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Traces of corrosion and air pollution dominate the vision of the common man in any city

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Abstract *—This article presents the critical vision of a common man, a worker, who lives and works in a district of a Brazilian city where pollution and atmospheric corrosion are the main focus of his concern in the daily journey that he makes from his home to the factory and the return from factory to house. In this journey made by bicycle, bus and on foot he feels, he sees and he registers with his critical eye and photographic camera the evil traces that the atmospheric corrosion leaves in the concrete lighting poles, the viaducts and the gates of the houses. In the semi-structured interviews carried out with this common man it is verified that the irreparable damages caused by the pollution and the atmospheric corrosion can compromise the safety and quality of life of the population.*

Keywords *— **corrosion, pollution, semi-structured interviews, common man, viaducts.***

I. INTRODUCTION

Each city is forming its own and logical design, based on the configuration of its morphology and the scenarios that reflect the social dynamics replicated in the production of the urban space [1]. Urban growth without proper planning often leads, in contrast to economic and social development, to a marked decline in the standard of living of the population. In this way, large cities end up concentrating noise, air pollution, dust, garbage, scrap, too much gray, ugliness, agglomeration, dependence, stress, delinquency, etc. The reduction of physical spaces, microclimatic changes due to deforestation, pollution, inadequate projects end up, directly or indirectly, bringing problems to the development and the daily life of a city [2-6].

This city can be defined as the set of architectural and engineering works according to its geographical dimension. It contemplates a series of everyday events that intertwine with the past and its historical evolution, establishing a coordinated system of community actions that bring a gate with streets, sidewalks, public squares, parking lots, shopping centers, schools, hospitals, gas stations, small and medium factories.

In order not to identify and penalize the district of this city and also preserve the identities of common man, a drawing was made, shown in Figure 1, representing the main places where the common man makes his home-work-home daily journey.

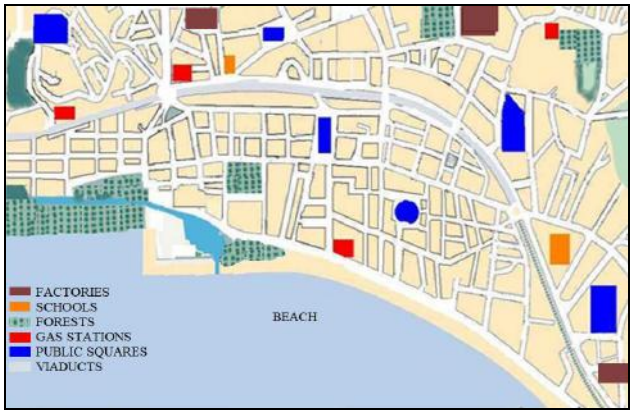

Fig. 1 – Drawing of the district of a city where the common man lives and works

This residential and industrial district belongs to a Brazilian city that based on the parameters of atmospheric corrosion is classified as having an urban, industrial and marine atmosphere. The climate is tropical; the average temperature is 23°C and average rainfall of 1100 mm/year. The urban atmosphere composed of contaminants such as CO_2, CO and NO_x is due to the intense traffic of cars, trucks and buses. In the industrial areas are SO_X, CO_2 and NO_X, while in the marine areas a sodium chloride (NaCl) mist is common at some times of the year.

The objective of this article is to show that, unrelated to the broader and more complex scenario of production

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relations, the common man in any city he lives and works in his day-to-day life, the resident and worker sees and registers with his critical and photographic vision, the evil traces that corrosion and air pollution promotes on his every day journey (home-work-home).

II. ATMOSPHERIC CORROSION ASSOCIATED WITH POLLUTION

Firstly, it should be noted that natural phenomena and human activities are the factors responsible for the presence of pollutants in the atmosphere, whether it be an active volcano or a capital goods industry that generate corrosive or toxic gases such as CO_2, SO_2 or H_2S.

Emissions from the chemical, petrochemical, metallurgical industries, automotive and waste incineration industries are largely responsible for the pollutants found in the atmosphere. These pollutants may be gases, fine chemical mists, dusts, fumes or combinations of these emissions. Primary pollutants are those emitted in the direct form while the secondary pollutants are generated by chemical atmospheric processes that act on the primary pollutants. Sulfur trioxide (SO_3) and sulfuric acid (H_2SO_4) are produced from the oxidation of the primary pollutant SO_2. In the same way, NO_2 is generated from NO oxidation and ozone (O_3) is produced from oxygen or from photochemical processes in the presence of hydrocarbons and NO_X [7-9].

Among the most common are carbon dioxide, carbon monoxide, sulfur dioxide, ammonia, hydrogen sulfide, nitrogen oxides, hydrogen fluoride and some organic compounds such as methane, ketones, alcohols, benzene, etc.

Even with the restrictions imposed by the anti-pollution laws and the awareness that begins to take shape, however, certain chemical contaminants are still detected in the atmosphere by the environmental agencies, incompatible with the demands of current scientific and social progress.

Consequently, all this polluting potential ends up being transformed into the cycle of pollution→corrosion → pollution→ corrosion that generates problems intrinsic to cities and the population.

According to Mainier et al. [10], atmospheric corrosion can be classified with based on two types of mechanism: the chemical corrosion that occurs in the absence of an electrolyte and the electrochemical corrosion that occurs in the presence of an electrolyte deposited on a metallic surface.

Figure 2 shows an attack of H_2S (moisture-free) on a ferrous surface. The formation of the sulfide deposit (FeS) depends on the temperature, pressure and physical-chemical characteristics of the metal in contact with H_2S.

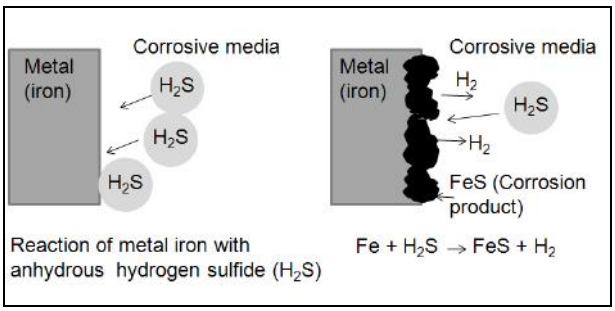

Fig. 2 - Chemical corrosion mechanism to H_2S [10]

According to Mainier et al. [11] in this process show in the Figure 3 are expected reactions of SO_2, water and sulfuric acid with calcium hydroxide free ($Ca(OH)_2$), dicalcium silicate ($2CaO.SiO_2$) and tricalcium aluminate ($3CaO.Al_2O_3$), cement constituents, forming crystals or precipitates in concrete matrix with volumes 30 times greater than the initial volumes of these crystals. That way, the increase of the volumes of these crystals will cause a high internal pressure in the cracks causing, consequently, the failure or desegregation (disagreement) of concrete, according to the following reactions:

$$SO_2 + ½\ O_2 + H_2O \xrightarrow{NOx} H_2SO_4$$

$$Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4.2H_2O$$

$$3CaSO_4.6H_2O + 3CaO.Al_2O_3 + 25H_2O \rightarrow 3CaO.Al_2O_3.3CaSO_4.31H_2O$$

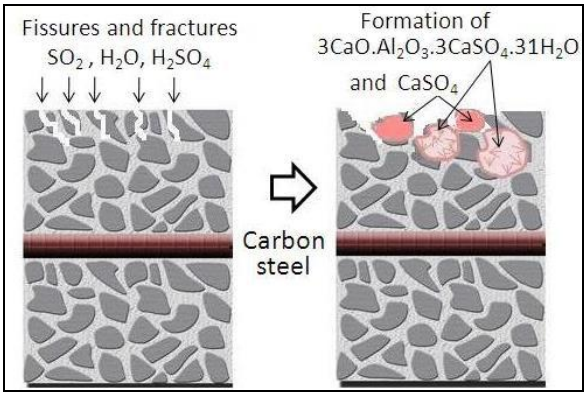

Fig. 3 - Chemical corrosion mechanism of concrete

It is important to note that in chemical corrosion, according to the examples presented, there is no transfer of electrons.

In the electrochemical corrosion the transfer of electrons from the anode to the cathode region is done by means of a metallic conductor (Fe) and a diffusion of anions and cations in solution closes the electrical circuit. The

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intensity of the corrosion process is determined by the number of ions that discharge in the cathode, or by the number of electrons that migrate from the anode to the cathode, according to the model and the reactions involved (Figure 4).

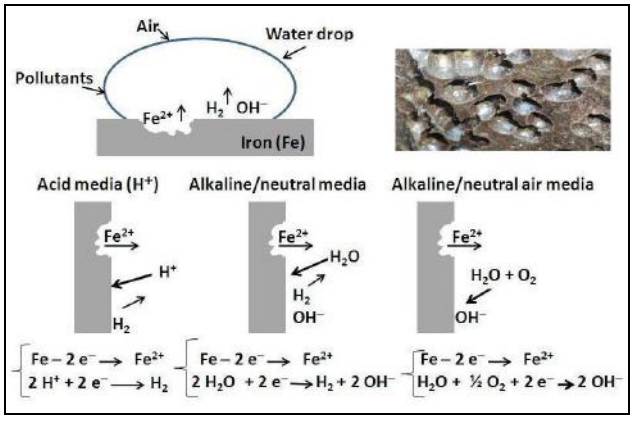

Fig. 4 – Electrochemical corrosion mechanism for atmospheric corrosion [11]

The anodic and cathodic reactions shown in figure 4 show the electron transfer in three corrosive media usually found on metal surfaces, such as acidic, alkaline or neutral and aerated. Pollutants such as SO_2, SO_3, NO_x, CO_2 and H_2S can provide corrosive acid media. Ammonia (NH_3) can be an intense corrosive agent for copper and nickel alloys while the sodium chloride mist from the marine environment promotes the increase of the electrical conductivity consequently accelerating the corrosive process [12-14].

III. THE CORROSION SEEN BY THE COMMON MAN IN HIS HOME-WORK-HOME TRAJECTORY

The semi-structured interviews (SSI) technique has been designed to determine people's subjective responses to a specific situation or phenomenon that they have experienced. From the simple theoretical basis of how the phenomenon of atmospheric corrosion associated with pollution occurs scientifically, sought to rescue, through SSI made with this ordinary man about what he sees, he feels and thinks about the deterioration registered in his path home-factory-house. In semi-structured interviews it is essential to preserve the respondent's identity [15-17].

The knowledge of these individuals usually arises as a result of their experiences, their continuous service, the tools they use and all the social relations developed during their work, thus generating a totally practical, conscious or unconscious, innocent or critical knowledge [18].

Referring to writer Umberto Eco [19], it is worth to consider the concepts that scientific humbleness is to recognize that everyone can teach someone something; that he who does not seem to be of great value has hidden qualities and quantities; and that those who intend to do a research cannot, on principle, despise any source.

In this article the common man identified as a factory worker working at a factory located four miles from his home. He is 40 years old. He works as a mechanical parts assembler, has a medium level of education and has not attended any university. In the displacement, he uses the bicycle, urban bus or on foot, usually when he has time, mainly, in the return of work. In this work-home-to-house trajectory he began to observe and feel the emissions of pollutants generated by the nearby factories and by cars, buses and trucks. He also went on to record the deterioration of viaducts, concrete lighting poles, facades and building structures, leaks from underground water and sewer pipes, recreational areas where his children play, etc.

Corrosion and environmental pollution are phenomena that can be considered as omnipresent, global, penetrating and diffuse in the ordinary man's life. Political consciousness emerges when he begins to understand, for instance, that such phenomena can be results of neglect in the conservation and maintenance of materials, in the undue use of the components, in the lack of inspection in the emissions of pollutants, mainly when it comes to public projects, whose budget it is one of its contributors through direct and indirect tax payments.

Figures 5 and 6, below, shows photographs taken on the viaduct showing intense corrosion of concrete and carbon steel reinforcement. Probably, the viaduct is not in danger of collapsing, however, lack of conservation shows that inspection and maintenance are not carried out by public conservation agencies.

The fragment of the interview conducted on the basis of figures 5 and 6, the common man says:

> "I go through this viaduct every day on top and bottom. I've been following this corrosion on the concrete that leaves the carbon steel armature exposed. I am concerned about the lack of recovery of these affected parts. The continuous deterioration can be disastrous for our community who need this viaduct to get around."
>
> "The smoke that is released by the buses and trucks is very large; the smell is strong and causes burning eyes. I think the pollution is great when the smoke from factories and buses and trucks intertwine. I think residents in this district are disadvantaged in relation to Public Health. In the end both the viaduct and our lungs are affected by this killer pollution. Does the

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Prefecture and the Health Posts know about this contamination? We pay taxes for what?"

Fig. 5 – Aspects of corrosion in the reinforced concrete viaduct

Fig.6 – Aspects of corrosion in the reinforced concrete viaduct

"Today, I'm 40 years old, 25 years ago, at my school I've never been alerted to these facts. Today, in the school of my children, pollution around our homes is discussed by teachers. My son said to me: Dad the teacher said that the factory you work for is the great polluter of the area. I heard and I was silent. In my heart I know it's true. Maybe if I say something I can be sent away from the factory."

Another point that attracted the attention of the worker was the deterioration shown in Figure 7 by the concrete lighting poles. Figure 8 presents details of concrete corrosion and corrosion of carbon steel reinforcement.

The fragment of the interview conducted on the basis of figures 7 and 8, the common man says:

"I am a factory worker and I can say, just look at the poor quality of these concrete lighting poles. They are not prepared to withstand the corrosion and pollution of this area which in addition to residential has factories that pollute. The workers of the electricity network do not keep, when the pole is to fall or already broke they exchange for another equal. I've seen several post exchanges. I do not understand why this disregard for the population, because in the end that pays this irresponsibility are all of us".

Fig. 7 - Aspects of intense corrosion of public lighting poles

Fig. 8 - Corrosion detail of the of public lighting poles

"The steel armature is exposed by showing that they were not made using the standards or assembly procedures. In my work we follow the rules and procedures that must be done in an assembly. Quality control does not leave a part that does not conform to the standards. I believe that in these post mills quality control does not exist or is not applied."

"These posts have already caused several accidents and can put the lives of walkers in constant danger."

Nor have the two gates of his neighbor's house escaped from their critical observation. One gate is made of galvanized grid and the other of carbon steel profiles coated with paint. As can be seen the lock itself also presents corrosion.

The fragment of the interview conducted on the basis of figure 9, the common man says:

"The gate is made with a galvanized grid that should not corrode; therefore, I have always heard that this zinc coating lasts a long time, more than 20 years. From what I heard from my neighbor this gate is 5 years old. Quality should not be the same as

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advertising claims. Sometimes I become quite skeptical of these materials that should last longer."

"I kept noticing that in the lower part of the gate the corrosion is more intense because the water becomes stagnant."

Fig. 9 - Intense corrosion of the gates and the lock

"This lock is simple and inexpensive, which is why it does not withstand pollution and atmospheric corrosion. I never worried about this thing, corrosion, in locks. But on second thought, in my house, I changed two locks one by internal defect and the other one because the handle already had points of corrosion. I dismounted the two locks and I saw that they were corroded on the inner parts."

The facts narrated in the interviews can lead the common man to the comprehension and dimension of the irreparable damages that can be caused to the environment by the pollution and the atmospheric corrosion that show their trace and consequently compromise the security and quality of life of the population.

IV. CONCLUSIONS

Based on this study, the following conclusions are presented:

- corrosion and pollution are a permanent challenge to man, because the more science creates and evolves and technology applies and advances, the more they find spaces and ways to be present;
- the lack of inspection, conservation and maintenance are responsible for the deterioration of poles and viaducts as evidenced by the photographic documentation made by the common man;
- the organized society is doubly penalized: by the environmental contamination that it breathes every day and also by the payment of the additional taxes to repair the damages caused by the corrosion.

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