H_{ss}:

The θ term is written for Λ = 0.

$$\langle \Lambda S\Sigma J\Omega' | H_{ss} | \Lambda S\Sigma J\Omega \rangle = \frac{2\lambda}{3}\left[3\Sigma^2 - S(S+1)\right]$$
$$+\frac{\theta}{12}\left[35\Sigma^4 - 30\Sigma^2 S(S+1) + 25\Sigma^2 - 6S(S+1) + 3S^2(S+1)^2\right] + \eta\Lambda\Sigma\left[\Sigma^2 - \frac{(3S(S+1)-1)}{5}\right]$$

$$\langle \Lambda S\Sigma' J\Omega' | H_{sscd} | \Lambda S\Sigma J\Omega \rangle = \begin{bmatrix} \lambda_D\left[\Sigma^2 + \Sigma'^2 - \frac{2}{3}S(S+1)\right] \\ +\frac{\eta_D}{2}\left[\Lambda\left(\Sigma^3 + \Sigma'^3 - (\Sigma+\Sigma')\frac{(3S(S+1)-1)}{5}\right)\right] \\ +\frac{\theta_D}{24}\begin{bmatrix} 35(\Sigma^4 + \Sigma'^4) - 30S(S+1)(\Sigma^2 + \Sigma'^2) \\ +25(\Sigma^2 + \Sigma'^2) - 12S(S+1) \\ +6S^2(S+1)^2 \end{bmatrix} \end{bmatrix} * \frac{\langle \Lambda S\Sigma' J\Omega' | H_{rot} | \Lambda S\Sigma J\Omega \rangle}{B}$$