Used of bottom ash waste from power plant and tailing as mine backfill

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Abstract. The using of bottom ash and tailing were by product from Mae Moh coal fired power plant as mine backfill. Laboratory was investigated the chemical, physical and mechanical properties of backfill containing bottom ash, tailing and cement. Using cast of backfill materials test the ability of compressive strength in box size 5x5x5 cm. Four different types of backfill that portland cement type 1 was replaced by bottom ash, in the proportion of percent 5, 10, 15 and 20 by weight uncured and cured in water for 7 and 28 days. Backfill materials characterization bottom ash have been examined in grain size distribution, chemical composition analyzed by X-ray fluorescence (XRF) of backfill material. For the mechanical property was test by uniaxial compressive strength machine. The result was found that mixing ratio of bottom ash can be used as backfill material ranging from 15-20 % by weight. The mechanical property of backfill mixture suitable for use with compressive strength from 6.4-19.7 MPa and cured in water 28 days was maximum compressive strength.

1. Introduction
Waste from Mae Moh coal fired power plant was fly ash and bottom ash. The bottom ash is the companion to fly ash in process of coal fired with an approximately amount of 20 % by volume of the total ash. It’s particle is porous, irregular and coarse grain than fly ash. The bottom ash produced annually in Thailand with an estimated amount of 750,000 tons, has been mostly dumped in landfill site.[1]

Mine backfilling that can solve such puzzles as shortage of backfilling aggregate, contamination of tailing occupied area, construction and maintenance of tailing reservoir, is an operative technology to reduce the backfilling cost, turn waste to reuse eliminate pollution effectively. Tailing cement backfilling body is a kind of low grade concrete which strength depend mainly on bond strength. [2] During the past ten years, significant studies have been completed which focused on the fundamental reasons for the strength variations between the different testing methods, other discoveries were also made which have assisted in maximizing the strength of backfill.

The objective of this paper have done the optimal ratio among cement, bottom ash and tailing based on laboratory investigation. The mechanism of bottom ash backfill will be revealed according to the physical, chemical characteristics, and mechanical properties will be evaluated based on bottom ash and cement ratio.
2. Materials and methods

In this study use the ground bottom ash size was 100 mesh and tailing was 30 mesh collected from Mae Moh power plant, Lampang province and Portland cement type 1 show in figure 1 that mix all materials ratio show in Table 1 which was replaced by bottom ash, in the proportion of percent 5, 10, 15 and 20 by weigh uncured and cured in water for 7 and 28 days. The physical properties (Bulk density, Specific gravity and Water content) and chemical analysis by X-ray fluorescence (XRF) of backfill materials show in Table 2-3, the major component of bottom ash was (SiO$_2$), (Al$_2$O$_3$), (CaO) and (Fe$_2$O$_3$), the major component of tailing was (SiO$_2$), (Al$_2$O$_3$), the major component of cement was (SiO$_2$), (Al$_2$O$_3$) and (CaO). Furthermore uniaxial compressive strength (UCS) test to evaluate mechanical property that can be use as suitable mine backfill.

![Figure 1. Backfill materials](image)

Table 1. Mixture ratio of backfill materials

| Mixture No. | Cement % | Cement (g) | Tailing (g) | Bottom Ash (g) | Water (g) |
|-------------|----------|------------|-------------|----------------|----------|
| 1C5         | 5        | 11.5       | 161         | 57.5           | 41       |
| 2C10        | 10       | 23         | 161         | 46.5           | 41       |
| 3C15        | 15       | 34.5       | 161         | 43.5           | 41       |
| 4C20        | 20       | 46         | 161         | 23             | 41       |
Table 2 Physical characteristic of backfill materials

| Sample                  | Bottom ash | Tailing | Cement |
|-------------------------|------------|---------|--------|
| Bulk density (g/cm³)    | 1.82       | 1.67    | 1.72   |
| Specific gravity (g/cm³)| 2.95       | 2.53    | 3.04   |
| Water content (%)       | 1.43       | 2.11    | 0.78   |
| Size (mesh)             | 100        | 30      | 200    |

Table 3. Chemical composition of backfill materials

| Chemical composition (%) | Bottom ash | Tailing | Cement |
|--------------------------|------------|---------|--------|
| (Na$_2$O)                | 1.10       | -       | -      |
| (MgO)                    | 1.64       | -       | 1.24   |
| (Al$_2$O$_3$)            | 17.75      | 11.27   | 5.22   |
| (SiO$_2$)                | 29.89      | 82.88   | 20.84  |
| (SO$_3$)                 | 1.83       | -       | 2.41   |
| (K$_2$O)                 | 4.37       | 0.34    | 0.22   |
| (CaO)                    | 18.68      | 0.20    | 66.28  |
| (TiO$_2$)                | 0.64       | 0.04    | -      |
| (Fe$_2$O$_3$)            | 20.42      | 2.72    | 3.2    |
| (SrO)                    | 0.17       | -       | -      |
| (ZrO$_2$)                | 0.02       | 0.04    | -      |
| (BaO)                    | 0.24       | -       | -      |
3. Results and discussion

The experimental result of cemented bottom ash backfill show that the bottom ash power plant waste has small particle, mine tailing waste has large particle and cement binder has fine particle when mixed in water to form slurry, the action mechanism of all materials active gelatinization and filling compaction and hardening are ability all component react which mineral phase in cement and its hydrates product Ca(OH)₂.

Using cast of backfill materials to test the ability of compressive strength in box size 5x5x5 cm. Four different types of mortar where Ordinary Portland cement type 1 was replaced by bottom ash, in the proportion of percent 5, 10, 15 and 20 by weight uncured and cured in water for 7 and 28 days. The test result is shown in Table 4. The result was found that mixing ratio of bottom ash can be used as backfill material ranging from 15-20 % by weight. The mechanical property of backfill mixture suitable for use with compressive strength from 6.4-19.7 MPa and cured in water 28 days was maximum compressive strength.

| Mixture No. | Uncured (MPa) | Cured in water for 7 days (MPa) | Cured in water for 28 days (MPa) |
|-------------|---------------|---------------------------------|----------------------------------|
| 1C5         | 0.8           | 1.2                             | 1.3                              |
| 2C10        | 3.0           | 4.1                             | 5.9                              |
| 3C15        | 6.4           | 8.0                             | 9.8                              |
| 4C20        | 8.0           | 11.6                            | 19.7                             |

4. Conclusion

Bottom ash waste from power plant and mine tailing can be used in the cemented backfill and can be used to replace partly cement. Initial strength of bottom ash cemented backfill is low for all mixture, but after curing in numerical control cement standard curing box for 28 days in water was found that mixing ratio of bottom ash can be used as backfill material ranging from 15-20 % by weight maximum compressive strength 19.70 MPa.
5. References

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