



Stabilization of a Nearly Collapsed Brick Liner in a Concrete Chimney, and Subsequent Reuse of the Liner

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Background:

This concrete chimney was built in 1962 with corbel supported brick liner. The chimney is 250 feet tall, 22 feet outside diameter at top. In 1975, the liner was removed and a new independent brick liner was installed to suit the new operating conditions. (SK-1)

In early March of 2001 during an inspection, it was found that the bottom 30 to 35 feet of the liner wall had severely cracked, the wall segments had broken and bowed out. (P-6, P-6A) The air space at the bottom of the chimney was quite small (1'-8" at base), which prevented the broken liner wall segments from further bow out and total collapse. There was significant amount of debris on the floor inside the liner and in the airspace. (P-7) The top section of the divider baffle wall was broken (P-8) and many bricks were dislodged and fell on the floor.

The cracks in the liner were very wide, some in excess of 12" in width. However, the cracks looked fairly clean with no debris build up in the cracks indicating sudden failure of the liner. (P-6, SK-2)

Concern:

The concerns at this time were possible additional bow out of the liner wall which may cause serious damage to the breeching duct, the baffle wall, etc. Additional cracking may also collapse the entire liner, and in the worst-case scenario, the entire concrete chimney may collapse if a completely collapsed brick liner exerts large outward pressure from the debris build-up, which the concrete shell is not designed for.

Additional Observation:

Quick and careful inspection of the upper portion of the liner from a safe area revealed no significant cracks or bulging of the remaining portion of the liner. Also, it appeared that the close proximity of the concrete shell prevented further movement of the liner, and may have stabilized the situation for the moment.

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Stabilization Concept:

After careful evaluation of the situation, it was decided that encasement of the bottom 35 feet of the liner in a low strength grout plug will stabilize the liner from further cracking or movement which will prevent a catastrophic chimney failure.

This, of course, is easier said than done. The hydrostatic pressure at either side of the liner wall has to be nearly equal. The liquid head should be kept to a minimum. The movement of the liner, if any, has to be monitored at all times during the stabilization process. Additional radial outward force exerted by the broken liner on to the concrete shell has to be resisted. Chimney foundation has to be checked for the additional weight of concrete encasement, which may exceed 600 tons.

On to the Drawing Board:

Based on additional discussions, a decision was made to attempt to stabilize the liner to a point that it can be used for a short period of time until the planned new chimney is built in 2003. Engineering, planning, and fabrication activities started at a frantic pace and round the clock. ([SK-3](#))

Small holes were drilled around the chimney shell to obtain air space measurements and monitor any liner movement. Wide steel bands were designed to be installed on the chimney exterior. 6” diameter holes were cored around the chimney wall for placement of grout. A grout mix with flash was designed that will set within a few hours, and will have low strength which will be desirable during eventual demolition of the chimney. Height of pour will be limited to 3 feet per 24 hours to maintain low hydrostatic pressure. A method was devised to ensure same level of grout in the airspace and inside the liner to minimize differential hydrostatic load on opposite sides of liner wall.

Execution:

Frequent monitoring of the airspace around the circumference revealed no movement of the liner. Bands were installed at about 5 feet on centers ([P-12](#)).

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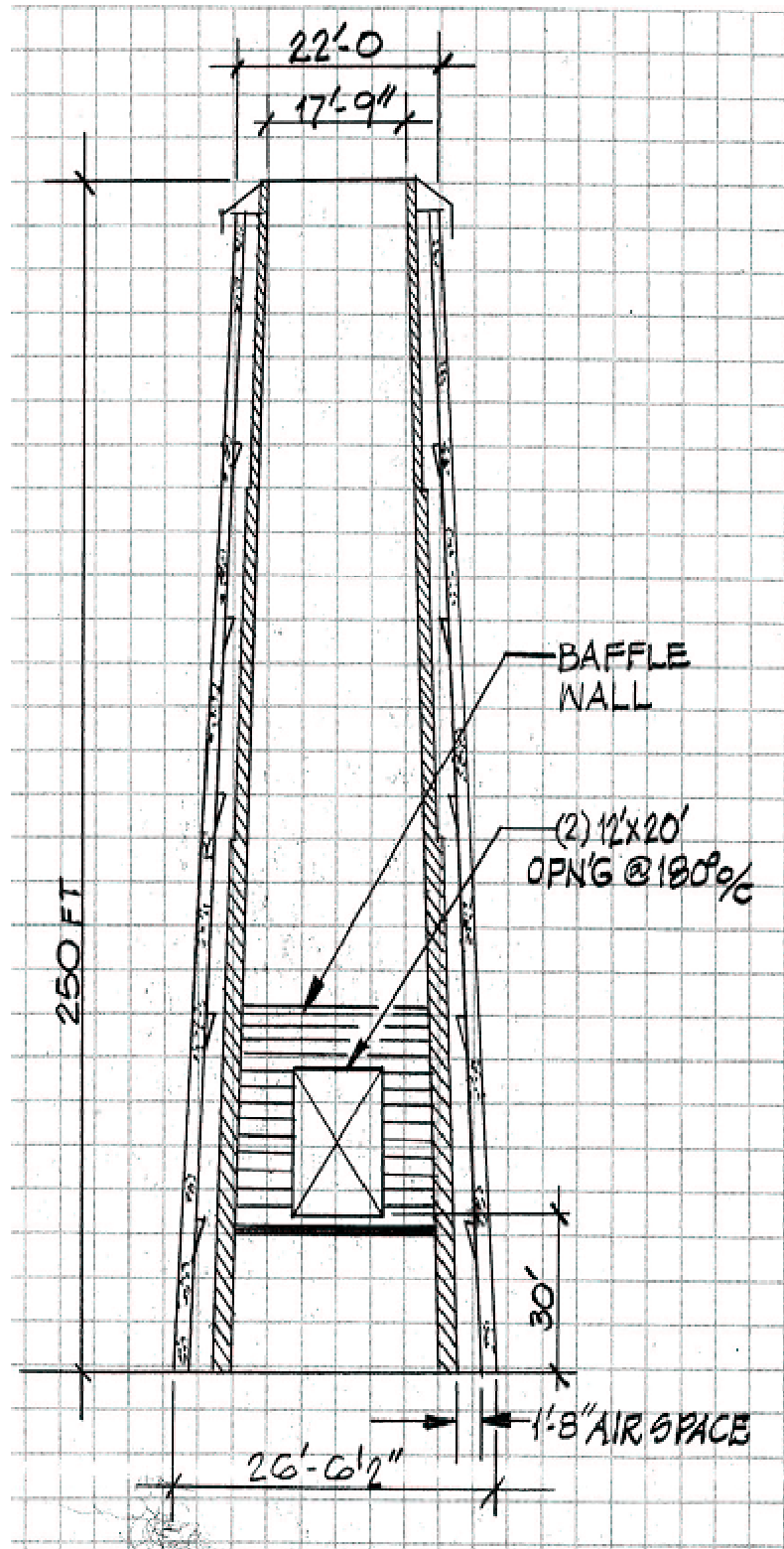
Flowable grout was placed in the airspace and in the liner simultaneously at a rate of 3 to 5 feet per 24 hours ([P-13](#), [P-14](#)). No additional movement was noticed. The stabilization project was completed successfully in 3 weeks, and the chimney was put back on line ([P-17](#)).

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SK-1



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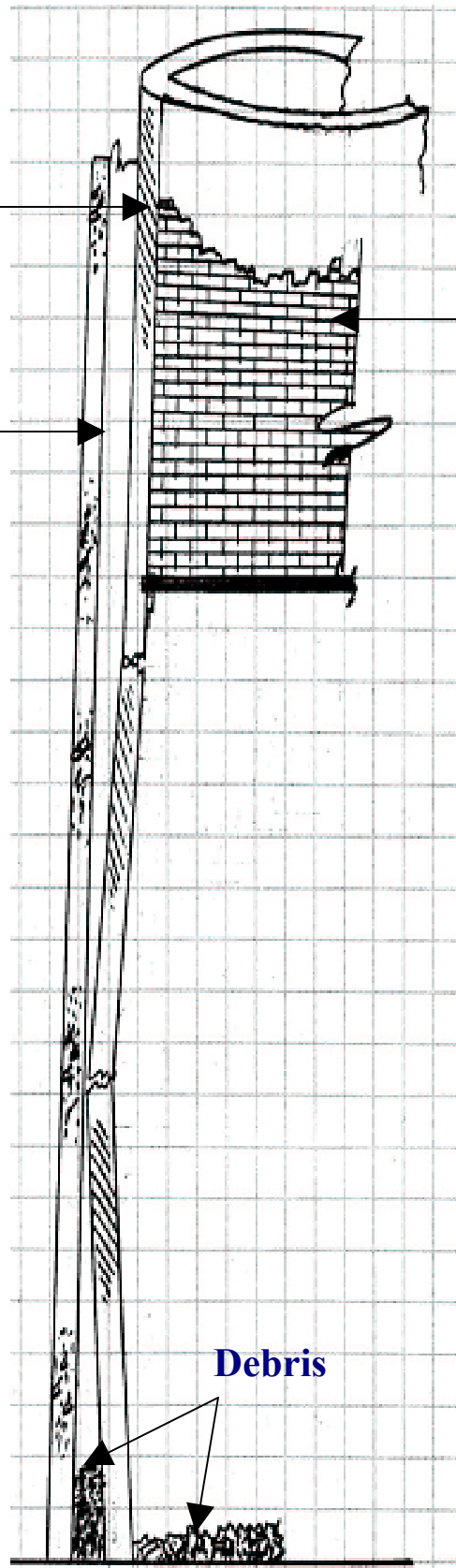
SK-2

Liner

Shell

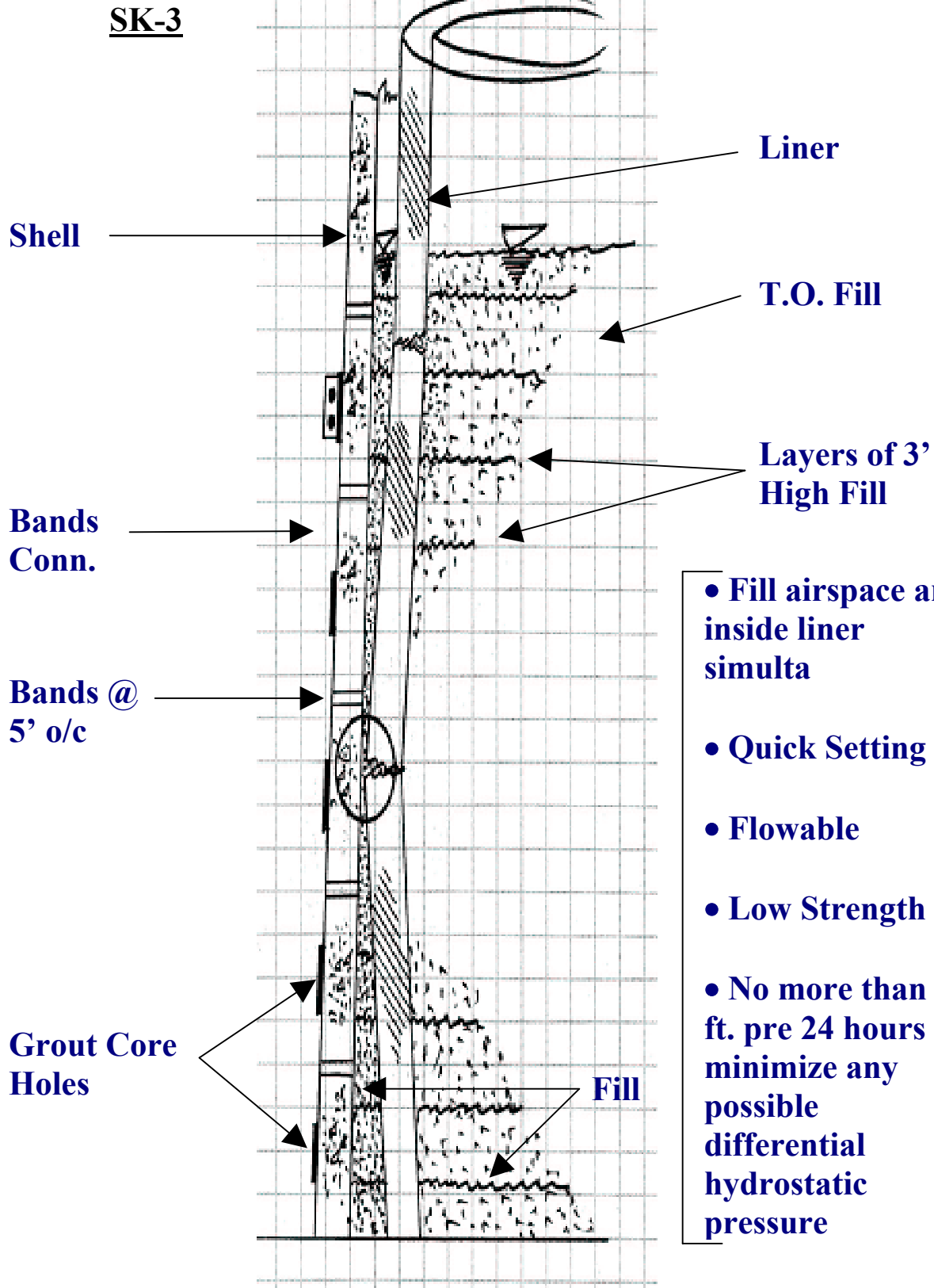
**Top of
Divider
Wall**

Debris



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- Fill airspace and inside liner simulta
- Quick Setting
- Flowable
- Low Strength
- No more than 3 ft. pre 24 hours to minimize any possible differential hydrostatic pressure

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P-6: Cracked Liner Wall



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P6-A: Cracked Liner Wall



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P-7: Clean Out Access Area



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P-8: Top of Baffle Wall



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P-12: Band Installation



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P-13: Concreting the Air Space



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P-14: Concreting inside the Liner



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P-17: Chimney back on Line



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