

## Evaluation of the effect of geological characteristics of carbonate rocks mines on the moisture sensitivity of hot mix asphalt

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### Abstract

Aggregates form the structural skeleton of the asphalt mixture. Thus, the physical, mechanical, and chemical characteristics of the stone play significant role on the performance of the asphalt. By identifying the geological characteristics of the aggregates, vital information could be obtained about the behavior of asphalt during utilization. In this research, 13 carbonate mountain mines with diverse geological formations located in Ardabil, Isfahan, Tehran, Zanjan, Semnan, Qom and Hamadan provinces were sampled. The geological characteristics of the rocks in each mine, including the type of texture, the minerals and its constituent elements, were identified and the influence of the determined geological characteristics on the experiments results of Asphalt samples were investigated and evaluated. These experiments include boiling water, Indirect tensile strength, Marshall strength ratio of asphalt, as well as bitumen absorption of the aggregates. The results of the investigations show that the type of microscopic texture of carbonate rocks is influential in reducing or increasing bitumen absorption. In addition, the presence of evaporative minerals, even in small amounts, increases the moisture sensitivity of asphalt.

**Keywords:** *Carbonate aggregates, geology, hot mix asphalt , humidity sensitivity*

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## Extended Abstract:

### 1. Introduction

One of the most important factor in many asphalt pavement failure, including stripping, sanding, fatigue and permanent deformation, is moisture sensitivity (Kim et al., 2008). Moisture sensitivity reduces the adhesion between bitumen and aggregate by different mechanisms (Little and Jones, 2003). The review of the conducted research shows that in order to investigate the effect of geological characteristics on the performance of asphalt mixture, aggregates from all three or two main rock groups (sedimentary, metamorphic and igneous) were selected and evaluated, and or aggregates selected from a main group do not have much diversity and abundance (Abo-Qudais and Al-Shweily, 2007, Anastasio et al., 2017, Labib et al., 2007).

### 2. Materials and methods

The materials used in the construction of asphalt samples in this research are aggregate and bitumen. The aggregates selected in this research were selected from 13 carbonate mines located in Ardabil, Isfahan, Tehran, Zanjan, Semnan, Qom and Hamedan provinces, which are named from Q<sub>1</sub>, Q<sub>2</sub>,..., Q<sub>13</sub>. PG 64-22 bitumen was used in making asphalt samples.

The evaluation in this research are divided into two general sections; first, investigating the geological characteristics of rocks includes: identifying the texture of the rock, determining the type of constituent minerals and the amount of carbonate minerals in the rock, and the second, is evaluating the hot asphalt mixtures made from the aggregates of each mine, including: absorption bitumen is the material and humidity sensitivity tests, and finally, based on the results of the tests, the impact of the geological characteristics of the rock on the humidity sensitivity of asphalt is analyzed.

### 3. Tests results

The XRF results confirmed that CaO amounts are significant compared to other oxides, and SiO<sub>2</sub> amounts exceeds ten percent at max. XRD results show that the main rock mineral in all 13 studied mountain mines is carbonate minerals. Gypsum evaporite mineral is observed in Q<sub>3</sub> mine, muscovite metamorphic mineral in small amount in the rocks of three mines Q<sub>3</sub>, Q<sub>7</sub> and Q<sub>11</sub> and kaolinite clay mineral in small amount in Q<sub>11</sub> and Q<sub>13</sub> mines. The results of asphalt tests are shown in figures 1, 2 and 3.

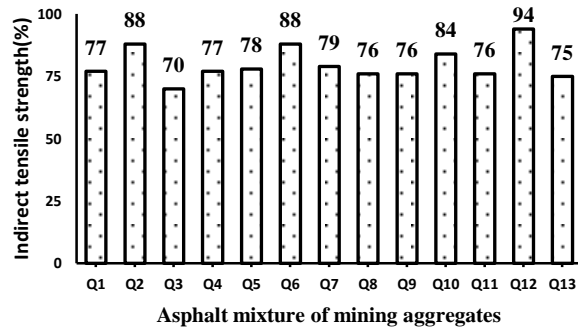


Fig 1. Indirect tensile ratio values of asphalt samples

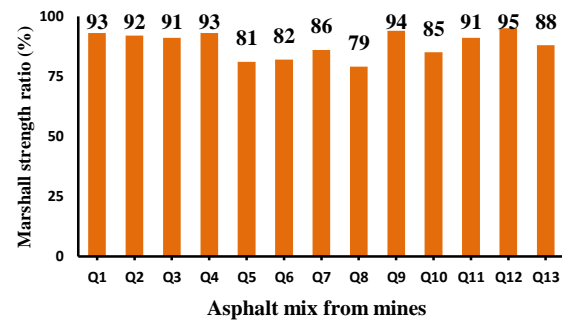


Fig 2. Marshall strength ratio values of asphalt samples

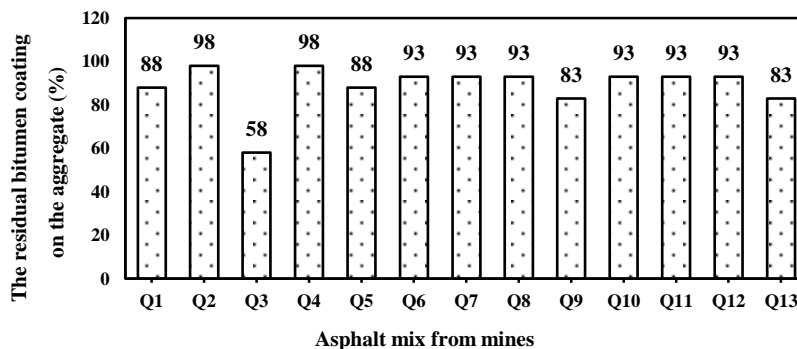


Fig 3. Boiling water test results

#### 4. Conclusion

The conclusions achieved from this research could be summarized as:

- Stone textures that are mostly made of carbonate clay show low bitumen absorption due to the small space between the particles in the stone texture, such as mudstone texture;
- The presence of an evaporative mineral (gypsum mineral in this research) in the rock causes a significant reduction in the bitumen coating remaining on the aggregates in the boiling water test;
- The more uniform the texture of the stone is, it will increase the Marshall strength ratio and, as a result, reduce the moisture sensitivity of the asphalt mixture;
- The presence of an evaporative mineral (gypsum mineral in this research) in the rock causes a significant decrease in the value of the indirect tension ratio and as a result increases the moisture sensitivity of the asphalt mixture;

- The presence of crystallized carbonate (coarse crystal cement and dolomite crystals) increases the values of the indirect tension ratio and as a result decreases the moisture sensitivity of the asphalt mixture;
- Stones with mudstone texture show lower values of indirect tension ratio compared to other textures; As a result, if the aggregate used to prepare the asphalt mixture has a dominant texture of mudstone type, the occurrence of moisture damage in that asphalt mixture will be probable;
- The results show that small amounts of silica (less than 11% in this research) do not have a negative effect on the results of the boiling water test, the indirect tensile ratio and the Marshall strength ratio.

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