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CITE: (U) (b) (2)

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COUNTRY: (U) NORTH KOREA (KN).

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SUBJ: (b) (2) NORTH KOREA DEVELOPED UNDERGROUND STRUCTURES IN SOFT ROCK MASS WITH LARGE DOMED, DOUBLE CEILINGS (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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SUMMARY: (U) NORTH KOREA FILED A PATENT APPLICATION FOR A METHOD OF CONSTRUCTING AN UNDERGROUND STRUCTURE IN SOFT ROCK MASS WITH A DOMED DOUBLE CEILING WITH LARGE CROSS SECTIONS IN 2001. THE DOMED UNDERGROUND STRUCTURE WILL POSSIBLY BE USED FOR POWER PLANTS OR OTHER MILITARY-RELATED CONSTRUCTION. ENCLOSURE.

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TEXT: 1. (U) RESEARCHERS OF THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA (DPRK) EVALUATED THE ROCK MASS VISCOSITY TO DESIGN UNDERGROUND STRUCTURES. OTHER RESEARCHERS CALCULATED THE BEDROCK LOAD OF ARCHED TUNNELS. A DPRK RESEARCH GROUP FILED A PATENT APPLICATION FOR A METHOD TO CONSTRUCT AN UNDERGROUND DOME STRUCTURE WITH A LARGE CROSS SECTION.

2. (U) ROCK MASS EVALUATION METHOD (b)(7)(E)
(b)(7)(E)

A. (U) AUTHOR

THE AUTHOR IS ((KIM)) SO'NG-HAK, P'YONGYANG UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS.

B. (U) TITLE

THE TITLE OF THE METHOD IS "ROCK MASS VISCOSITY EVALUATION FOR UNDERGROUND STRUCTURE DESIGN".

C. (U) SUMMARY

THE AUTHOR DEVELOPED A NUMERIC MODEL TO EVALUATE ROCK MASS VISCOSITY. THIS IS AN IMPROVED VERSION OF THE KELVIN-VOIGT MODEL WHICH SHOWS DISPLACEMENT VALUE OF LINING CREEP AND IS USED FOR UNDERGROUND STRUCTURE DESIGN. THE AUTHOR ANALYZED A DASH POT TO EVALUATE ROCK MASS VISCOSITY, USING THE KELVIN-VOIGT MODEL. THE TYPES OF USED ROCK MASS WERE SHALE, ARGILLACEOUS SHALE, SILT SHALE, AND SILICIC CLAY.

3. (U) BEDROCK LOAD CALCULATION METHOD (b)(7)(E)
(b)(7)(E)

A. (U) AUTHORS

THE AUTHORS ARE ((CHU)) CH'ANG-YO'P, AND ((CHO'NG)) MIN-HUI WHO BELONG TO P'YONGYANG UNIVERSITY OF CONSTRUCTION AND BUILDING MATERIALS.

B. (U) TITLE

THE TITLE OF THE METHOD IS "METHOD OF CALCULATING BEDROCK LOAD AROUND TUNNEL LINING".

C. (U) SUMMARY

THE AUTHORS CALCULATED THE BEDROCK LOAD PLACED ON LINING BY ROCK MASS EXCAVATION DURING TUNNEL CONSTRUCTION. CONVENTIONAL METHODS INCLUDED FAILURE ZONES AROUND CROWN CAUSED BY ROCK MASS EXCAVATION IN BEDROCK LOAD CALCULATION. HOWEVER, THE METHOD DEVELOPED BY THE AUTHORS INCLUDED A LOOSENED ZONE CAUSED BY ROCK MASS EXCAVATION IN BEDROCK LOAD CALCULATION. THE WEIGHT OF LOOSENED ZONE WAS THE LOAD ON LINING DUE TO ROCK MASS PLASTIC FLOW. THE AUTHORS CALCULATED THE AXIAL FORCE AND BENDING MOMENT PLACED ON LINING BY THE WEIGHT OF LOOSENED ZONE. THEY ILLUSTRATED THE AXIAL FORCE AND BENDING MOMENT IN THE CONVENTIONAL AND AUTHORS' METHODS IN ILLUSTRATION OF LINING SHAPE AND SIZE (ENCLOSURE). THE SHAPES AND SIZES OF LINING, AS WELL AS THE AXIAL FORCE AND BENDING MOMENT IN THE CONVENTIONAL AND AUTHORS' METHODS, ACCORDING TO THE ILLUSTRATION FOLLOW.

- LINING SHAPE AND SIZE --
  - SHAPE -- ARCH
  - WALL HEIGHT -- 2.5 METERS (M)
  - BASE TO CROWN HEIGHT -- 4.0 M
  - X-SECTION WIDTH -- 6 M
- CONVENTIONAL METHOD --
  - AXIAL FORCE --
    - SIDE WALL HEIGHT 2.5 M POINT -- 122.7 KILONEWTON (KN)

- SIDE WALL BASE -- 130.6 KN
- CROWN -- 62.4 KN

- BENDING MOMENT --
- SIDE WALL HEIGHT 2.5 M POINT -- 36.4 KILONEWTON METERS (KNM)
- SIDE WALL BASE -- 11.7 KNM
- CROWN -- 31.2 KNM

- AUTHORS' METHOD --
- AXIAL FORCE --
- SIDE WALL HEIGHT 2.5 M POINT -- 90.5 KN
- SIDE WALL BASE -- 60.3 KN
- CROWN -- 46.3 KN

- BENDING MOMENT --
- SIDE WALL HEIGHT 2.5 M POINT -- 23.2 KNM
- SIDE WALL BASE -- 7.8 KNM
- CROWN -- 12.7 KNM

4. (U) CONSTRUCTION METHOD FOR LARGE DOMED CEILINGS (b) (2)

(b) (2)

A. (U) DEVELOPERS

IN 2000, ((PAEK)) T'AE-SAM, ((CHO)) HYO'NG, AND CHU CH'ANG-YO'P FILED A PATENT APPLICATION FOR A METHOD OF CONSTRUCTING AN UNDERGROUND STRUCTURE WITH A DOMED DOUBLE CEILING WITH A LARGE CROSS SECTION (FIELD COMMENT -- CROSS SECTION SIZE UNKNOWN).

B. (U) METHOD

THIS PROCESS TOOK 10 DAYS, A QUARTER OF THE TIME COMPARED TO THE CONVENTIONAL METHOD. THE CONSTRUCTION METHOD USES REINFORCING BARS HUNG FROM THE CEILING INSTEAD OF FORMS AND BEAMS TO CONSTRUCT A DOUBLE CEILING IN THREE STEPS --

- SETUP FOUR PILLARS AND BUILD CIRCULAR TIMBERING
- PLACE EIGHT TYPES OF MEMBERS ON THE CIRCULAR TIMBERING AND FIX THEM WITH REINFORCING BARS HUNG FROM THE CEILING
- CONNECT REINFORCING BARS VERTICALLY AND HORIZONTALLY WITH JOINTS BETWEEN MEMBERS AND CAST CONCRETE.

(b)(7)(E)

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