References

Quoting from Chapter XIII of Gilbert, page 225:

"Three ways are known in which the velocities of a stream are affected by the suspended load. In the first place, the load adds its mass to the mass of the stream, and as the stream's energy is proportional to the product of mass by slope, and the stream's velocity has its source in this energy, the addition tends to increase velocity. Second, the suspended particles are continually impelled downward by gravity.... The energy expended is potential energy, or energy of position, given to the particles by the flowing water, and its source is the energy of flow. So the work is the measure of the work of the stream in suspending the particles. It may therefore be regarded as a tax on the stream's energy, resulting in reduction of velocity. Third, the imperfect liquid constituted by the combination of water and debris is more viscous and therefore flows more slowly than the water alone.

"For the actual stream with diversified load the equation is

$$V_{ms} = V_m + Wf_1 (S,Q) - \sum f_2 (D) - \sum f_3 (D)$$

"This may be read: The mean velocity (V_{ms}) of a stream carrying a load of suspended debris of diameter (D) equals the mean velocity (V_m) of the same stream when without load, plus a factor (f_1) due to the weight (W) of the load and varying directly with the slope (S) and inversely with the discharge (Q), minus a factor (f_2) due to the work of suspension and varying directly with the diameter of particles, minus a factor (f_3) due to viscosity and varying inversely with the diameter (D) if the particles are minute and directly with the diameter if they are larger."

~~Procedure~~ The traction flume experiments by Gilbert are quoted below to illustrate the experiments which ~~should~~ could be extended beyond the range of the coarse sands employed:

"This (table 80) brings out the apparent fact that the reduction of mean velocity by traction is greater for small loads than for large, for gentle slopes than for steep; for low velocities than for high, and for large depths than for small...."