We introduce the concept of average best $m$-term approximation widths with respect to a probability measure on the unit ball of $\ell^n_p$. We estimate these quantities for the embedding $id : \ell^n_p \to \ell^n_q$ with $0 < p \leq q \leq \infty$ for the normalised cone and surface measure. Furthermore, we consider certain tensor product weights and show that a typical vector with respect to such a measure exhibits a strong compressible (i.e. nearly sparse) structure.