Summary:

QCD in Weyl gauge looks similar to QED except that the magnetic term \( F_{ij} F_{ij} \)
is not just a quadratic term in the fields:

\[
\sum_{Q = e, \mu} F_{ij} F_{ij} = \sum_{Q} \left( \frac{1}{4} F_{ij} F_{ij} \right) \]

\[
\Rightarrow \text{highly nonlinear.}
\]

QED

\[
F_{ij} = \partial_i A_j - \partial_j A_i - i g \sigma_{\alpha} A_{\alpha}^i A_j^\alpha
\]

\[
\frac{1}{4} F_{ij} F_{ij} = \frac{1}{2} B^2
\]

\[
\Rightarrow \text{highly nonlinear.}
\]

Condon-Shortley gauge.

As in QED we could eliminate the constraint and incorporate it into the Hamiltonian. Even though we have looked at QED only in the absence of matter fields we can easily see what would happen if we had included, say, charged fermions. Simply take our QED result and eliminate all terms\( \sim \) for then:

\[
\frac{1}{2} \sum_{\text{Q}} F_{ij} F_{ij} = \sum_{Q = e, \mu} \frac{e^2}{2} g^2 \left( \frac{1}{2} B^2 \right) = \frac{e^2}{2} g^2 \left( \frac{1}{2} \right) f_Q
\]

\[
\quad \quad \quad \quad \text{electromagnetic force}
\]

\[
\text{This is just Coulomb potential in an external field.}
\]
\[ \frac{1}{D^2} f(x) = g(x) \]

\[ \nabla^2 g(x) = f(x) \]

**Theorem:** 
\[ -\left(\frac{1}{D^2}\right) f(x) = \frac{1}{4\pi} \int d^3y \quad \frac{1}{|x-y|} f(y) = g(x) \]

**Proof:**
\[ -\nabla^2 g(x) = \frac{1}{4\pi} \int d^3y \quad \frac{\partial^2}{\partial x_i^2} \left( \frac{1}{|x-y|} \right) f(y) \]

\[ = -\frac{4\pi}{4\pi} \int d^3y \quad \delta^3(x-y) f(y) = f(x) \quad \Box \]

Thus,
\[ \frac{1}{2} \int d^3x \quad g_1(x) \left( \frac{-1}{D^2} \right) g_2(x) = \frac{e^2}{4\pi} \int d^3x \quad g_1(x) \int d^3y \quad \frac{1}{|x-y|} g_2(y) \]

\[ = \frac{1}{2} \int d^3x \quad g_1(x) \quad \frac{4e^2}{4\pi |x-y|} g_2(y) \]

\[ \text{Coulomb potential.} \]
In 2D the nonabelian Coulomb potential is however much more complicated as it depends on the vector potential $\vec{A}$ that sits in $D^4$ and when treated as in perturbation theory in the coupling $g$ the Hamiltonian contains terms to all orders in $g = \hbar$ while the Lagrangian or Hamiltonian in the way! gauge where only terms to $O(g^2)$ are present.