



Modeling the Protection of Highways in the Areas of Moving Sands

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ABSTRACT: In this article presents the work carried out to protect roads passing through sandy areas from moving sands and recommendations for computer modeling of means of protection from moving sands for the conditions of Uzbekistan. The flow of wind and sand interacts with any type of obstacles installed on the ground, which in turn causes erosion, sand displacement around them, and subsidence on the surface after the wind subsides. This can lead to harmful consequences, such as the loss of functionality of a structure or infrastructure at risk. For example, vehicles and pedestrians could be made more difficult or restricted and could even be dangerous to users in the event of design failures.

KEYWORDS: Aerodynamic laboratory, Computer modeling, Moving sands, Obstacles, Simulation model, wind–sand flow.

INTRODUCTION

The migration of sand from one place to another by wind affects transport facilities, the safe movement of all types of vehicles moving in it and causes problems with their current storage. Technological solutions of all types of protection, which are used to avoid a sandstorm, are regularly improved. However, the technological solutions currently in use do not fully protect roads from landslides. For this reason, there is a growing demand for technological solutions based on innovative technologies that are resource–efficient, locally appropriate and effective for protecting against avalanche–prone sands [1].

This requires the development and implementation of improved new technological solutions based on 100 years of worldwide landslide protection [2].

MATERIALS AND METHODS

The study of winds as an engineering work is becoming increasingly interested in modeling wind–sand flows and mitigating their impact on structures. In particular, many scientists, such as N.J. Middleton [3], influence on pipelines, industrial objects by A.A. Alghamdi, N.S. Al–Kahtani [4], impact on large and small cities by C.L. Zhang and others [5], impact on social sphere objects by X.M. Wang, C.X. Zhang, E. Hasi, Z.B. Dong [6], impact on highways the secret of J.H. Redding, J.A. Lord, [7] and influence on railways L. Bruno, D. L. Francois, A. Giudice, L. Raffaele [8], have studied the impact of the dust–sand mass created by the wind on a number of civil structures and infrastructures in or near desert areas.

The digital modelling of sand winds was mainly carried out by studies of wind and sand flow aerodynamics and EOL processes, i.e. by identifying Eulerian–Lagrange models or full Eulerian models that combine erosion, transport, deposition and, as a consequence, snow migration [9].

The wind and sand aerodynamics processes were performed in research facilities as well as in aerodynamic devices and recommendations were made based on the local conditions of the area where the research facilities are located [10].

Results. In particular, the regions we are investigating are roads in the Bukhara, Navoi and Fergana regions of the Republic. The location of these highways and the natural and climatic conditions of the territory were studied. At the same time, wind speeds and directions, granular composition of drifting sands, the condition of existing sand protection devices, and the condition of the highway were determined using laboratory equipment.

Based on the analysis of the studied literature and the results obtained from the subject of the study, an immersion model of road protection against migratory sands was created (fig.1).

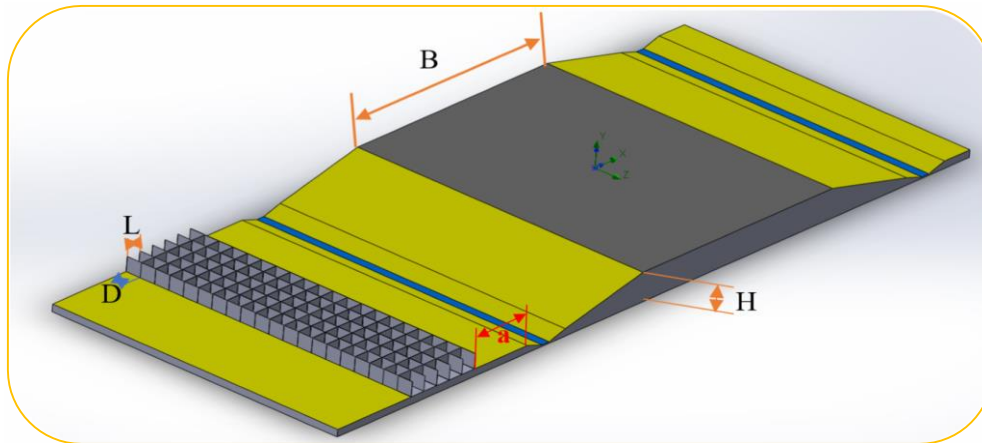


Figure 1. A view of the road and its obstacles
($H=1.5$ m; $B=15.0$ m; $L \times D = 1 \times 1$ m; $a=5.0$ m)

This model of permanence included a road constructed according to the geometric dimensions of a Class II motorway, which was considered a reference, and a place with adjacent moving sands. This model included wind speed and analysed how wind and sand flow can be reflected during impact (Fig. The model analyzes the size of the means protecting the highway from sand migration ($L \times D$, m), the height of road lift (H , m), the distance from the curb to the obstacle (a , m) and the width of the road (B , m) at different values.

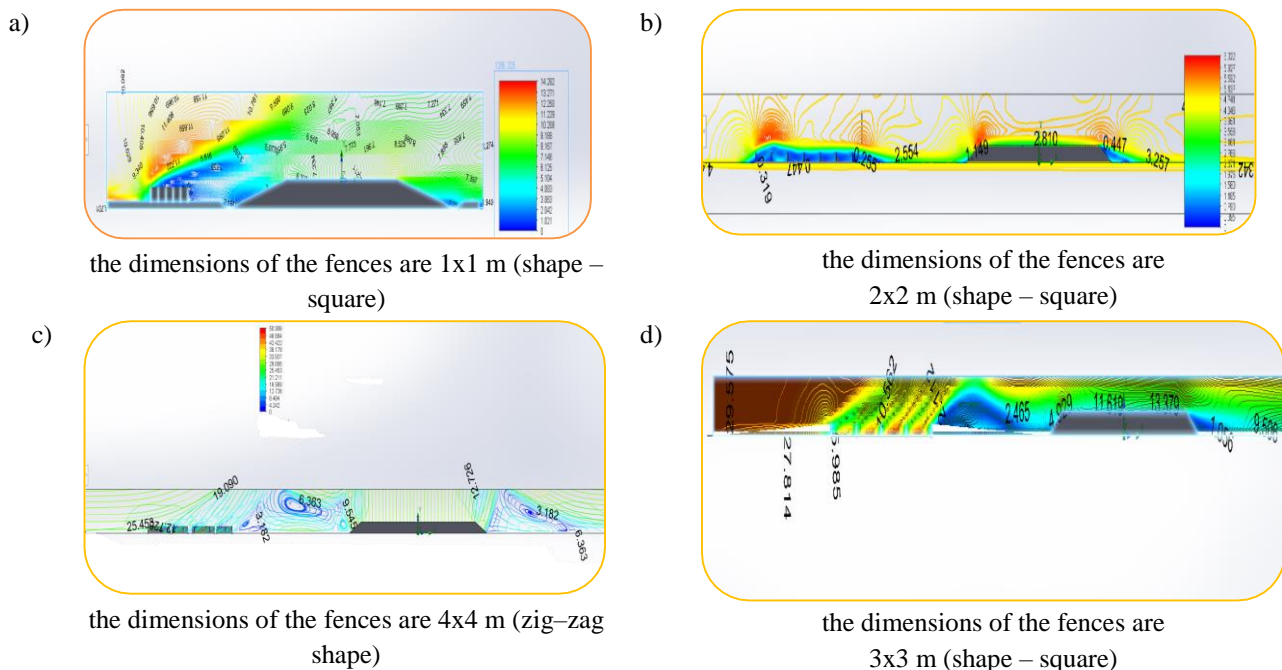


Figure 2. Effect of wind on barriers installed in the area near the highway

With the help of the performed analysis, the movement trajectory of the wind–sand flow and the places of deposition of sand particles in the sections with reduced wind speed were determined (Fig. 3). The speed of the wind–sand flow varied depending on the height of the barriers and the number of rows.

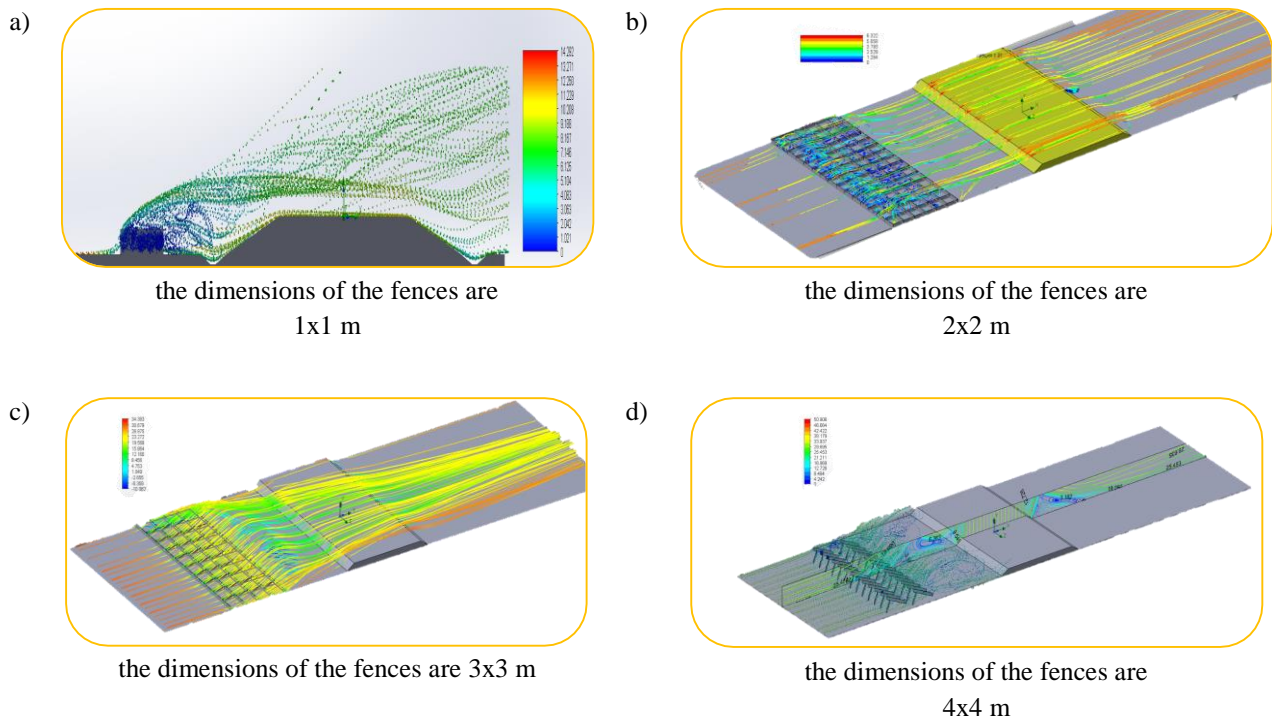
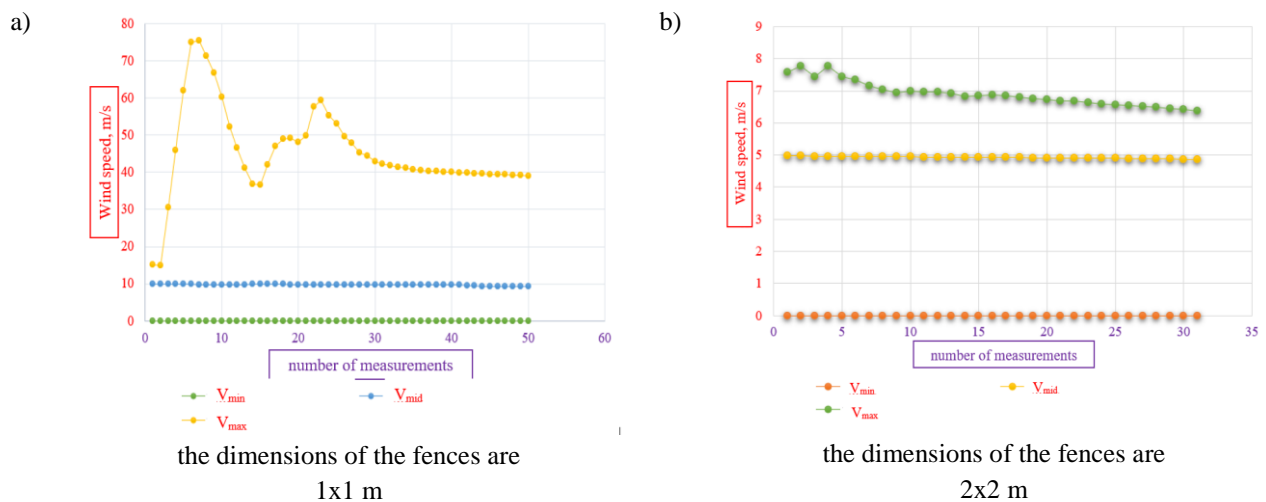


Figure 3. Trajectory of movement of sand particles around barriers installed in the area next to the road

The Virtual Aerodynamic Laboratory changed the wind speed to different values and mastered the working conditions of protection against sand avalanches. On the basis of the results obtained a graph of changes in wind speed during the measurements (Figure 1).



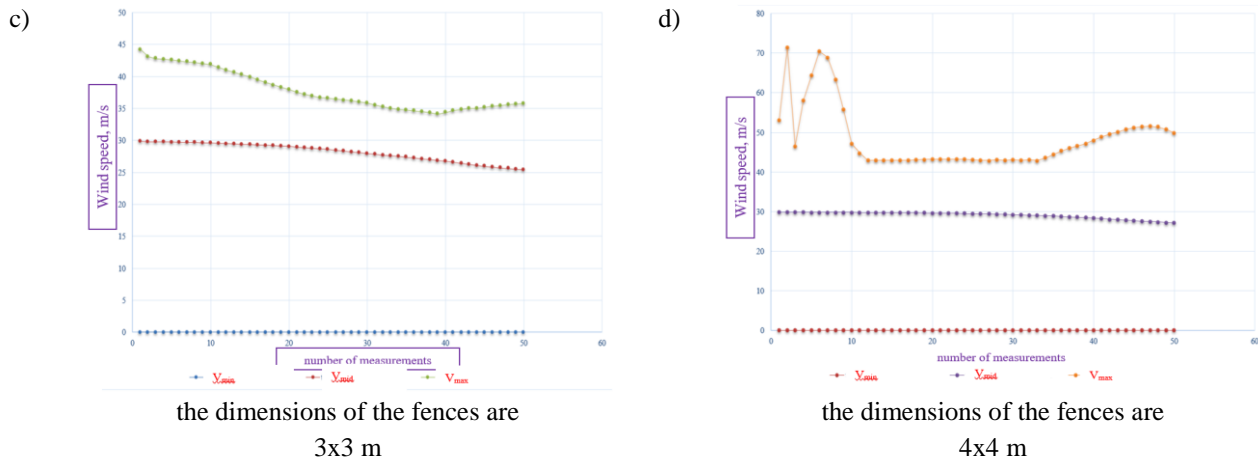


Figure 4. Variation of wind speed affecting the barriers installed in the area next to the highway: barrier height $H=0.6$ m

CONCLUSION

As a result of many years of research, mechanical, chemical and biological methods of protection of transport structures in sandy deserts from sand migration were proposed. Despite the fact that these methods are well studied and widely used in practice, there is still no effective way to store structures in sandy deserts, including transport infrastructure, from avalanche sands. In order to further improve the increase of the desert climate in the world for natural and man-made reasons, based on modern computational methods of protection against avalanche sands, the study was modeled at a virtual aerodynamic laboratory and compared with the methods available at the research center. The advantage of a virtual aerodynamic laboratory is that it is possible to carry out studies in different sizes and viewing values. This also ensures that data can be processed in a clear representation of each reference point. For practical use, the choice of sand avalanche barrier sizes in the form of 2x2 m, 3x3 m and road to barrier distances in the range of 5–10 m serves to achieve high efficiency.

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