Why are our roads pot-holed?

Soon after putting hotmix layer on our roads, pot-holes appear. Whether the rain is heavy or light, and the traffic is of loaded rolling stocks or light vehicles, the pot-holes become progressively larger. Eventually the pot-holes engulf the entire road where the conditions become stressful.

This happens because the roads do not have the protective carpet made up of finer sand admixed with asphalt – the bituminous sandy *surfacing* layer – resulting in the exposure to onslaught of raindrops and impacts of speeding vehicles of the hotmix base consisting of mostly granules and granule-sized rock fragments cemented together by asphalt (Figure 1).

Geologists are aware that coarse-grained rocks are more vulnerable to physical erosion and chemical weathering than fine-grained rocks, and that compared to sands (0.5–1.0 mm), the gravels and granules are more easily and rapidly abraded and weathered[1–4]. This is because in gravels (2–64 mm and above) and granules (2–4 mm) much larger space is available for physical abrasion and chemical decay. The exposed grain boundaries (Figure 2) become the surfaces of weakness along which minute fracturing occurs, leading to disintegration of grains and dislodgement of their fragments. Allowing entry of water, the grain boundaries promote chemical weathering even as the binding (cementing) material (asphalt) is slowly nibbled and washed away by rainwater. There is thus rapid loosening of grains and formation of pits.

As stated above, the finer grains are less vulnerable to abrasion and erosion. Therefore, bituminous *surfacing* layer, made up of finer sand admixed with asphalt is not easily affected by water and moving rolling stocks. Since our roads (with some exceptions) are bereft of bituminous surfacing cover, the base comprising mostly granule-sized rock fragments, is exposed directly to the actions of rainwater and speeding vehicles. The road base becomes easily pitted. The loosened grains or fragments are dislocated one after another and the pits become pot-holes.

Civil engineers laying the road know that the road pavement should comprise three layers (Figure 3) and that the thickness of the top layer – the bituminous *surfacing* – should vary from 20 to 40 mm or more depending on the traffic density[5]. This protective surface layer serves well against the erosive power of water and the pressure of vehicles.

Despite being aware of the norms set by the Indian Road Congress, it is surprising that our competent engineers allow

Figure 1. One of the very busy roads in Bangalore near Cubbon Park. Without the protective carpet of surfacing, which should consist of finer sand admixed with asphalt, the base is made up of mostly granule-sized rock fragments cemented together by asphalt. Figures show granule-size grains held together by thin veneer of asphalt, without the protective surfacing of sand–asphalt admix.

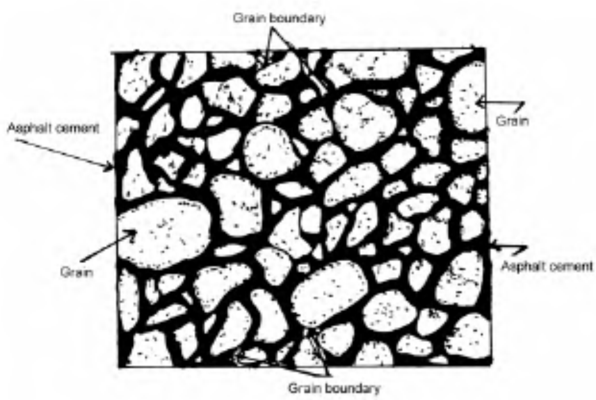

Figure 2. Granule-sized grains are held together by the cement of asphalt (shown in black) in the hotmix layer of base. Grain boundaries (shown by arrows) become surfaces of weakness and allow entry of water, which erodes away the binding material (asphalt). A grain may be granule-sized or pebble-sized rock fragments.

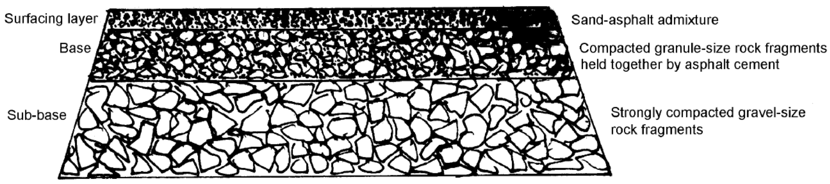

Figure 3. Triple-layered road pavement should comprise (i) strongly compacted gravels or gravel-sized rock fragments, (ii) hotmix base made up of granules or granule-sized rock fragments held together by asphalt, and (iii) top bituminous surfacing consisting of finer sand (0.25–1.0 mm) admixed with asphalt. In the diagrammatic sketch, fine stipples represent asphalt (based on Anon[5]).

the laying of roads without the protective layer at the top (Figure 1). Bereft of the top layer of sand–asphalt mix (*surfacing*), our roads are like a body flesh without its skin. The roads are bound to get 'seriously wounded', as is happening all over India, with few exceptions.

These considerations lead to some questions of far-reaching implication. (i) Have the engineers done away with the mandatory provision of 20–40 mm thick bituminous surfacing made up of sand–asphalt mix? (ii) Is provision of this top surfacing layer made in the design of the roads, and whether this mandatory imperative is spelt out in the tenders? (iii) If the tenders do indicate the provision of bituminous (sand–asphalt mix) surfacing, do the engineers ensure its laying down? (iv) Whether contractors get paid for construction of roads with or without the top surfacing layer?

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K. S. VALDIYA

Jawaharlal Nehru Centre for Advanced Scientific Research,
Jakkur,
Bangalore 560 064, India
e-mail: nehrucen@jncasr.ac.in

NEWS

MEETING REPORT

Ecological complexity and sustainability*

The world is experiencing catastrophic global environmental problems such as climate change, global warming and rise in sea-level. Rapid urbanization, industrialization and globalization have enhanced the pace of these changes, and have exerted severe ecological stress on the earth and its life-supporting systems from local to regional, and global scales. Water shortage, desertification, soil degradation, greenhouse gas emission, elevated sediment and nutrient flux to the coastal seas and other environmental problems are increasingly becoming the common side effects of those human activities. Sustainability can only be assured with an ecological understanding of the complex interactions among environmental, economic, political and social/cultural factors, and with careful planning and management grounded in ecological principles. Ecological complexity and sustainability are becoming a core concept and instrument for improving our common future.

The structure of EcoSummit was unique in the sense that it was a summit and not a workshop or conference, and ensured active participation of all delegates through the Working Groups, in addition to the symposia, oral presentations and poster sessions. The first EcoSummit was held at Copenhagen, Denmark in August 1996.

EcoSummit is being held once in four years to discuss the complex global problems. This year it was held in Beijing. The primary objective of the EcoSummit was to encourage greater integration of both the natural and social sciences with the policy and decision-making community, to develop a better understanding of the complex nature of ecological systems. About 1400 leading environmental scientists from 70 countries met at EcoSummit 2007 to discuss how ecology can help to mitigate global climate change, ecosystem degradation, and to find ways to improve human well-being in the context of the UN Millennium Development Goals.

EcoSummit 2007 included four plenary sessions, 50 symposia, 20 oral sessions, three poster sessions, nine evening sessions and one forum. The plenary session covered topics from ecology in the 21st century, sustainable development, ecoscaping, ecological indicators, urban ecology, ecological engineering, ecological sustainability, ecological traps, ecology-systems approach, microbial ecology, ecosystems services and impacts of invasive species and climate changes. The symposia covered a wide array of topics, including ecosystem modelling, system analysis, invasion biology, sustainable management of coastal lagoons, mathe-

*A report based on EcoSummit 2007 – 'Ecological Complexity and Sustainability: Challenges and Opportunities for 21st Century', held in Beijing, China during 22–27 May 2007, jointly organized by a number of ecological societies and associations along with Chinese Academy of Sciences, International Council of Scientific Union and Elsevier Publications.