WORKSHOP

"IMPACT OF AIR POLLUTION ON MONUMENTS AND CONSERVATION"

3RD NOVEMBER 2018 AT NEW DELHI.

Indians are heirs to priceless cultural wealth in the form of monuments, archival materials, archaeological sites and vast museum objects. To preserve the wealth and pass on to next generation, as unspoilt as possible, is a challenging task. India has a variety of geo-climatological regions, hence the problem of conservation of historical structures spread all over India is compounded and approach naturally differs from one part of the country to another. The climate of India has distinct regional variations discernible by the pattern of winds, temperature and rainfall; further, also in the form of rhythm of seasons and the degree of wetness or dryness. Added to the problem if the increasing air pollution from anthropogenic sources, in the form of dust, fine particles, soot, fumes and gases and their chemical reactions in the presence of moisture, heat and oxygen. Since monuments are exposed directly to the atmosphere, they suffer physical and chemical alterations. The damage is expected in all sort of possible forms such as growth of biological activity, exfoliation, darkening of surfaces, soiling, pitting and cracking of building materials. Air pollutants not only disfigure the aesthetic beauty of monuments but also accelerate the rate of natural weathering / decay. Some of this decay is a consequence of deposition of air pollutants.

In deposition, mass transfer from the atmosphere to the receptor surface occurs as a sequence of three steps; pollutants must mix from the surrounding air to the vicinity of the surface, then they must cross a near surface boundary layer, and finally they must be captured by the surface in some way. The first stage of the mass transfer process is influenced by the atmospheric mixing and aerodynamic flow fields nearby. Uptake of pollutants by the surface depends on numerous other factors; surface

physical characteristics such as roughness and wetness, the chemical affinity of the pollutant to the surface material and resident biological organisms.

Many historical monuments are made up of marble. Deterioration of marble is not a simple result of the marble's reaction to various weathering agents, neither the exposure nor the deterioration is uniform. Chemical, mineralogical, and physical variations in the marble account for some of the variation in durability. In order to protect and preserve historic marble buildings, it is important to consider both the characteristics of marble deterioration and the factors that influence where and how extensively it will deteriorate.

Monuments situated in various historic cities of the world have suffered extensive decay. If we compare Indian monuments to monuments in USA, Italy, Germany and France, we would find that air pollution impact has not yet shown its vigour, except those located in urban centres like Agra and Delhi.

Taj Mahal so far is well preserved. The red sandstone does not have the strength of marble. It gets chipped off due to weathering, sandstorms and other stress. Floors and some walls show more deterioration. These are replaced regularly in the Taj Mahal. While marble jalis have generally been strong and have been unaffected, many red sandstone jalis break or show cracks, and are replaced through very careful replicas made by highly skilled artisans.

In an affidavit submitted to Supreme Court, ASI sated "Marble of Taj is not a pure variety of marble but a dolomite one containing carbonates of calcium and magnesium as well as silica, iron, arsenic and tellurium in traces are present. The yellowishness of the marble is the cumulative effect of moisture deposition, aerosols particularly in sulphate, particulate carbonaceous matter and gaseous pollutants present in ambient air. The coating they form is superficial in nature anis being removed by suitable physical and chemical methods from time to time. Cracks in marble has nothing to do with air pollution and have been produced as a result of uneven stresses produced on the surface. Where more water have accumulated, black deposits of microbiological growth has been noticed.

The NEERI report of July 1993 mentions about damage from SPM and SO₂ in vague terms. The report was highly controversial.

The study by Roorkee University concludes that the useful life of brick lime mortar will be in excess of 930 years. It also states that staining and pitting of marble can occur due to NOx and chlorides in air.

The report by US National Park Services stated that the adverse effects of air pollution on monuments depends on the chemical composition of the particles, their size, chemically reactive particles like NH₄, SO₄, etc. While all particles contribute to soiling and stone discolouration, neutral particles (dust, silica) are simply cleaned but removal of reacted particles entails some damage to the stone substrate. The unmeasured air pollutants like HC and other products of combustion from dung, tires, plastic and other refuse are also of concern. The suite of measurement does not capture the odour of sewage and haze.

The Vardarajan Committee report (1994) ruled out pollution related damage to the monuments in Agra including Taj Mahal and attributed deteriorating air quality in the region mainly due to non-industrialized sources such as traffic and diesel gensets. The committee did not oppose the relocation of the local industries, although shifting them outside the TTZ, it recommended shifting them to nearby sites towards the south/south east of the Taj Mahal.

Environmental issues often generate considerable heat and public debate. While the traditional focus of these debates has been the role of governments and that of political and commercial vested interests, the role played by scientists and expert committees has seldom been examined seriously. Given the fact that every environmental controversy is either cleared or backed by some expert opinion, and that more often than not, environmental scientists and engineers have themselves been at the root of these controversies. Interestingly, the original issue of whether the Taj has suffered any damage due to air pollution and whether it can be attributed to industry /traffic / DG sets /Biomass burning alone, on which scientists and expert committee continue to differ for the last 3 decades, seems to have become less important.

Indian Association for Air Pollution Control (Delhi Chapter) organised the Workshop on "Impact of Air Pollution on Monuments and Conservation" on 3rd November 2018 at New Delhi. The workshop was sponsored by the Oil & Natural Gas Corporation Limited. More than 75 experts participated in the proceedings.

Dr. J.S.Sharma, in his welcome address spoke about the objectives of the workshop and stressed the need to conserve the historical monuments located in urban areas of the country because they are facing threats due to increasing pollution, namely dust, gases, ozone and variety of insects. Dr. Rakesh Kumar, Director National Environment Engineering Research Institute, in his inaugural address mentioned the various atmospheric factors that are affecting the quality of Indian monuments and research studies undertaken by NEERI to understand the magnitude of problem faced by Taj Mahal. In his Keynote address Dr. J.R.Bhat, Advisor, Ministry of Environment, Forests & Climate Change spoke about the various initiatives taken by the Government to conserve the historical monuments, the existing gaps and how it can be plugged. Experts from PGI-Chandigarh, Agra University, IMD Delhi, IIT Kanpur, and former Scientists from CPCB shared their data and experiences and also the research work in the two sessions that followed.

The workshop concluded with Valedictory session chaired by Mr. Ajit Seth, former Cabinet Secretary in the presence of Director, National Physical Laboratory, Shri Paritosh Tyagi, Former Chairman of Central Pollution Control Board, Dr. B. Sengupta, Former Member Secretary of Central Pollution Control Board and Prof Girish Maheshwari, Head Department of Entomology at Saint John College Agra. Main conclusion that emerged during the workshop are i) revisit the Taj Trapezium concept made in 1985-86 around Taj Mahal in light of latest advances in science and technology by changing its shape to oval and demarcating concentric zones namely core and buffer zone; ii) conduct an emission inventory and source apportionment study, prohibit industry and other polluting activities in the core zone, encourage only green, white and orange category industry in the buffer zone; iii) intensify the density of trees and plant trees as strips in the entire area except close to Taj Mahal; iv) make available uninterrupted electricity in the entire area and ban use of DG Sets; v) Prohibit discharge of sewage and other solid wastes in Yamuna river and maintain minimum flow in Yamuna river around Taj Mahal; vi) Convert wood based crematoriums in the core area of Taj Mahal into electric or CNG fired; vii) Introduce Biomonitoring technique as indicators of pollution, Listing of all monuments in India by using RFID tags; viii) improve quality assurance in

pollution monitoring methods ix) increase coordination among all stakeholders namely Central & State Pollution Control Board, Archaeological Survey of India, India Meteorological Department, Transport Department, Industry Department, Town & Country Planning Department, Local Urban Body (Municipality, Cantonment Board, etc).