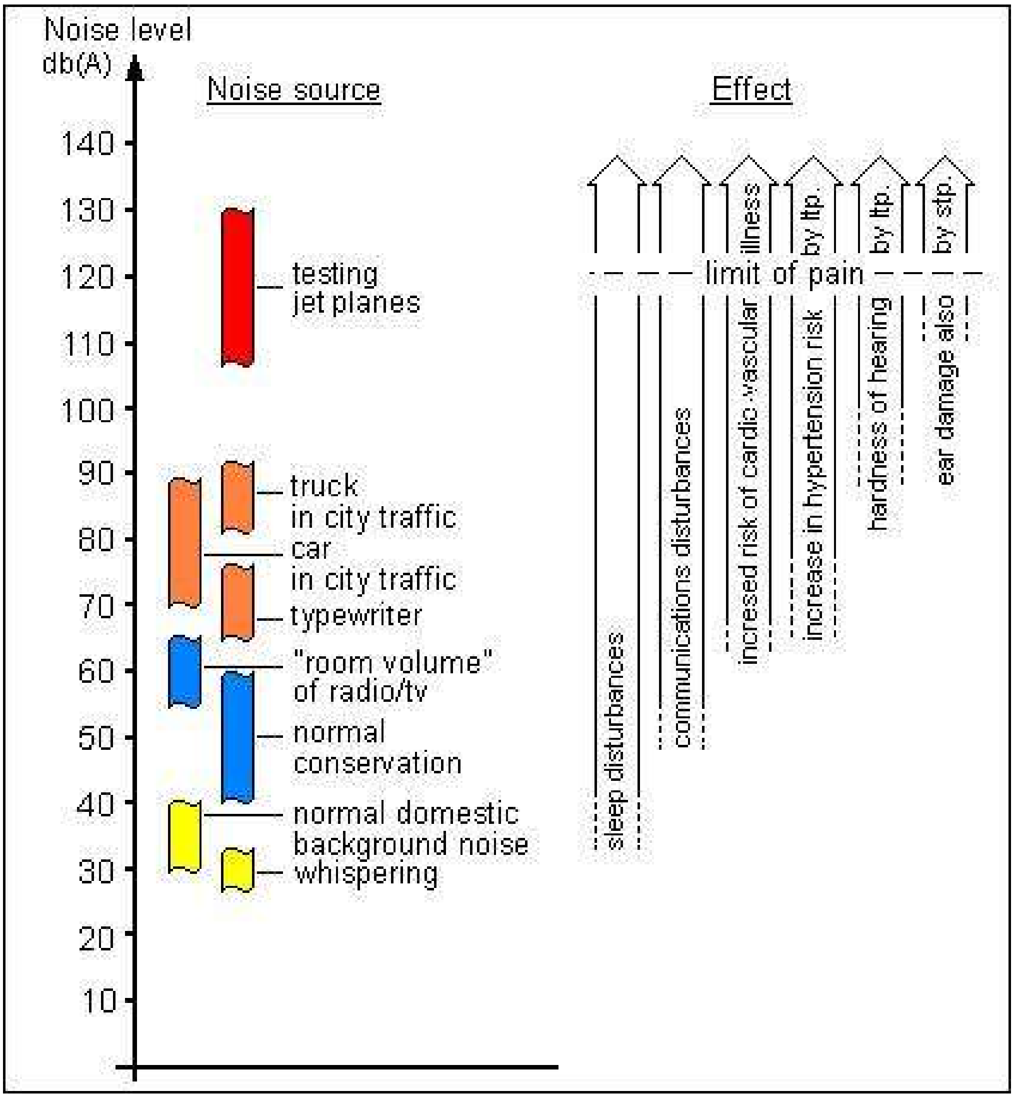

Fig. 1. Volume of certain noise sources and their possible effects
(ltp.- log-term pollution; stp.- short-term pollution).

The results of the action undertaken by the Institute of Public Health – Bucharest, in co-operation with specialized local branches, to monitor urban noise pollution, carried on, have rendered evident the continuously ascending dynamics of exposing levels, from mean values of 50 dB(L) at the beginning of the 80's to about 70 dB(L) in 2000. Even worse, ascending dynamics were recorded in all the areas being monitored, thus outlining the generalization of noise pollution throughout the city. Thus, the mean annual levels of the diurnal noise by the limit of lodgings located nearby intensely circulated roadways, large boulevards, frequently exceed 70 dB(L), while the maximum levels are recorded regularly in the cities of Brasov, Braila, Galati, Bucuresti [5]. The sound climate in common residential areas, where most of the urban population dwells, tends to range between 60 and 70 dB(L), which renders likely the effects of exposing to excessive noise.

2. Description about the noise pollution in Brasov city

We studied the traffic noise pollution in some areas of Brasov city. The region of Brasov is situated in a mountainous area in the centre of Romania. In Brasov county there are 4 municipalities and 5 towns, 43 communes and 150 villages. The county population registered is 626499 inhabitants, from which in the urban environment 472620 inhabitants and in rural environment 153879 inhabitants. In Brasov county, the length of the public roads of different technical categories is 1348 km, from which 396 km are modernized (national roads). The measured length of urban streets is 900 km, from which 627 km are modernized and 275 km have stone pavement.

Brasov has been a point of passage for many centuries since it is located at the crossing of important trade routes. Because of the geographical positioning Brasov district grown as an important industrial and commercial centre. This fact determined the urban agglomeration, and implicit the growing of the transportation demands (both, of the passengers and of the merchandise). The analysed route was: Lunga Street, Eroilor Boulevard, 15 Noiembrie Street, Castanilor Street, Iuliu Maniu Street, Nicolae Iorga Street.

Fig.2 The studied area of Brasov city (the historical center).
Where: 1- The City Hall; 2- Prefect Hall; 3- Building N of the Transilvania University; 4- Unirea High School; 5- Capitol Hotel; 6- Aro Palace Hotel; 7- Casa Armatei Building; 8- Sica Alexandrescu Theatre; 9- Building M of the Transilvania University; 10- Comercial Area; 11- C.F.R. Hospital; 12- Lecture Room of the Transilvania University; 13- Mihail Eminescu Hospital; 14- Romano-Catholic Church; 15- Offices and Banks Area.

The annual medium levels of day noise pollution in the residences on the main streets in Brasov, frequently pass over the 70 dB limit. One measure of pollution is the danger it poses to health. The average sound levels emitted by vehicles travelling at 50-60 km/h in a 12-15 m road (no. vehicles per hour / sound level): 100 v/h (63dB), 500 v/h (70dB), 1000 v/h (73dB), 2000 v/h (76dB) [5].

The evolution of the auto fleet in Brasov district between 1995 – 2002 is presented in the next table [5]:

Table 1

Vehicle cathegory	Year							
	1995	1996	1997	1998	1999	2000	2001	2002
Cars	74698	83802	92839	97253	101506	103733	108059	100874
Minibuses	165	186	212	257	344	343	363	343
Buses	769	792	833	878	922	942	1150	572
Vans	6779	7725	8490	9856	10112	10791	11571	9888
Mixt vehicles	928	1094	1206	1276	1334	1460	1652	2224
Special vehicles	4003	4125	4296	4355	4412	4311	4241	2904
Heavy trucks	3652	3725	3767	3835	3826	3735	3544	613
Tractors	582	650	770	925	1068	1653	1931	1513
Autotrailers	108	112	114	114	111	99	87	87
Travel trailers	92	99	105	106	107	107	110	40
Agriculturals	7392	7798	8382	8536	8500	8428	6415	5286
Motorcycles	3712	3634	2702	708	773	748	718	1402
Ligth commercials	45	43	43	37	22	21	16	7
Ligth motorcycles	9453	9381	9440	9298	9263	9131	8854	1102
Total vehicles	112648	123193	133189	137434	142300	145502	148711	126855

3. The analysed route, and determination of the environment noise pollution level in this area

The points where the traffic noise was measured with the noise analyzer Bruel&Kjaer 2237 Controller:

Point 1: Lunga Street - Eroilor Boulevard - Muresenilor Street Intersection:
MaxP = 108.4 dB;
Leq = 77.8 dB;
Point 2: Balcescu Street - Pietei Street Intersection:
MaxP = 101.0 dB;
Leq = 74.2 dB;
Point 3: 15 Noiembrie Street - Agriselor Street Intersection:
MaxP = 104.8 dB;
Leq = 76.5 dB;
Point 4: 15 Noiembrie Street - Castanilor Street Intersection:
MaxP = 109.1 dB;
Leq = 76.2 dB;
Point 5: Castanilor Street - 15 Noiembrie Street Intersection:
MaxP = 114.1 dB;
Leq = 76.9 dB;
Point 6: 15 Noiembrie Street - Gradinarilor Street Intersection:
MaxP = 99.8 dB;
Leq = 74.3 dB;
Point 7: Iuliu Maniu Street - Castanilor Street Intersection:
MaxP = 107.6 dB;
Leq = 74.7 dB;

Point 8: Iuliu Maniu Street - Alexandru Ioan Cuza Street Intersection:
MaxP = 101.8 dB;
Leq = 73.4 dB;
Point 9: Iuliu Maniu Street - Vlad Tepes Street Intersection:
MaxP = 95.2 dB;
Leq = 65.4 dB;
Point 10: Nicolae Iorga Street →City Hall:
MaxP = 104.6 dB;
Leq = 76.2 dB;
Point 11: Nicolae Iorga Street - Lunga Street Intersection:
MaxP = 98.7 dB;
Leq = 70.9 dB;
Point 12: Lunga Street - Eroilor Boulevard Intersection:
MaxP = 96.4 dB;
Leq = 67.6 dB;
Point 13: 15 Noiembrie Street - Eroilor Boulevard Intersection:
MaxP = 102.2 dB;
Leq = 74.0 dB;
Point 12: Republicii Street - Eroilor Boulevard Intersection:
MaxP = 99.6 dB;
Leq = 72.4 dB.
Where: MaxP = the maximum value of the noise; Leq = the medium value of the noise.

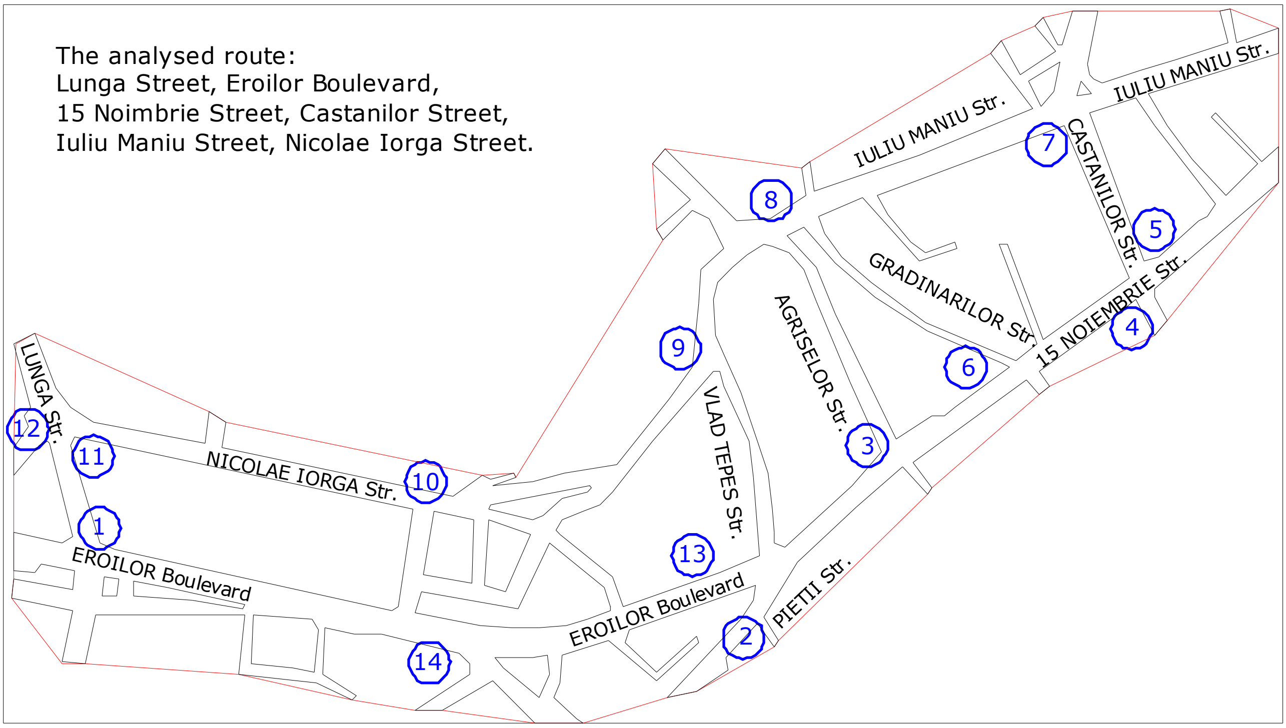

Fig. 3. The points where the traffic noise was measured (points 1 ÷ 14).

The traffic noise measurement conditions (30.03.2004) :
- type of source: line source;
- distance from source = 1 meter;
- measurement interval = 60 seconds;
- wind → medium;

- temperature = (7 ÷ 11)ºC;
- time of the day: 10.00 ÷ 13.00;
- precipitation: none (sunny weather).

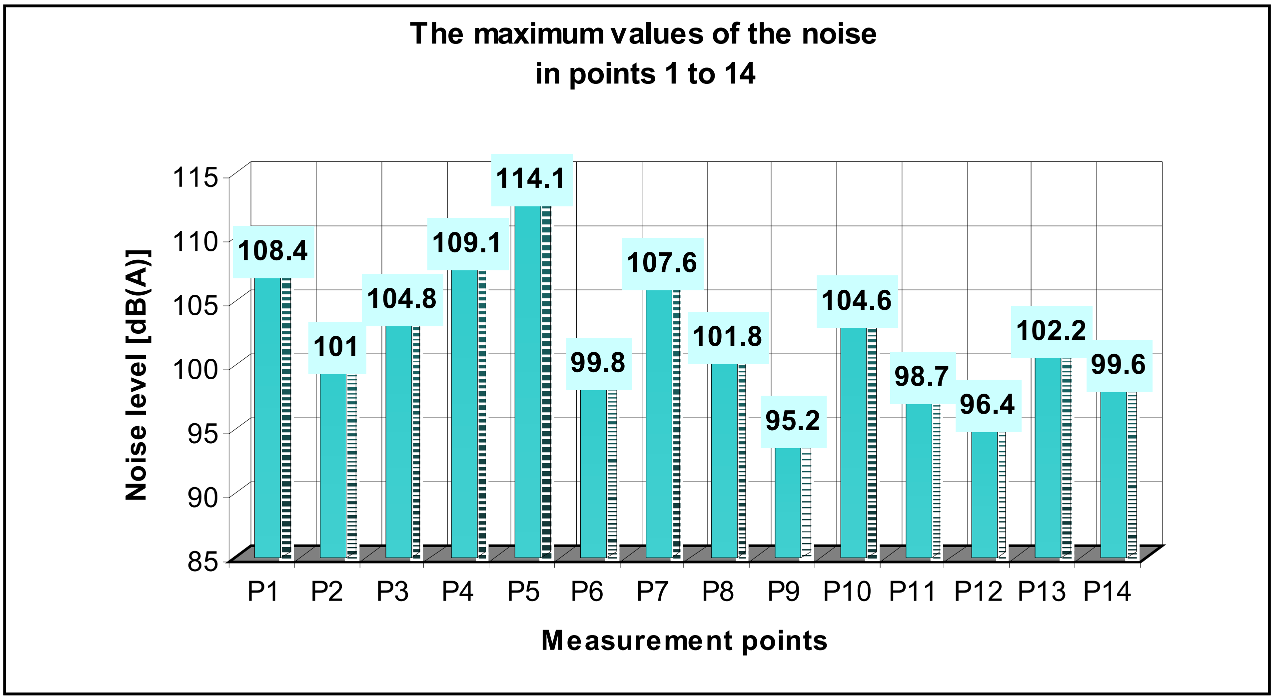

Fig. 4. The maximum values of the noise.

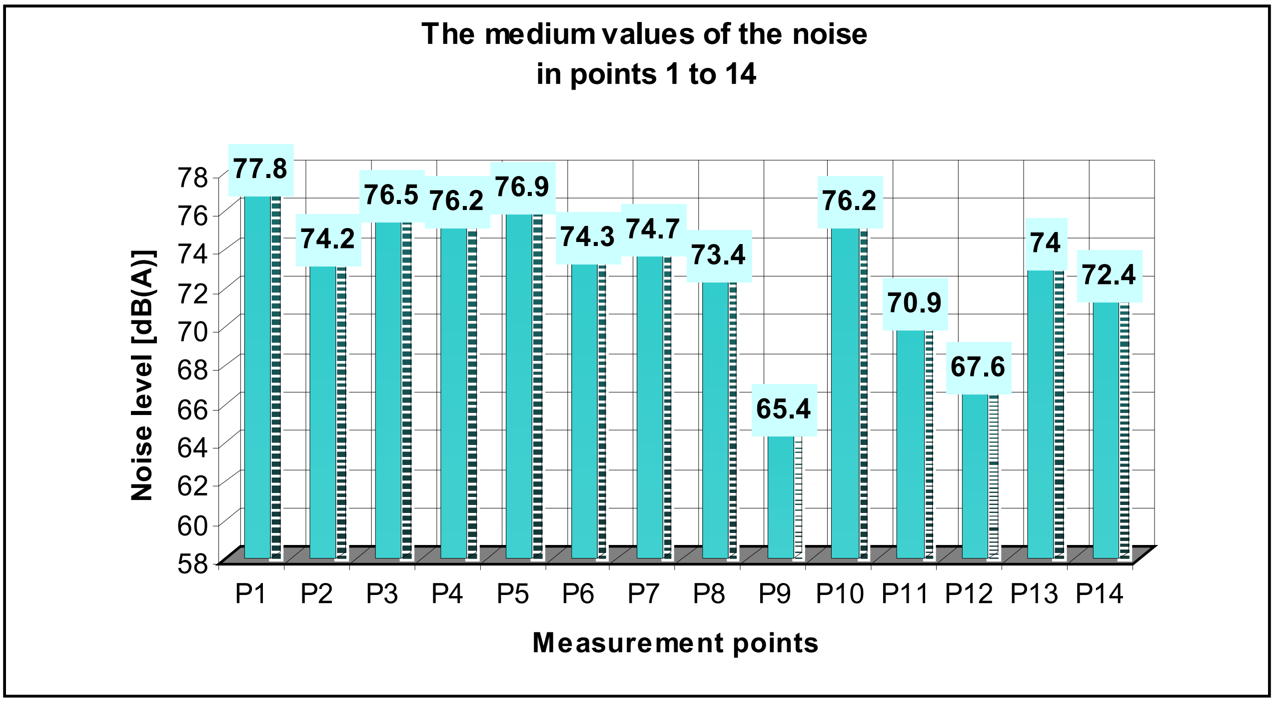

Fig. 5. The medium values of the noise.

4. The noise-reducing methods

4.1. Traffic planning is an important tool in efforts to reduce noise from traffic. Speed limits for roads may reduce the level of noise in cities. Noise in urban areas can also be reduced by by-passes and traffic calming measures, in order to keep traffic out of residential areas.

4.2. International experience shows that special road surfaces may reduce traffic noise. Several types of asphalt are available. High-drain asphalt reduces noise efficiently, but maintenance of this type of paving is rather expensive. The new noise-reducing thin-layer pavement does not reduce noise quite as much, but, on the other hand, it is expected to be only slightly more expensive than conventional paving, and is equally durable.

Example:

a) Porous asphalt PA 11 was designed in Austria according to RVS 8.06.28, (obligatory according to Zl.801.108/7-VI/1/90, BMfwA (Federal Ministry for Economic Matters)). Because of the high cavity, which is formed by connected pores, rainfall can enter into the road surface and is divert. For this reason the danger of aquaplaning and the constituting spray fog is decreased [6].

b) Stone-mastic asphalt SMA 11. A dense, relatively rough surface, which has been used for highways lately and is supposed to reduce noise emissions. SMA 11 distinguish itself because of its high resistance against deformation [6].

4.3. Promotion of tyres that produce less noise. The tyre noise of a truck dominates exterior noise at higher constant vehicle speed, as it is driven on transit roads. For this reason it is necessary to reduce the tyre noise to decrease the noise nuisance of the population.

4.4. Restrictioning of the traffic in some areas. In the historic center area it can be made traffic restrictions for some time intervals, for different types of vehicles: cars, minibuses, buses (with diesel engines), trucks. The traffic restriction will be made for the following time intervals: 9^{00}-14^{00} and 17^{00}-22^{00}.

4.5. Construction of bicycle lanes. Bicycle lane = a portion of the roadway designated by striping, signing, and/or pavement markings for preferential or exclusive use by bicycles and/or other non-motorized vehicles. Advanced bicyclists are the experienced riders who make up the majority of the current users of collector and arterial streets, wish to operate at maximum speed with minimum delays, and require sufficient space on the roadway shoulder to be treated as vehicles. Designated bicycle lanes along a roadway give riders an even greater degree of comfort along arterial and collector streets [3].

4.6. Speed limits in selected urban areas (40 km/h speed limit in residential areas).

4.7. Establishment of more noise walls (very expensive solution).

4.8. Traffic calming in urban areas, for instance by concentrating traffic in fewer streets and restrictions on heavy-duty vehicles in specific protected urban zones.

4.9. Noise insulation of building facades (very expensive solution).

4.10. Placing nonresidential land uses such as parking lots, maintenance facilities, and utility areas between the source and the receiver (Fig. 6). Noise protection can be achieved by locating noise-compatible land uses between the road and residential units. Whenever possible, compatible uses should be nearest the noise source.

***Fig. 6. Proposed parking garage along two sides of a residential area.
1 – garage, 2 – residential area, 3 – roads.***

4.11. Designing of street-traffic control lights programs for traffic fluidization and noise reduction [3]:

a) Semiactuated Signals (using

vehicle detector on minor street):

- Green is always shown on major street unless minor street actuation occurs;
- Two phase plan is common: one phase for main street and one phase for minor street;
- Usually installed where insufficient gaps occur in major stream.

b) Fully Actuated Signals:

- Most flexible form of signal control;
- All approaches have detectors;
- Each phase subject to minimum and maximum times;
- Some phases can be “skipped” if no demand detected (right hand turn);
- Cycle length varies.

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