

Forces on Highlines Caused by Objects in River Currents

Seattle Mountain Rescue (SMR) has been requested to rig and run highlines to recover bodies from rivers, and hold divers conducting searches in rivers. We know that water can exert large forces on objects, and we decided we needed to do some analysis to help us figure out what situations would be safe and what would not. SMR rigged a highline across a river, measured the current speed, measured the angles in the system, held a boat and diver in the river, and measured the force observed on the track line of the highline. Engineers tell us that the force of a current on an object is roughly two times the area of the object in the current, times the velocity of the river squared (the shape and texture of the object have some effect on the coefficient of drag, which we assume to be two). This equation means that for an object of a given size, as the current speed doubles the force quadruples. Our testing shows that in currents less than three miles per hour, the tension on the track line when holding a rescue boat and diver is less than the 3 kN (660 pound) tension that we seek to have as a maximum on the track line of a highline where a single 11 mm low-stretch rope used as the track line. We would like to do more testing before we do operations at river current speeds above 5 mph. At higher current speeds, it may be possible to limit forces by increasing the droop of the highline, allowing the current to push tethered objects so they skim on the surface of the river, or by limiting the cross-sectional area of the objects in the water. Also we recommend considering the consequences of failure of the track line: will a person be swept into a strainer or hazardous hydraulic? Can the system be rigged so that a system failure results in the load being pendulumed safely to a pre-determined bank of the river? This testing is preliminary and we recommend that others conduct further testing.