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CITE: (U) (b) (2)

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SERIAL: (U)

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COUNTRY: (U) NORTH KOREA (KN).

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SUBJ: (b) (2) NORTH KOREA RESEARCHED TECHNOLOGY TO PROTECT UNDERGROUND FACILITIES FROM BUNKER PENETRATING BOMBS (U)

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WARNING: (U) THIS IS AN INFORMATION REPORT, NOT FINALLY EVALUATED INTELLIGENCE. XXXX XXXXXX XX XXXXXXXXXX XXXXXXXXXXXX.

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DEPARTMENT OF DEFENSE

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DOI: (U) 20061200.

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SUMMARY: (U) NORTH KOREA PROBABLY CONDUCTED RESEARCH WITH STEEL LINERS IN TUNNELS TO PREVENT DAMAGE FROM BUNKER PENETRATING BOMBS. ENCLOSURE.

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TEXT: 1. (U) RESEARCHERS AT THE INSTITUTE OF CONSTRUCTION SCIENCE, P'YONGYANG UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS CALCULATED THE STRESS ON TUNNELS GENERATED BY GROUND VIBRATION FROM BLASTING. THE RESEARCHERS USED COMPUTER SIMULATIONS TO DETERMINE THE MOST EFFECTIVE USE OF STEEL LINERS IN TUNNELS TO PREVENT DAMAGE FROM BUNKER PENETRATING BOMBS. THE INSTITUTE OF CONSTRUCTION SCIENCE, P'YONGYANG UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS, WAS COMPRISED OF 10 LABORATORIES IN 2006.

2. (U) CALCULATION OF STRESS ON TUNNEL SECTIONS

RESEARCHERS OF THE P'YONGYANG UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS CALCULATED THE STRESS GENERATED ON THE RECTANGULAR SECTION OF A TUNNEL USING THE RESPONSE DISPLACEMENT METHOD AND THE FINITE ELEMENT METHOD. THE RESEARCHERS ALSO USED COMPUTER SIMULATIONS OF BLASTS TO IMPROVE THE DESIGN OF TUNNEL LINERS. THE RESULTS WERE PUBLISHED IN THE FOLLOWING TWO PAPERS.

A. (U) RESPONSE DISPLACEMENT METHOD (b)(7)(E)

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- TITLE -- CALCULATION OF THE STRESS GENERATED ON THE RECTANGULAR SECTION OF A TUNNEL

- AUTHOR -- ((KIM)) KYO'NG-IL, A STAFF MEMBER AT THE UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS (FIELD COMMENT -- PROBABLY MEANS THE P'YONGYANG UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS).

- SUMMARY -- THE AUTHOR CALCULATED THE STRESS ON THE RECTANGULAR SECTION OF A TUNNEL LINING GENERATED BY GROUND VIBRATION FROM BLASTING. THE RESEARCHER CREATED NUMERICAL MODELS OF THE GROUND AND THE LINER AND USED THE RESPONSE DISPLACEMENT METHOD IN THE CALCULATION OF THE NUMERICAL MODELS. AS A RESULT, IT WAS DISCOVERED THAT THE AMOUNT OF REINFORCING STEEL USED FOR A LINER CAN BE REDUCED UP TO 85 TO 90 PERCENT. PARAMETERS OF THE EXPLOSIVE CHARGE AND THE PROPERTIES OF THE NUMERICAL MODELS OF THE GROUND AND THE LINING FOLLOW --

- THE EXPLOSIVE CHARGE --
  - DISTANCE FROM THE CROWN TO THE CHARGE -- 70 METERS (M)
  - AMOUNT OF THE CHARGE -- 262 KILOGRAMS (KG)
- THE NUMERICAL MODEL OF THE GROUND --
  - GROUND PROPERTY -- ROCK MASS
- THE NUMERICAL MODEL OF THE LINER --
  - SHAPE OF THE LINING -- ARCH-SHAPED. SOURCE INCLUDED A DRAWING WHICH SHOWS THE AXIALLY SYMMETRIC RIGHT HALF OF THE LINER TO THE PLUMB LINE PENETRATING THE RECTANGULAR SECTION OF THE LINER (ENCLOSURE) AND MAXIMUM STRESS AT FOUR POINTS ON THE LINER. THE DIMENSIONS OF THE LINER SECTION WERE AS FOLLOWS --
  - X-SECTION WIDTH -- 2 M
  - WALL HEIGHT -- 1.5 M
  - CROWN HEIGHT -- 0.5 M
  - LINING THICKNESS -- 0.25 M

B. (U) FINITE ELEMENT METHOD (b)(7)(E)

- TITLE -- CALCULATION OF STRESS GENERATED ON RECTANGULAR SECTION OF A TUNNEL USING THE FINITE ELEMENT METHOD

- AUTHORS -- ((KIM)) CH'UL-LAK AND KIM KYO'NG-IL, STAFF MEMBERS AT THE UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS.

- SUMMARY -- THE AUTHORS CALCULATED THE STRESS GENERATED ON THE SIDES OF THE LINING BY GROUND VIBRATION FROM BLASTING. THE AUTHORS USED THE FINITE ELEMENT METHOD IN THEIR CALCULATIONS AND CREATED

NUMERICAL MODELS OF THE GROUND AND THE LINING. AS A RESULT, THE MAXIMUM DISPLACEMENT, THE MAXIMUM VELOCITY, AND THE MAXIMUM ACCELERATION OF THE LINER WERE DETERMINED TO BE PLUS 0.733 MILLIMETERS (MM), MINUS 0.04789 M PER SECOND (M/S), AND MINUS 4.079 M/S, RESPECTIVELY. THE AUTHORS USED THESE VALUES TO CALCULATE THE STRESS ON THE LINING. PARAMETERS OF THE EXPLOSIVE CHARGE AND THE PROPERTIES OF THE NUMERICAL MODELS OF THE GROUND AND THE LINING FOLLOW --

- THE EXPLOSIVE CHARGE --
  - WAVELENGTH OF VIBRATION FROM BLASTING -- SHORTER THAN THE PERIMETER OF THE LINING
  - DISTANCE FROM THE CHARGE TO THE LINER -- 20 M
  - AMOUNT OF THE CHARGE -- (FIELD COMMENT -- NOT SPECIFIED)
- THE NUMERICAL MODEL OF THE GROUND --
  - GROUND PROPERTY -- ROCK MASS
  - LONGITUDINAL WAVE PROPAGATION VELOCITY IN THE GROUND -- 4,000 M/S (FIELD COMMENT -- EQUIVALENT TO THAT IN GRANITE)
  - UNIT WEIGHT OF ROCK MASS -- 18 KILONEWTONS PER CUBIC M (KN/CU M)
- THE NUMERICAL MODEL OF THE LINER --
  - SHAPE OF THE LINING -- CYLINDRICAL
  - LINING DIAMETER -- 4 M
  - LINING THICKNESS -- 0.5 M
  - UNIT WEIGHT OF THE LINING -- 22 KN/CU M

3. (U) CALCULATION OF LONGITUDINAL STRESS (b)(7)(E)

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SOURCE PUBLISHED A PAPER BY KIM KYO'NG-IL TITLED CALCULATION OF THE STRESS GENERATED IN THE LONGITUDINAL DIRECTION ON A TUNNEL. COMPUTER SIMULATION OF ONE BLAST WAS USED TO IMPROVE THE DESIGN OF TUNNEL LINER. THE PAPER IS SUMMARIZED AS FOLLOWS. THE AUTHOR CALCULATED THE STRESS GENERATED IN THE LONGITUDINAL DIRECTION OF THE LINER BY VIBRATION FROM SUBSURFACE GROUND BLASTING. THE RESEARCHERS CREATED NUMERICAL MODELS OF THE GROUND AND THE LINING AND THE RESPONSE DISPLACEMENT METHOD WAS USED IN THE CALCULATION OF THE NUMERICAL MODELS. AS A RESULT, THE DISPLACEMENT GENERATED IN THE LONGITUDINAL DIRECTION OF THE LINING WAS FOUND TO BE 0.0541 CENTIMETERS (CM), THE STRESS ON THE LINER WAS 282.563 KN PER SQUARE M (SQ M), AND THE STRAIN TRANSMISSIBILITY WAS 0.67847. PARAMETERS OF THE EXPLOSIVE CHARGE AND THE PROPERTIES OF THE NUMERICAL MODELS OF THE GROUND AND THE LINING FOLLOW --

- THE EXPLOSIVE CHARGE --
  - WAVELENGTH OF VIBRATION FROM BLASTING -- LONGER THAN THE PERIMETER OF THE LINING
  - DISTANCE FROM THE LINING TO THE CHARGE -- 50 M
  - AMOUNT OF THE CHARGE -- 1,000 KG
  - SHAPE OF THE CHARGE -- SPHERICAL
- THE NUMERICAL MODEL OF THE GROUND --

- GROUND PROPERTY -- UNSTABLE
- SPRING CONSTANT OF THE GROUND -- 4 TIMES 10 TO THE POWER OF 6 KN/SQ M
- MAXIMUM VELOCITY AMPLITUDE -- 0.25 (b)(7)(E)
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- THE NUMERICAL MODEL OF THE LINER --
- SHAPE OF THE LINING -- CYLINDRICAL
- INSIDE DIAMETER OF THE LINING -- 3 M
- LINING THICKNESS -- 0.5 M
- LINING DEPTH FROM THE SURFACE -- SHALLOW
- SPRING CONSTANT OF THE LINER -- 2.65 TIMES 10 TO THE POWER OF 7 KN/SQ M

4. (U) P'YONGYANG UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS

THE INSTITUTE OF CONSTRUCTION SCIENCE, P'YONGYANG UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS, HAD 10 LABORATORIES, INCLUDING THE LABORATORY OF ARCHITECTURE, THE LABORATORY OF STRUCTURAL MECHANICS OF CONSTRUCTION, THE LABORATORY OF ORGANIC MATERIAL, THE LABORATORY OF SURVEY, AND THE LABORATORY OF INORGANIC BUILDING MATERIALS (b) (2) ACCORDING TO THE ATLAS OF THE DPRK PUBLISHED IN 1997, THE P'YONGYANG UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS IS LOCATED AT 39 DEGREES 01 MINUTE NORTH LATITUDE AND 125 DEGREES 48 MINUTES EAST LONGITUDE (b) (2)
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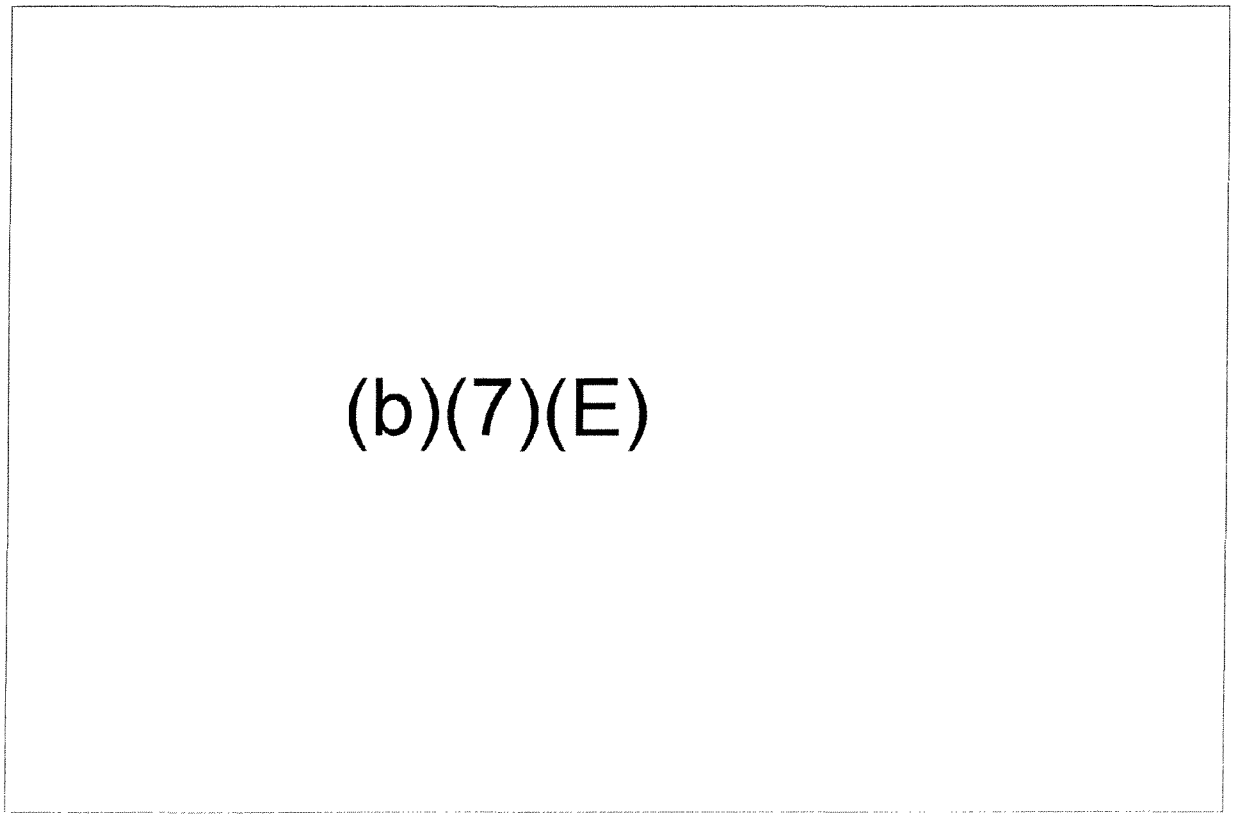

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DISSEM: (U) FIELD -- NONE.
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