

Optimum condition for soil carbonation and efficient CO₂ consumption in a lime-treated silt

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1. Motivation

- ❖ Failed subgrade material in road pavement due to freezing and thawing of pavement layer made with frost susceptible soil causes huge cost of repair and reconstruction annually.
- ❖ Most soil improvement techniques to curb this menace are expensive and time consuming.
- ❖ Cement based-soil stabilization is effective but the Carbon dioxide emitted during its production cannot be captured.
- ❖ For lime-based soil carbonation, some process-related Carbon dioxide can be sequestered.



Fig 1: Failed pavement Fig 2. Freezing and thawing in pavement

2. Objectives of the Research

- To understand the influence of soil properties (such as lime content, degree of saturation, void ratio) on the degree of carbonation DOC.
- To understand the conditions influencing the efficiency of CO₂ consumption during soil carbonation.

3. Methodology: Experimental set up

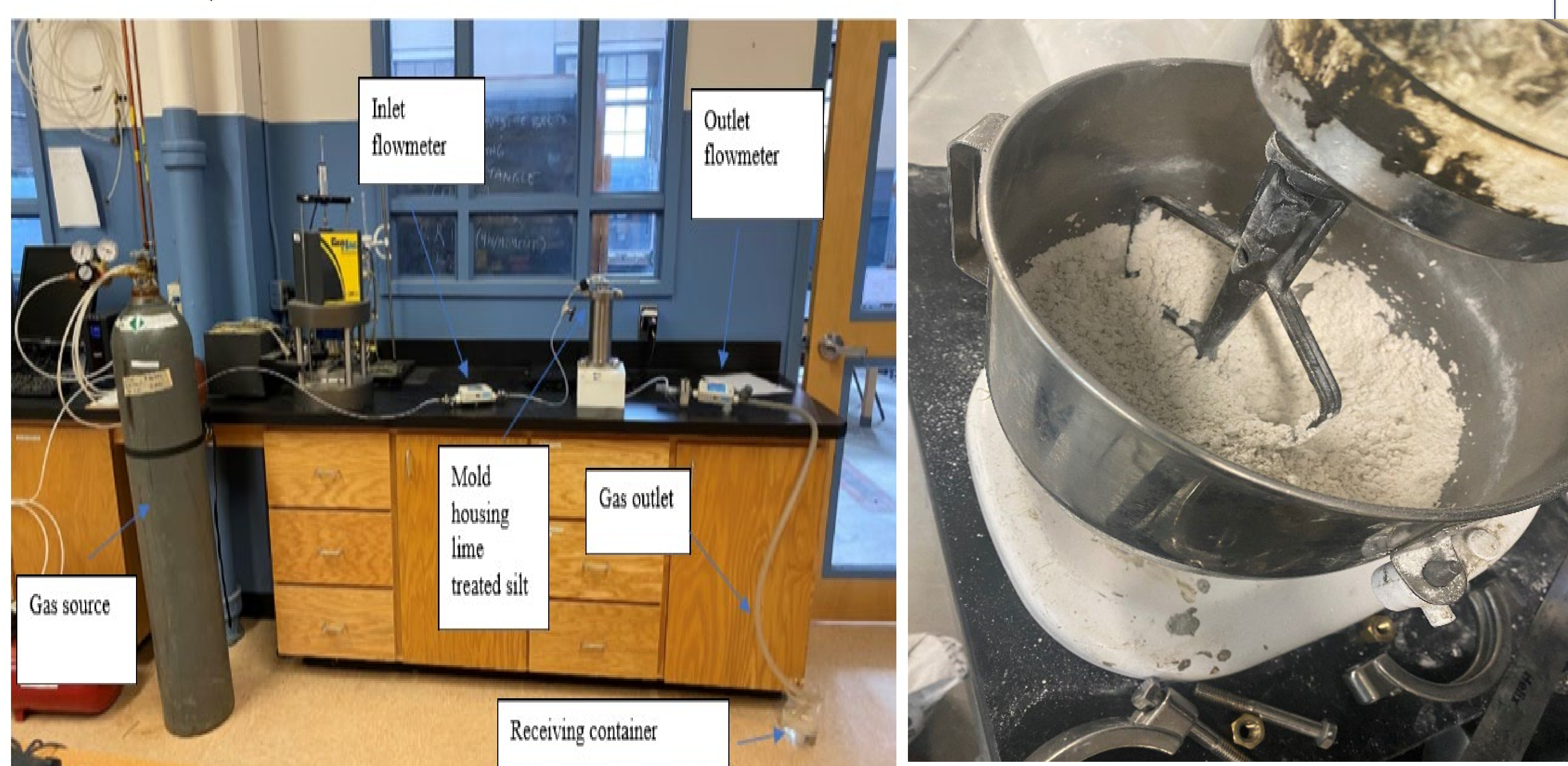


Fig. 3 Test set up.

Fig.4 Sample preparation

4. Soil carbonation reaction mechanism

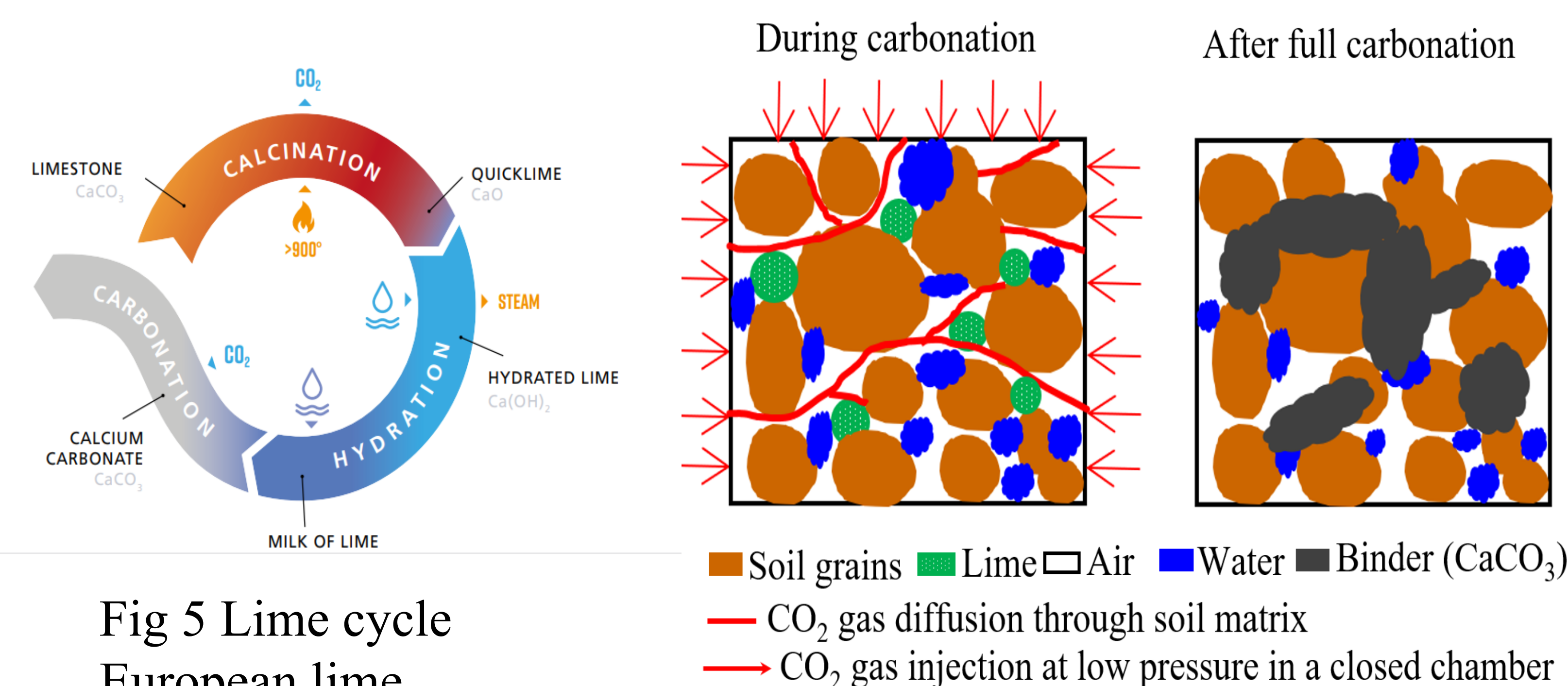
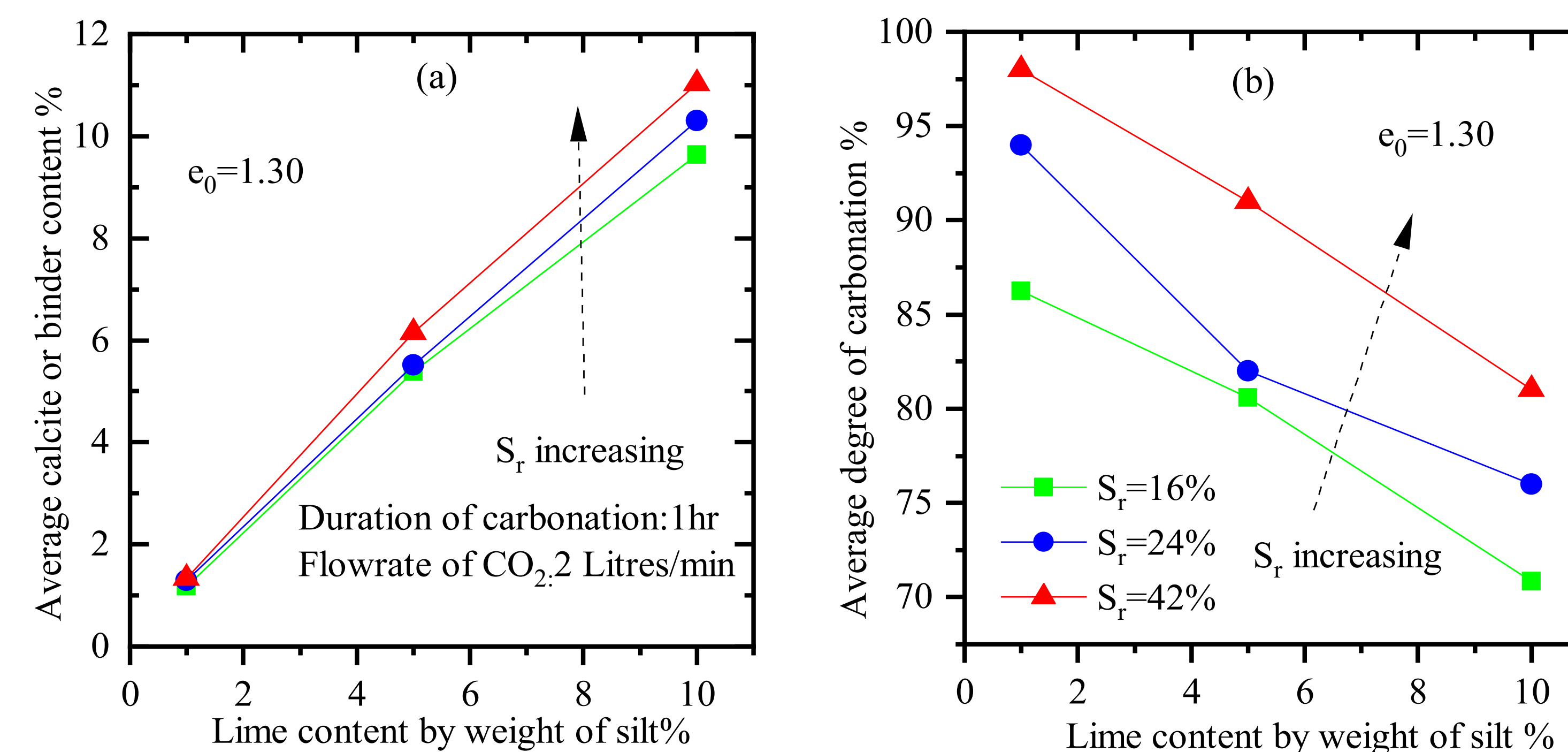


Fig 5 Lime cycle
European lime
Association 2021

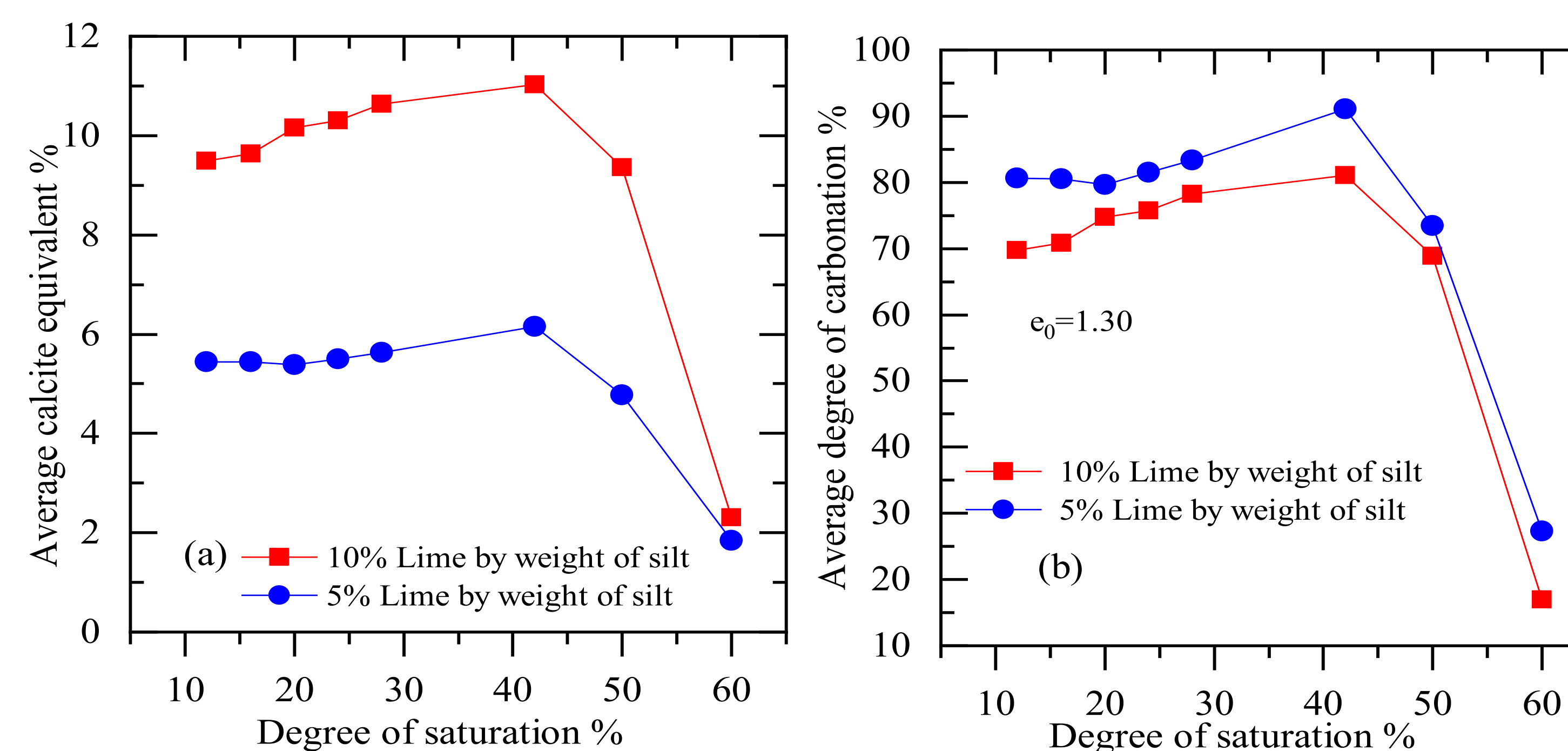
Fig. 6 Soil-carbonation mechanism

5. Laboratory Results

5.1 Effect of Lime content on the degree of carbonation



5.2 Effect of degree of saturation on the degree of carbonation



6. Summary /Conclusion

- The higher the lime content in the mix, it becomes more difficult to convert lime particles into calcium carbonate, which means, the degree of carbonation reduces as the lime content in the mix increases
- The degree of saturation plays a huge role in the formation of calcite, as the degree of saturation increases from 16% to 42%, the degree of carbonation increases.
- The degree of carbonation reduces drastically as the degree of saturation approaches 50%, at degree of saturation $\geq 50\%$, due to gas mobility problem within the soil matrix.

7.Expected Benefits

- Rapid strength improvement which contributes to the enhancement of the transportation infrastructure durability
- Sequestration of CO₂ which reduces the carbon footprint of lime
- Reduces the susceptibility of Pavement subgrade materials in New England states to freezing and thawing.

8. Future work

- To determine the effect of void ratio of the degree of carbonation
- To determine the effect of flowrate of CO₂ on the degree of carbonation
- To determine the efficiency of CO₂ consumption

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