To Assess The Impact Of Organophilic Nanoclay on Marshall Properties Of Asphalt Material

[a] Abu Bakar*, [b] Zimran Nasir,

a: CivilEngineeringDepartment,APCOMS,Rawalpindi,Pakistan.chabubakar2003@gmail.com

b: Civil Engineering Department, APCOMS, Rawalpindi, Pakistan. zimrannasir@gmail.com

*Corresponding author: Email lID:chabubakar2003@gmail.com

Abstract- In recent years, the escalation in traffic volume and loads, alongside fluctuating temperatures, particularly high summer temperatures in winter, pose a significant challenge for pavement construction companies and engineers. This research aims to explore the impact of Organophilic Nano Clay on the Marshall Properties of Asphalt Mixture. The study investigates the Marshall properties of both Nano clay- modified asphalt mixture and conventional asphalt mixture. In the Nano clay-modified asphalt mixture, filler aggregates were substituted with varying percentages of Nano clay, ranging from 3.5% to 5.5%, with an optimum value of binder (OBC) of 4.33%. The OBC value was determined through Marshall Stability testing on the conventional asphalt mixture. Findings reveal that the addition of Nano clay enhances the Marshall Stability of the asphalt mixture, withthemaximumstabilityobservedat4.5%Nanoclay content. Conversely, the Marshall Flow of the asphalt mixture decreases with the inclusion of Nano clay.

Keywords-Marshall Stability Test, Marshall Flow, Modifiers, Nano clay.

1 Introduction

Asphalt mixtures are widely used as a road pavement material across the globe. A durable mixture is required to sustain heavy loads form the anticipated traffic and also to with stand extreme weather conditions[1]. The road pavements are designed to last for a certain period of time, but sometimes premature failure occurs due to different distress types, which the pavement undergoes during its lifespan[2]. One of the major distress among all is moisture damage. These days, flexible pavement is the utmost commonly utilized material for roadways, finding employment in a variety of settings including parking lots, highways, walkways, runways, and harbors. Over 90% of European pavements are thought to be made of bituminous materials[3].

The commendable skid resistance, minimal noise levels, smoothness, safety, and long-lasting nature of asphalt pavements are directly linked to the composition of aggregates, fillers, and asphalt binder employed. Still, the problem of pavement distresses, including fatigue and heat cracking, rutting, and raveling, cannot be overlooked[4]. It's important to note that these distresses have escalated recently due to increased vehicle loads as well as the effects of environmental changes. The behavior of asphalt concrete, in particular, is largely determined by the asphalt, which also affects the pavement's performance and service life[5]. Pavement service life is shortened due to the aging of asphalt, which exacerbates fatigue and low-temperature performance during the service period. Therefore, building high- performance asphalt pavements may benefit from the use of asphalt with improved qualities[6]. Great efforts have been made by researchers and practitioners to accomplish this goal. Many studies have shown that in order to increase the overall performance of asphalt pavements, various additives such as polymers[7].

The application of fibers, one of the most often used additions in asphalt mixtures Using fibers with a high tensile strength could be a workable solution in this situation. When fibers are added to asphalt mixtures, they function as

reinforcing elements and improve mix cohesiveness, reducing reflective or fatigue cracking and boosting resilience to long-term deformations[8]. Additionally, fibers can be added to asphalt mixtures as stabilizers to lessen their drain-down effects. This is particularly useful for porous asphalt mixtures and SMAs (Stone Matrix Asphalts), which are often high in asphalt binders[9]. All things considered, adding fibers can change the visco elasticity of asphalt, raise the dynamic modulus, increase creep compliance, and enhance water stability, cracking resistance, freeze-thaw resistance, rutting performance, and so on. Moreover, fibers added to the asphalt mixtures can be utilized in many ways[10].

2 Research Methodology

The experimental program consisted of preparing asphalt mixtures with different combinations of binder and organophilic Nano clay. The 60/70 bitumen was selected as the binder, and Margalla aggregates were used for mixture preparation. Organophilic Nano clay was incorporated into the asphalt mixtures at varying percentages to determine the optimal dosage for Marshall Stability improvement and to study Marshall Flow of asphalt mixture. Mechanical testing, including Monotonic resistance evaluation using appropriate testing protocols, was conducted on the prepared asphalt specimens. The experimental setup and all samples of Marshall Test are shown in Figure 1.

Figure 1: Marshall Apparatus and Marshall Molds

Conventional Properties of bitumen used in the study are shown in Table1.

Table 1: Conventional Test results of 60/70 binder

Binder Test	**Binder (60/70)**	**Limit**
Softening Point	48 ℃	46-54
Penetration	63 mm	60-70
Ductility	119cm	100 (min)
Flash and fire Point	248°Cand252°C	232-450
Specific Gravity	1.02	0.99-1.05

3 Results

3.1 Optimization of Organophilic Nano Clay:

Research findings indicate a correlation between the proportion of Nano clay and Marshall Stability, revealing a pattern where stability initially rises with increased Nano clay content, peaking at 4.5% with a maximum value of 14.5 KN. However, beyond this threshold, as the Nano clay percentage continues to escalate, stability diminishes. The effect of Nano clay on Marshall Stability is shown in Figure 2.

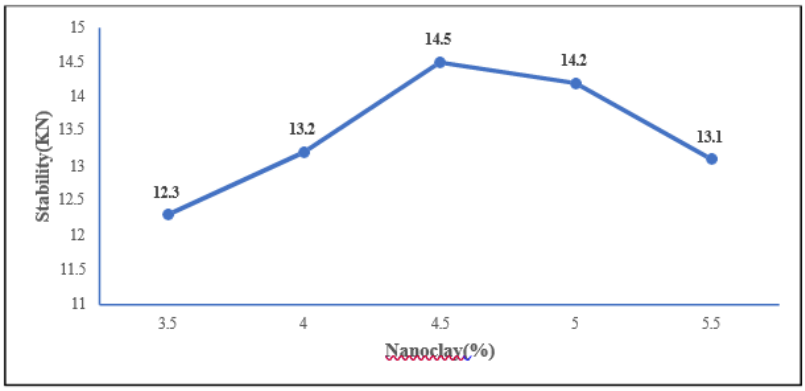

Figure 2: Effect of Nano clay on Marshall Stability of asphalt mixture

3.2 Effect of Nano Clay on Marshall Flow:

Incorporating organophilic Nano Clay led to enhanced stiffness of the asphalt cement, as indicated by lower Marshall Flow values. Modifiers like as polymers or fibers can improve the characteristics of an asphalt mix, but they frequently limit flow ability, resulting in lower Marshall flow values. Low Marshall flow values in hot mix asphalt suggest higher stiffness and resistance to deformation. This can be advantageous since it indicates stronger resistance to rutting and deformation under traffic loads, resulting in increased pavement durability and performance. Hot mix asphalt with low Marshall flow values has a higher viscosity. This higher viscosity increases the stiffness of the asphalt mix, which improves resistance to deformation and performance under traffic loads. Figure 3 shows that at an optimum bitumen percentage of 4.5%, the marshall value for modified asphalt binder is 7.01, compared to 7.3 for virgin asphalt with no modifier. The Marshall Flow values with and without modifier are shown in Figure 3.

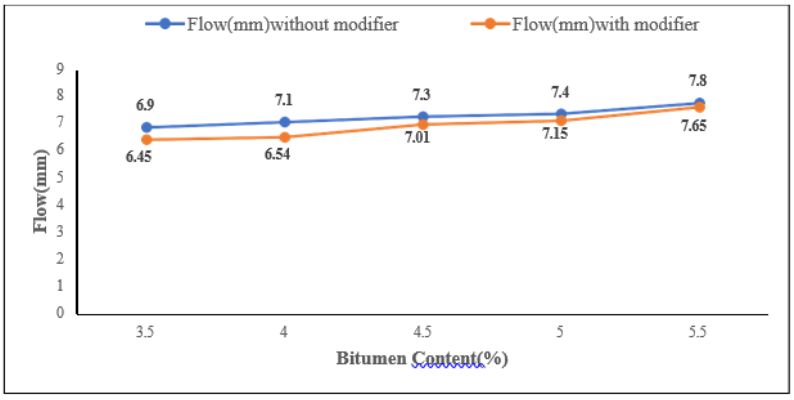

Figure 3: Effect of Nano clay on Marshall Flow of asphalt mixture

4 Practical Implementation

Incorporating Organophilic Nano clay into the asphalt concrete wearing course can prolong the serviceability of pavement. The adaptation of asphalt concrete with organophilic Nano clay enhances pavement design and fatigue life. Introducing Nano Clay into asphalt pavement significantly mitigates rutting and raveling which are the major pavement failures.

5 Conclusion

Following conclusions can be drawn from the conducted study:

- Adding Nano clay increased the Marshall Stability of the asphalt mixture, with the highest value observed at a 4.5% Nano clay concentration.
- Marshall Flow of asphalt mixture decreased with the addition of Nano clay and consequently its stiffness increased.

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