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FRONT WHEEL FAT TIRE ELECTRIC BIKE ANALYSIS

The first issue is to consider riding on any soft surface, or when hitting any raised obstacle, such as a rock or tree root. When you look at a normal mountain-bike tire-track in sand, there is a 'track' (depression) left behind. Essentially, the lowest part of the tire is lower than the surface ahead. The deeper the tire sinks into the sand (or any soft deformable surface), the higher-up the front-edge of the tire is 'the obstacle'. The higher-up this is, the more this 'obstacle' seeks to push the tire backwards (with that obstacle's 'push' being on a point that is well ahead of the imaginary line down through the 'head' which is the axis of rotation of the steering). So, unless you have an incredibly strong grip locking the steering on 'dead straight ahead', the more likely it is that the front portion of the front wheel will be twisted around to the side, which is when a cyclist is forced to 'dismount' as the front tire has 'dug in and skewed' in the sand. It is somewhat similar with a rock or tree root, in that, the higher-up the front leading-edge of the tire that the obstacle is encountered, the greater the tendency to twist the front wheel around, rather than having the wheel climb cleanly over the obstacle. That sudden uncontrolled twist of the front wheel (caused by an obstacle) is a very common cause for a cyclist to have a fall when riding on an uneven surface (eg a dirt track).

With the motive force on the front wheel, this forward section of the front tire is constantly 'climbing' the tire out of that sand hollow, or actively pulling the bike over the obstacle, rather than being twisted away from the line the cyclist is wishing to keep.

B. The second issue are the force vectors when turning. This is similar to cars, and easier to understand with cars. In the middle of a turn a car has its front tires pointing 'where you want to go', while the rear tires are still pointing 'where the car WAS heading'. So, if you consider the 'force vector', there is an arrow from the centre of the tire (its contact point on the road) heading forward in the direction of the tire applying the motive force. So if you are applying motive force to the rear tire, that force is pushing the car 'outwards' on the corner ('under-steer'). But applying the motive force instead to only the front tires has the effect of pushing the car 'around' the corner, ie in the direction that only the front wheels are facing. The same is true on a bike, even though it is easier to imagine the forces with a car. And this explains why front-wheel-drive cars outperformed rear-wheel-drive cars in rally times, when those were the only two options. As discussed above, when a bicycle hits an obstacle, it can have its front wheel pushed 90-degrees away from the forward direction (which doesn't normally happen in a car, because each front wheel is locked to being parallel to the other front wheel, and usually the obstacle only hits one or other front wheel). So it is 'more' important for riding an e-bike on a dirt track (than a rally car) to have the motive force preferentially applied to the front wheel.

Since the 'front vs rear' drive issue, rally cars have moved on to using all-wheel-drive as this is even better for grip on dirt roads. The equivalent for riding a fat-bike on dirt tracks is to have the electric motor driving the front wheel, while the rider's legs power the rear wheels, if maximum performance or grip is required. But if one takes it easier, by using only the electric motor, it is more comfortable and safer to have that motive power applied to the front wheel, to dramatically lessen the chance of having the front wheel spun around 90-degrees. To test this idea for yourself, the easiest way is to take a traditional street/racing bicycle with a tire-width of under 1-inch and ride it at 15-20kph from a solid surface into thick dry sand. As one leaves the road or grass surface, the tires start to dig-in to the sand, progress becomes immediately difficult and speed slows, despite pedalling harder... and eventually the front-wheel spins around as you are forced to put a foot down to prevent falling down completely. And if you can't remember trying this as a youngster, you need only to look around you on a beach, to see that no-one rides a thin-tired bicycle on the beach - not only because the tires sink in too much, but also because control over the front wheel orientation becomes extremely difficult. Front-wheel drive will not make it possible for a racing bicycle to ride on a beach - as you still need fat-tires to prevent sinking-in too much, but you are also far better served with front-wheel-drive as the front wheel will apply 'a climbing force' on its leading edge to be constantly 'climbing out of its own rut', rather than being pushed to one or other side by the obstacle, which in this case is the wall of sand ahead of the front tire.