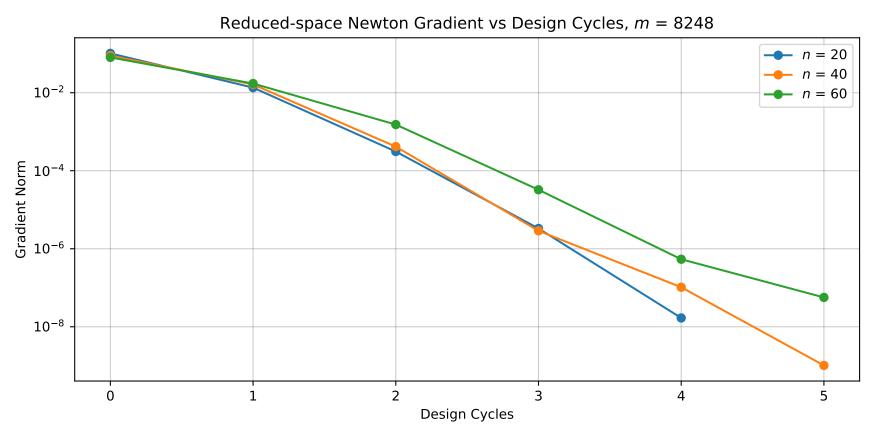
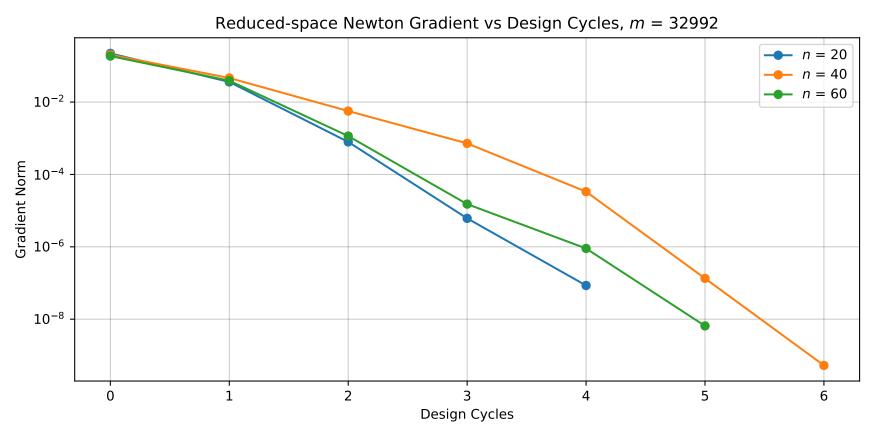
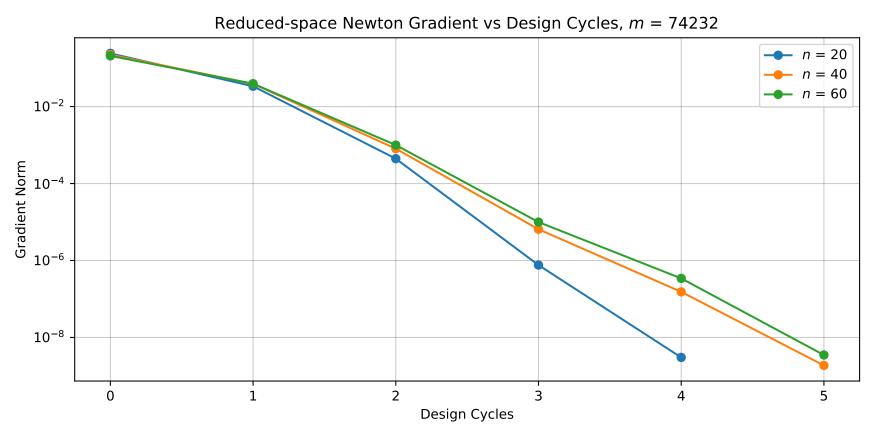
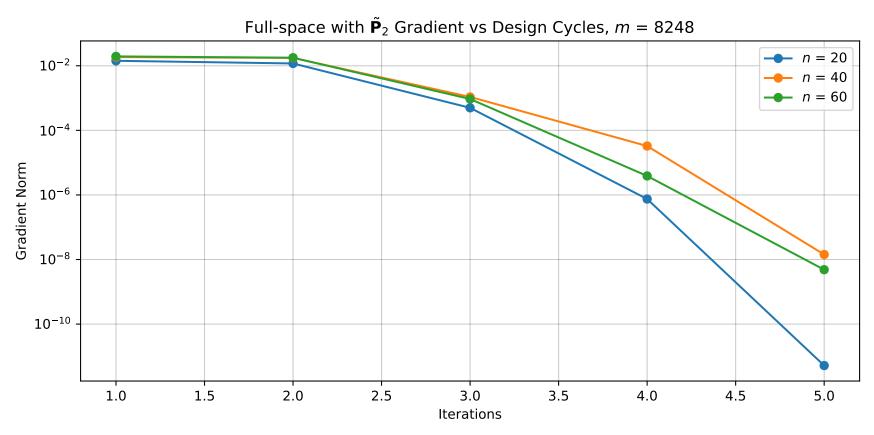


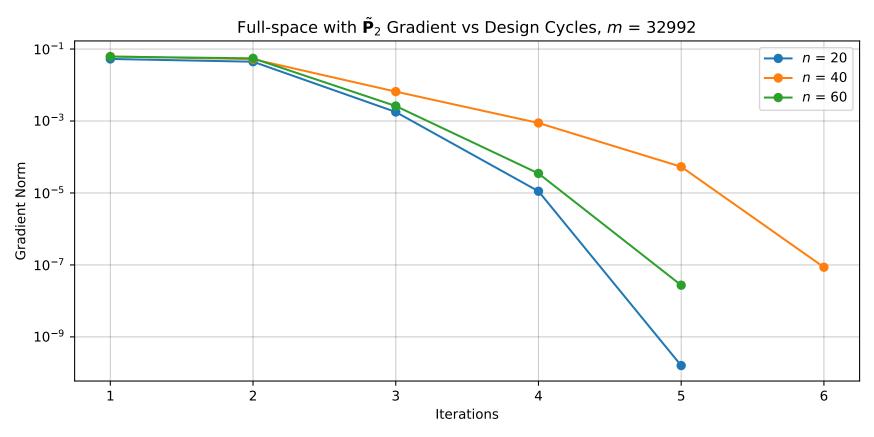
Reduced-space BFGS Gradient vs Design Cycles, m = 74232n = 20n = 40 10^{-1} n = 60 10^{-2} **Gradient Norm** 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 20 80 100 40 60 **Design Cycles**

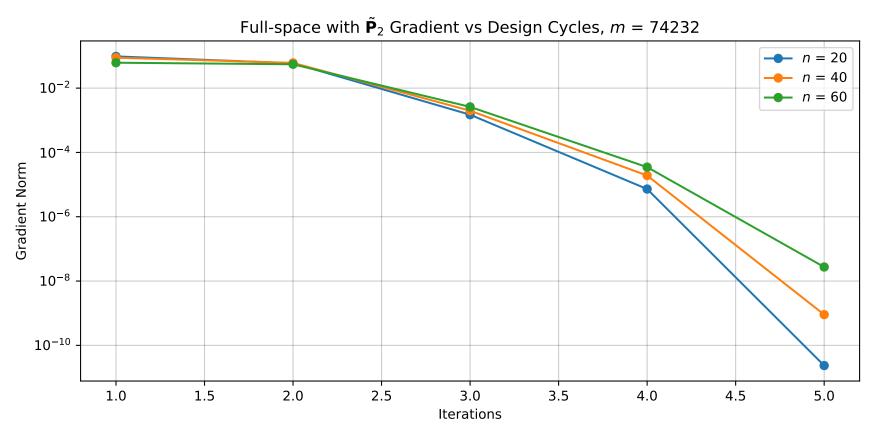




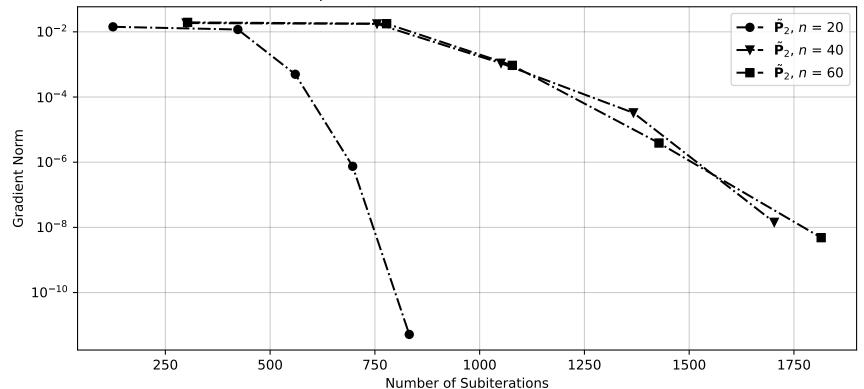








Full-space Gradient vs Subiterations, m = 8248



Full-space Gradient vs Subiterations, m = 32992 10^{-1} **→-** $\tilde{\mathbf{P}}_2$, n = 20**-▼**- $\tilde{\mathbf{P}}_2$, n = 40**-■-** $\tilde{\mathbf{P}}_2$, n = 60 10^{-3} **Gradient Norm** 10^{-7} 10^{-9}

1500

Number of Subiterations

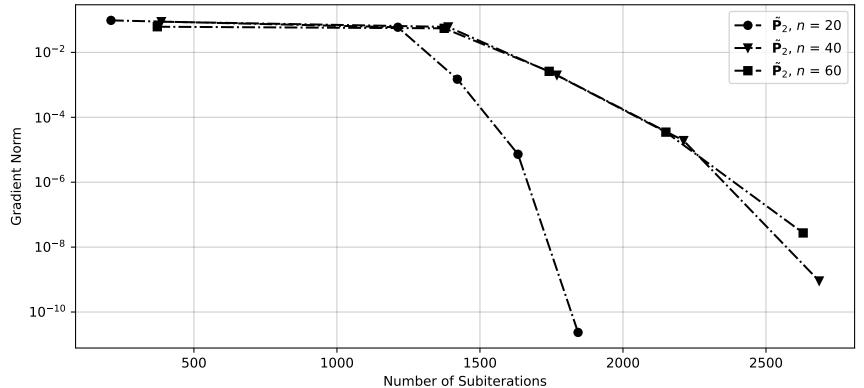
2000

2500

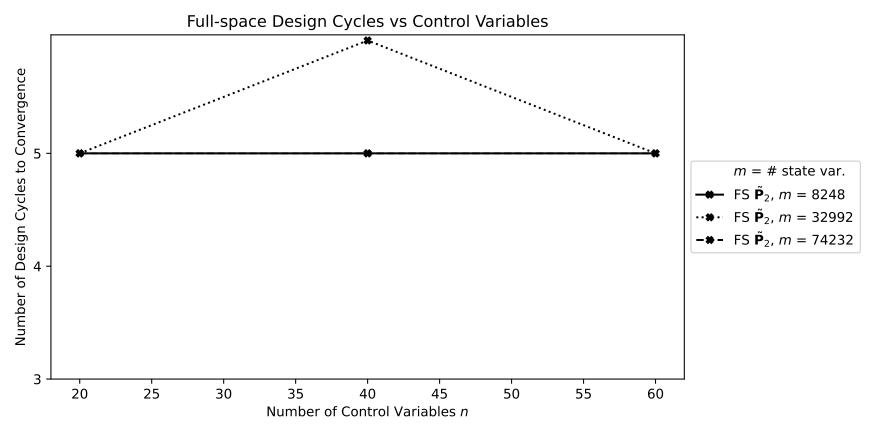
500

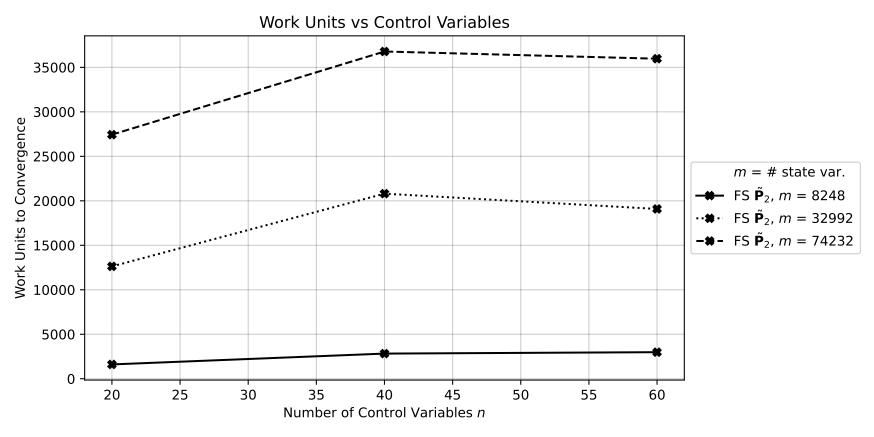
1000

Full-space Gradient vs Subiterations, m = 74232



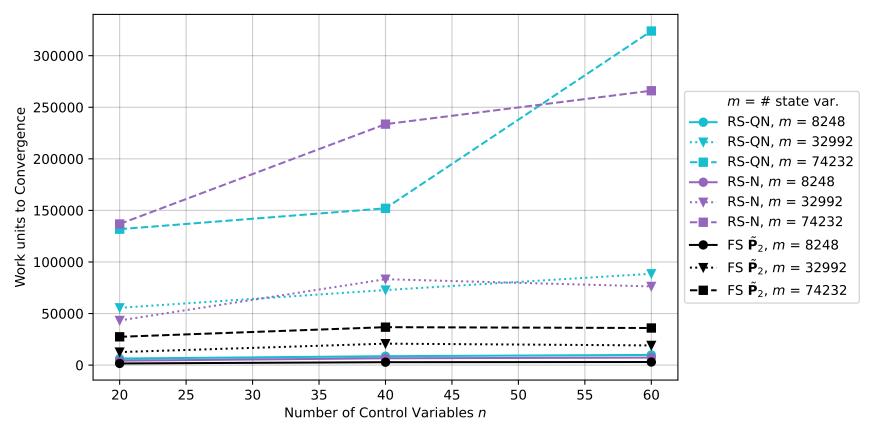
Full-space Gradient vs Subiterations State Variables, m = 8248 10^{-2} **-•** - $\tilde{\mathbf{P}}_2$, n = 20 $\mathbf{\overline{\Psi}}$ - $\tilde{\mathbf{P}}_2$, n = 40 10^{-4} **Gradient Norm -■**- $\tilde{\mathbf{P}}_2$, n = 60 10^{-6} 10^{-8} 10^{-10} State Variables, m = 32992 10^{-1} 10⁻³ **Gradient Norm** 10^{-5} 10^{-7} 10^{-9} State Variables, m = 74232 10^{-2} **Gradient Norm** 10^{-4} 10^{-6} 10^{-8} 10^{-10} 500 1000 1500 2000 2500 Number of subiterations





Total Subiterations vs Control Variables FS $\tilde{\mathbf{P}}_2$, m = 8248FS $\tilde{\mathbf{P}}_2$, m = 32992**-#-** FS $\tilde{\mathbf{P}}_2$, m = 74232**Total Subiterations to Convergence**

Number of Control Variables n



Reduced-space Design Cycles vs Control Variables RS-QN, m = 8248RS-QN, m = 32992Number of Design Cycles to Convergence RS-QN, m = 7423260 -Number of Control Variables n

Reduced-space Gradient vs Design Cycles State Variables, m = 8248- RS-QN, n = 20 10^{-2} RS-QN, n = 40**Gradient Norm** RS-QN, n = 60 10^{-4} RS-N, n = 20RS-N, n = 40 10^{-6} RS-N, n = 60 10^{-8} State Variables, m = 32992 10^{-2} **Gradient Norm** 10^{-4} 10^{-6} 10^{-8} State Variables, m = 74232 10^{-2} **Gradient Norm** 10^{-4} 10^{-6} 10^{-8} 20 40 60 80 100

Design Cycles

