Study on composition analysis of foaming agents used in backfilling high-strength lightweight fluidized soil

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Abstract. This paper studies the pollutants released by the foaming agent used in the green and low carbon backfill material of high strength and light fluid soil, which can effectively solve the problem of "bridge jump". The results showed that the concentrations of total volatile organic compounds, benzene, toluene + xylene and free formaldehyde in the pollutants were all within the qualified range. The concentration of non-methane total hydrocarbon in the pollutants increases with the increase of temperature. The concentration of non-methane total hydrocarbon in the pollutants is 3.90mg/m³ at 180 °C, which is within the allowable range. During production and use, attention should be paid to ventilation and monitoring.

Key words: abutment backfill; light liquid soil; foaming agent; pollutant; non methane hydrocarbon.

1. Introduction
With the rapid development of China's economy, the annual growth rate of automobiles far exceeds the economic growth rate, which provides more stringent requirements and stronger traffic capacity for highways in the infrastructure. Because of its special location, near the abutment structure, such as the construction is more complex, if the design is unreasonable, improper measures during construction, can cause bridge transition section area to produce uneven settlement, caused the phenomenon of vehicle dumping on, not only affects the speed and comfort, and may even cause serious traffic accident [1]. Research on the backfilling material of high-strength lightweight fluid soil with abutments has become one of the hot issues in solving "bridge jump" [2]. The new material can greatly reduce the filling load of the subgrade, reduce the foundation stress, restrain the settlement, lateral movement and damage of the new subgrade, and greatly reduce the differential settlement near the connection between the abutment and the subgrade. It can effectively solve the problem of "bridge jump", ensure the capacity of road transportation and reduce the investment of maintenance period.

The foaming agent used in the production of lightweight fluidized soil determines the performance of the new material to a certain extent. At present domestic main varieties have gum rosin foaming agent, foaming agent of waste animal hair blowing agent, resin oil soap, hydrolyzed blood plastic foaming agent, foaming agent aluminium sulfate foaming agent and so on, our country also has animal protein as the main raw material of foaming agent, foaming ratio and stability is good, but because of the raw material source is limited, the production cost is high, so the development and application is restricted,
overall domestic foaming agent is not ideal, low quality, although some foaming ratio is enough big, but poor stability [3]. The foaming agent of Japan and Italy is protein kind mostly, quality is better. At present, there are many researches on the performance of lightweight fluidized soil. As a new low-carbon green material, it is necessary to analyze the pollutant composition of foaming agent used in it.

2. Materials and Methods
The foaming agent was animal globulin. The items to be tested are total volatile organic compounds, benzene, toluene + xylene, free formaldehyde and non-methane total hydrocarbon. Total volatile organic compounds, benzene, toluene + xylene, free formaldehyde in accordance with the national standard GB18583-2001 "indoor decoration materials in the adhesive limit of harmful substances" to detect. The sampling method of non-methane total hydrocarbon is to take 100ml of sample and pour it into a conical flask with stopper. The sampling tube is inserted into the flask through the stopper, and the gas is collected into a 1L fluorine film sampling bag with sampling double ball. The test temperature of non-methane total hydrocarbon is designed to be normal temperature, 105℃ and 180℃ (at which the sample has boiled). When the latter two temperatures are tested, the conical flask containing the sample shall be put into the drying oven with a blast, and the sample tube shall be put out through the tuyere of the drum. The test method of non-methane total hydrocarbon is in accordance with the standard HJ604-2017 "Determination of total hydrocarbon, methane, and non-methane total hydrocarbon in ambient air direct injection gas chromatography". The analysis conditions of gas chromatography were as follows: cylinder temperature was 60℃, two samplers temperature was 100℃, detector temperature was 200℃, thermal conductivity cell temperature was 50℃, auxiliary furnace temperature was 150℃, and sample volume was 1 mL.

3. Results and Discussion
The measurement results of total volatile organic compounds, benzene, toluene + xylene and free formaldehyde are shown in Table 1. As can be seen from the results in the table, the concentrations of total volatile organic compounds, benzene, toluene + xylene and free formaldehyde are all within the qualified range. The foaming agent product meets the requirements of environmental protection and green, and has little impact on the environment and construction workers. However, it should also be recognized that the concentration of pollutants can accumulate. If it is produced indoors or in an environment with poor air circulation, measures should be taken to maintain air circulation so as to facilitate the diffusion of pollutants and continuous long-term monitoring [4].

The total non-methane hydrocarbons of the samples at three temperatures were analyzed according to the gas chromatography analysis condition in 1, and the flow chromatogram was obtained.

According to the chromatogram, the peak areas of total hydrocarbons, methane and oxygen were obtained. After deducting the peak areas of methane and oxygen, the concentrations of non-methane total hydrocarbons (mg/m³) in the foaming agent samples at three temperatures were obtained by using the formula in HJ604-2017, which are 1.96, 2.15 and 3.9.

When the total non-methane hydrocarbon concentration in the atmosphere exceeds a certain concentration, it is not only harmful to human health directly, but also can produce photochemical smog under certain conditions through sunlight irradiation, which will cause harm to the environment and human beings [5]. According to the data in the figure, as the temperature increases, the concentration of non-methane total hydrocarbon released by the foaming agent sample increases, and the concentration at 180℃ is nearly twice that at room temperature. However, the concentrations in all three cases were less than 4mg/m³, which did not reach the dangerous value. However, as with TVOC, benzene, toluene + xylene, and free formaldehyde, due to the cumulative effect, attention should also be paid to ventilation and monitoring.
Table 1. The measurement results

| Test Item                                      | Property Index | Test Result |
|------------------------------------------------|----------------|-------------|
| total volatile organic compounds, g/L, g/Kg    | ≤50            | 19          |
| Benzene, g/Kg                                  | ≤0.2           | not detected|
| toluene + xylene, g/Kg                         | ≤10            | 0.25        |
| free formaldehyde, g/Kg                       | ≤1             | 0.05        |
| pH                                             | /              | 6.9         |
| Density, g/cm³                                 | /              | 1.13        |

4. Conclusion
As a new low-carbon green material, light fluid-soil foaming agent used has a low content of pollutants, which will not affect the environment and human health, but attention should be paid to ventilation and continuous monitoring.

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