ARROW DRAG

Books on aerodynamics give the drag force on a subsonic body travelling through the air as $\frac{1}{2}\rho V^2 A C_d$ where ρ is the air density, V is the velocity of the body, A is a reference cross-sectional area and C_d is the drag coefficient referred to that cross section. If the mass of the body is m then the deceleration is the force divided by the mass. Clearly the deceleration can be written as kV^2 where $k = \frac{1}{2}\rho A C_d / m$. In the case of an arrow the reference area is most logically taken to be the arrow shaft i.e. $A = \pi d^2/4$. ρ varies with atmospheric conditions but may be found in tables of physical constants to be 1.293 kg per cubic metre. Substituting these values gives $k = \frac{\pi}{8} \times 10^{-6} \times 10^3 \times 1.293 d^2 C_d / m$ where d and m are measured in mm and gm respectively. Conventionally, arrow weights are measured in grains so by multiplying the above value of k by the number of grains in a gramme (15.43) we get $k = 0.0078 d^2 C_d / m$ where m is now measured in grains.

By studying the information from Easton on the optimum arrow set-up it turns out that for a wide range of arrow types d^2/m is roughly constant at 0.15 square mm per grain. Furthermore, in tests I have carried out using XX75 and ACEs a reasonable drag coefficient is 3.2 giving $k = 0.00375$ the units are (metres/sec^2)/(metres/sec)^2 or metres^{-1}.

So in summary, the deceleration on an arrow is roughly $0.00375V^2$ metres/sec^2 where V is measured in metres/sec.