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Road Surface Deterioration Caused by Burning Car Tyres

Alhammali A Younis, Naser A Ali, Hamza A Abdelsalam, A. Elhoud
Mechanical Engineering Department, Sirte University, Libya[1,2]
Civil Engineering Department, Sirte University, Libya[3]
Chemsystems, Ambachtsstraat, Westmalle, Belgium[4]

Abstract- Burning car tyers is the most common tool protesters use to express their anger. Nevertheless, people do not know the impact of flaring tyers on road structures. The elevated temperature of burning on road surfaces is harmful to pavement materials like bitumen. An investigation to determine the influence of tyer fire on a road was carried out after exposure to heavy fire during a demonstration. The investigation concluded that the severe damage to the road was due to the high temperature on the pavement surface, which was hundreds of degrees above the softening temperature of bitumen. In the meantime, the rubber ash as well as the steel wires' fine hot spot regions in the form of deep damages supported the bitumen and binder segregation.

Index Terms- Car tyres, protesters, road pavement, bitumen

I. INTRODUCTION

The road pavement consists of three basic components: surfacing, structural layers, and subgrade. All together, they ensure good road performance. Weakness in one of these layers can lead to significant defects. The refined asphalt/bitumen is the most suitable binder for aggregates in making flexible pavements, i.e., roads and highways. Climate heat in the summer time causes the road temperature to reach a stiffer bitumen with less viscosity, 60–135 °C, according to viscosity tests [1]. Bitumen performs in elastic, viscous and brittle behavior, depending on time of loading and temperature [2-6]. The materials of modern pneumatic tyers are synthetic rubber, natural rubber, fabric for reinforcement, and several kinds and sizes of steel, along with carbon black and other chemical compounds [3]. Information on the effect of a car tyer fire on pavement is rare. However, this subject deserves to be studied further. Besides the effect on pavement materials, the car tyer burn can produce clouds of smoke, which may disturb the environment too [4, 8]. There is a good opportunity for researchers to carry out detailed studies on the impact of car tyer burns on roads as well as on the environment. An investigation was carried out on one road after a demonstrators burned car tyers on this road.

II. ROAD DAMAGES SCENARIOS AFTER CAR TYRES BURNING

Photos from the damaged roads are shown in Figure 1. A general view of the fire damage marks on the road surface is seen in Figure 1a. A close view of the significant damage resulting from the burns on the road surface is clearly observed in Figure 1b. The road damage mechanism is described below in three stages: road surface burn, depletion of bitumen, and finally binder segregation.

Figure 1: a) A general view of the burned road; b) A369 close view of the damaged location

III. ROAD SURFACE BURN

A sketch illustrating the burning components of the road surface (black coat), road structure, and fire flare is shown in Figure 2. The fire deteriorates the structure, which is manifested by the locally increased roughness of the road surfaces. Underneath the flare, the bitumen liquefies over the road. The bitumen diluted after the road temperature exceeded the softening degree of the bitumen.

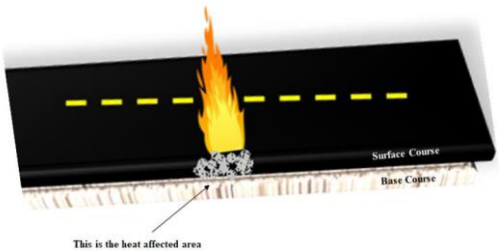

Figure 2: Sketch for fire burning on pavement surface

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IV. DEPLETION OF BITUMEN

The first stage of road deterioration after catching fire was the depletion of the bitumen from the black coat (surface course) at the heat-affected area, as indicated in Figure 2. The burn temperature of bitumen in this thermal condition is different from conventional bitumen heat. The exposure of bitumen to a hot climate for a period of time in moderate heat (aging) is responsible for the oxidation. The burning of bitumen by tyer flares has instant chemical reactions due to the exposure to hundreds of degrees of heat above the predetermined softening temperature mentioned elsewhere (1, 2). Moreover, the rubber and bitumen increased the heat release on the road surface. The depletion of asphalt binder caused degradation and damage to the road aggregates. The effect of degradation on the aggregate is clearly observed in Figures 3 and 4.

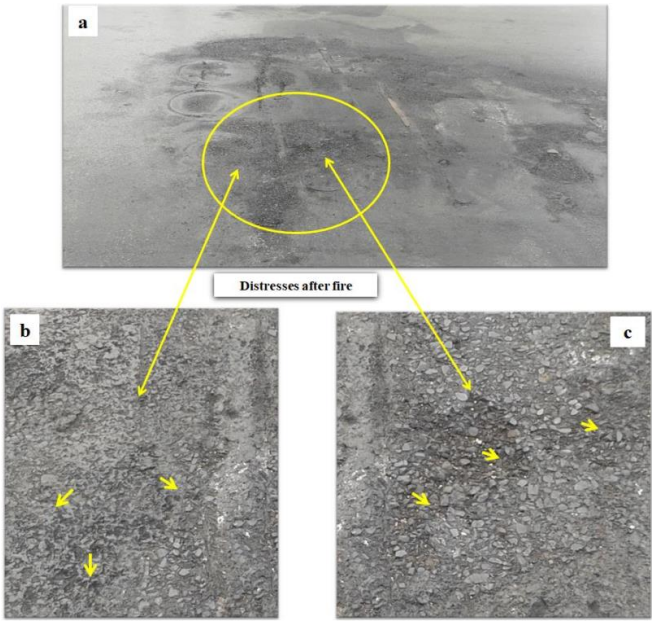

Figure 3: Raveling distress after car tyer fire

V. BINDER SEGREGATION

Thermal exposure resulted in the segregation of binder from the aggregate boundaries. This can reduce the adhesion and strength properties of pavement. The distress after binder segregation is the raveling (weathering) of the road surface. The features of the Raveling are seen in Figure 3 (a–c). On some roads in the city, the damaged areas exposed to moderate traffic rates caused the propagation of aggregate degradation. This propagation of aggregate damage is attributed to the loss of strength in the binder course. The other observed distress is the polishing of the aggregates. Obviously, the road polishing distress happens after the road ages. The angular or aggregate particles become polished. The observations indicated that after some days of traffic on burned areas, premature polishing and deterioration of aggregates took place, as seen in Figure 4. The concern is that the damage will grow faster with the abrasion caused by repeated traffic of cars and vehicles if no quick action is taken.

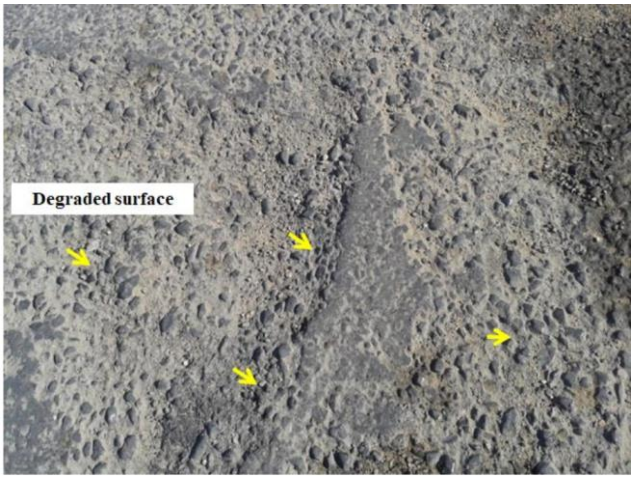

Figure 4: Early polished aggregates after fire burns and then traffic

VI. THE SEQUENCES OF THE FIRE BURNS ON ROAD SURFACE

1. The Influence in Winter Time

The bitumen possesses water-proofing and adhesion properties. However, the burning of bitumen will affect these properties. In good road design, rainwater goes to the drainage system. The presence of road damage can affect the water drain because the damaged locations become the preferred region for stagnant water. The stagnant water can penetrate through the road aggregates and affect the pavement properties, such as strength. Another impact of water penetration is the development of swelling, cracks, and potholes in road pavement. Cracks and potholes can affect road performance as well as the safety and comfort of passengers and vehicles.

2. The Influence by Repeated Traffic

Traffic of vehicles and cars on the damaged areas will lead to aggregate pull out due to the reduction in strength after the fire exposure. The loss of aggregates results in other distresses, mainly potholes. Further stresses imposed by the flow of traffic will considerably weaken the pavement, resulting in pavement deformation and road failure as described elsewhere [8].

VII. CONCLUSION

Car tyers burned on the road surfaces caused distresses such as thermal degradation of bitumen in less time than it may take years in a normal climate and conventional traffic conditions. The reason for such thermal distress is the fast softening of the bitumen and the bonding loss between the aggregates and the

asphalt binder. The loss of binder caused aggregate to be pulled out by the heat and fire flare. The raveling and the segregated aggregate distresses will transform into pothole damages. These damages can reduce the lifetime of the road.

Recommendations

1. Immediate repairs are an adequate solution to prevent further road deterioration.
2. Immediate repairs, such as resurfacing, are the most effective cost solution to avoid unplanned expenses.
3. Delay in repairing damages will expose the affected locations to the following:

- Enhance premature failure of the road.
- Various distress will become visible.
- Less-speed vehicles can be harmful.
- The load-spreading capabilities will drop.
- The load contact area will grow.
- Alternative option of maintenance, such as reconstruction, it comes necessarily.

4. A repair strategy should be planned for the damaged roads before the winter season.
5. Leaflets indicating the risk of car tyers burning on roads must be given to the public.
6. TV and radio programs must elaborate on this issue.

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