when the seams were discovered, and (3) the seams were the result
of postplacement saturation of low-density, high-permeability layers
of fill material. The existence of these seams and lack of evidence
near the left abutment of embankment cracking due to hydraulic
fracturing or differential settlement have changed the relative em-
phasis on the possible modes of failure. Field observations support
the possibility of
"one or more physical modes of failure involving (1) seepage at the
fill / rock contact in the bottom of the key trench, (2) seepage
through the top of the grout curtain, and (3) seepage through a
low-density high-permeability lens of fill material within or adjacent
to the right key trench." (p. iv)

However, the lack of field evidence of hydraulic fracturing of the
core of the remaining embankment has not completely eliminated
hydraulic fracturing as a possible initiating failure mechanism. The
IRG final report notes:
"Reservoir-induced hydraulic fracturing and embankment cracking
caused by differential settlement within the embankment are still
considered possible modes of failure because hydraulic-fracture
testing in the embankment in the vicinity of the left key trench
indicated the possible existence of local zones of embankment stress
low enough to allow reservoir-induced hydraulic fracturing. How-
ever, no evidence of prefailure cracking was found within the left
embankment remnant." (p. iv)

Although we have narrowed the possible initiating mechanisms to
the four or five possibilities noted in this discussion, the evidence
needed to pinpoint a single definite mechanism was removed by
erosive and plucking actions of the reservoir water released by the
failure. Thus Flagg was correct when he stated that the cause of
failure was piping of fine-grained material from the core of the dam,
but that the actual mechanism of failure may never be known.

References
U.S. DEPARTMENT OF THE INTERIOR TETON DAM FAILURE
REVIEW GROUP (1977): Failure of Teton Dam -- a report
Office, 107 pp., 9 appendices (638 pp.).
U.S. DEPARTMENT OF THE INTERIOR TETON DAM FAILURE
REVIEW GROUP (1980): Failure of Teton Dam -- final
96 pp., 5 appendices (684 pp.).

Information concerning purchase of these reports can be obtained
from:
Water and Power Resources Service
Engineering and Research Center
Att.: 922, P.O. Box 25007
Denver, Colorado 80225 (U.S.A.)

THE INFLUENCE OF JOINTING ON FAILURE OF TETON DAM -- A REVIEW AND COMMENTARY

L'INFLUENCE DE LA FISSURATION SUR LA RUPTURE DU BARRAGE DE TETON -- REVUE ET
COMMENTAIRE

FECKER E., Department of Soil Mechanics and Rock Mechanics, Rock Mechanics Chair, University of
Karlsruhe, F. R. Germany*

Summary
The Teton Dam located on the Teton River, northeast of Newdale, Idaho U. S. A., was breached on June 5, 1976. Construction
on the project started in February 1972 and the embankment was completed in October 1975. After the failure of the dam
an Independent Panel and a Teton Dam Failure Review Group of the U. S. Department of the Interior investigated the
reasons for the disaster and reported on them. The paper reviews these reports and gives a commentary on the conclusions
made therein.

Résumé
Le barrage de Teton qui se trouve sur la rivière Teton au nord-est de Newdale, Idaho U. S. A., fut rompu le 5 juin 1976. On
avait commencé la construction du barrage en février 1972 et en octobre 1975 la digue fut achevée. Après la rupture de la
digue une "Commission Indépendante" et un groupe d'investigation de l'U. S. Department of the Interior ont étudié les
causes de l'accident et en ont fait un rapport. Cette publication présente les résultats principaux de ce rapport et commente
les conclusions que l'on en a tirées.

Introduction
Engineering geologists are always grateful for the experience gained
by the failure of dams, particularly, because it leads to improvement
in the methods of design and construction by demonstrating the
deficiencies of the approach used. I am indebted to the Independent
Panel (1976) and to the U. S. Department of the Interior Teton
Dam Failure Review Group (1977), set up to review the cause of the
Teton Dam failure, for their comprehensive reports. The paper
reviews these two reports and gives a commentary on the conclusions
made therein.

* Dr.-Ing. Dipl.-Geol. E. Fecker, Institut für Bodenmechanik und Felsmechanik, Lehrstuhl für Felsmechanik, Kaiserstraße 12, D-7500 Karls-
ruhe (F. R. Germany)
The chronology of failure events is shown in Fig. 1. The locations of visual events associated with the failure are:

1. Two springs with estimated flow of 40 gal/min and 60 gal/min of clear water from right abutment, 1,300 feet and 1,500 feet, respectively, downstream from toe of dam, elevation 5030 ft, June 3, 1976.

2. Spring with estimated flow of 10 to 20 gal/min of clear water, from right abutment, 150 to 200 feet downstream of toe of dam, June 4, 1976.

3. Leak at elevation 5045, 750 feet downstream from centerline station 17+25 flowing turbid water from right abutment first observed between 7:30 a.m. and 8:00 a.m., first estimated flow of 9000 gal/min to 13500 gal/min at 8:30 a.m., second estimate of 18000 gal/min to 22500 gal/min at 9:30 a.m., June 5, 1976.

4. Erosion of channel through fine material overlying zone 5, along right groin of dam between elevation 5200 and elevation 5045, occurred sometime during morning of June 5, 1976.

5. Leak at elevation 5200, 283 feet downstream of station 15+05, flowing turbid water from right abutment, estimated at 900 gal/min at 9:10 a.m., first observed at 7:00 a.m.

6. Initial location of leak from embankment that developed between 10:00 a.m. and 10:30 a.m., initially estimated flow of 6750 gal/min of turbid water, elevation 5200, 15 feet from right abutment and 283 feet downstream from station 15+25.

7. Erosion gully extent at approximately 11:00 a.m.

8. Whirlpool developed at 11:00 a.m., 130 feet upstream from station 14+00.

9. Additional extent of erosion gully developed between 11:00 a.m. and 11:45 a.m.

10. Sink hole developed about 11:45 a.m. at station 14+00 and elevation 5315.

11. Upstream erosion gully developed between 11:45 a.m. and 11:57 a.m., when dam was breached (IRG 1977).

The erosion of the embankment subsequent to 11:30 a.m., and indeed the entire failure sequence, occurred with great rapidity. It took only 5 hours from the time of the first observed seepage in the immediate proximity of the dam until the dam failed. From the time at which the dam was last observed to have no visible leakage, 9:00 p.m. the previous night, only 15 hours were required to breach the 90 m high dam.

The tragic consequence was the loss of eleven lives and the disrupted lives of the 25,000 people who were left homeless as a result of the flooding. It is now estimated that the total claims to be paid for damage of private and public property is more than 400 million U. S. Dollars.