A typical wormhole is characterized by a tunnel in spacetime connecting two arbitrary spacetime sections. These sections could either belong to the same spacetime or to two different spacetimes. The wormhole geometry arises naturally as a solution of the Einstein field equations [1–3]. Interest in wormhole physics was initiated when Morris and Thorne investigated the wormhole structure and proposed that the material required to construct it has to be exotic, i.e. its (negative) radial pressure and energy density must satisfy the inequality $|p| > \rho$ [4]. They also concluded that this structure could also serve as a time travel machine if it is horizon-free.

From the cosmological perspective, a candidate for exotic matter exists namely the phantom energy. Presently it is well-motivated from the observational data that the observable universe is pervaded with the phantom energy, which is characterized by $\omega = p/\rho < -1$ [5, 6]. In recent years, several studies are performed regarding construction of wormholes with the use of phantom energy as an exotic matter [7–11]. The phantom energy is exotic due to its weird and esoteric properties: its energy density increases as the universe expands; its accretion onto all gravitationally bound objects results in disassociating them; it can rip apart the spacetime itself in a finite time which is called the Big Rip.

Understanding the nature of gravity is one of the hardest and most challenging problems in theoretical physics. Interest in (2+1)-dimensional theories of gravity - especially general relativity - dates back to early sixties. Since then several toy models have been built up in (2+1) gravity which help in understanding the corresponding (3+1) dimensional problems [12]. Gravity in (2+1) dimensions behaves very differently compared to the usual (3+1) dimensional gravity, for example, the gravity does not exist outside the matter source and remains confined locally. Since gravity does not propagate outside the gravitating source, gravitational waves don't arise in this case. In recent years, models of wormholes in (2+1) dimensional gravity are presented [13–16]. In these models, coordinate θ is fixed so that $d\theta = 0$. Consequently, this reduces the complexity of the field equations.

The metric of a (2+1)-dimensional Morris-Thorne (MT) wormhole is given by [13–15]

$$ds^2 = -e^{2f(r)}dt^2 + \frac{1}{1-\frac{b(r)}{r}}dr^2 + r^2 d\phi^2, \tag{1}$$

where $f(r)$ is called potential function while $b(r)$ is the shape function. These functions are arbitrary functions of radial coordinate r and will be determined below for a specific choice of matter distribution. The radial coordinate has a range that increases from a minimum