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Concrete production based on metallurgical waste

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Abstract:

This article discusses the use of secondary resources generated by industrial enterprises in the production of construction materials. It analyzes the potential of processing slag and other similar waste from the metallurgical industry to produce new, environmentally friendly construction products. Such technologies help reduce the consumption of natural resources and facilitate waste utilization. The study examines the technical characteristics, economic efficiency, and environmental advantages of concrete produced from metallurgical waste. According to statistical data, such concrete products are 20–30% cheaper than conventional concrete and are competitive in the market. Furthermore, reusing waste in construction reduces the amount of harmful substances released into the environment. This approach aligns with the zero-waste production concept by converting industrial waste into valuable products. As a result, it creates opportunities for achieving economically and environmentally sustainable development.

Keywords:

Construction, enterprise, industrial waste, metallurgy, cement, building materials, types of concrete

Metallurgik chiqindilar asosida beton ishlab chiqarish

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Annotatsiya:

Mazkur maqolada sanoat korxonalarining faoliyati natijasida hosil bo'ladigan ikkilamchi resurslardan qurilish materiallari ishlab chiqarishda foydalanish masalalari yoritilgan. Metallurgiya sanoatida yuzaga keladigan shlak va boshqa shu kabi chiqindilarni qayta ishlash orqali yangi, ekologik toza qurilish mahsulotlari olish imkoniyati tahlil qilingan. Bunday texnologiyalar tabiiy resurslar iste'molini kamaytirish va chiqindilarni utilizatsiya qilishga yordam beradi. Tadqiqotda metallurgik chiqindilardan tayyorlangan betonlarning texnik xususiyatlari, iqtisodiy samaradorligi va ekologik afzalliklari ko'rib chiqilgan. Statistik ma'lumotlarga ko'ra, bunday beton mahsulotlari an'anaviy betonlarga nisbatan 20–30% arzon bo'lib, bozorda raqobatbardoshdir. Shuningdek, chiqindilarni qurilishda qayta ishlatish orqali atrof-muhitga chiqariladigan zararli moddalar hajmi kamayadi. Ushbu yondashuv sanoat chiqindilarini foydali mahsulotga aylantirish orqali chiqindisiz ishlab chiqarish konsepsiyasiga mos keladi. Natijada, iqtisodiy va ekologik jihatdan barqaror rivojlanishga erishish imkoniyati yaratiladi.

Kalit so'zlar:

Qurilish, korxona, sanoat chiqindilari, metallurgiya, sement, qurilish materiallari, beton turlari

1. Kirish

Bugungi kunda ilm-fan va texnologiyalar misli ko'rilmagan sur'atlarda rivojlanmoqda. Bu jarayon sanoat sohalarida, xususan qurilish materiallari ishlab chiqarishda yangi, ekologik toza va iqtisodiy jihatdan samarali yondashuvlarni talab qilmoqda. Xususan, metallurgiya sanoatida hosil bo'ladigan chiqindilar – shlaklar, changlar, shlamlar va boshqa ikkilamchi mahsulotlar – uzoq yillar davomida tashlandiq yoki zararli moddalar sifatida qaralgan. Ammo hozirgi kunda bu chiqindilarni qurilish materiallari ishlab chiqarish jarayonlarida bog'lovchi va to'ldiruvchi sifatida qayta ishlash istiqbollari keskin ortib bormoqda. Tadqiqotlar shuni ko'rsatadiki, yiliga dunyo bo'yicha 1,5 milliard tonnadan ortiq metallurgik chiqindi hosil bo'ladi, shundan katta qismi qayta ishlanmasdan to'g'ridan-to'g'ri poligonlarga yo'naltiriladi. Bunday yondashuv nafaqat ekologik muammolarni keltirib chiqaradi, balki iqtisodiy jihatdan ham samarasizdir. Shu sababli, metallurgik

chiqindilarni qurilish sanoatida bog'lovchi va to'ldiruvchi sifatida qayta ishlash istiqbollari tobora ortib bormoqda.

Metallurgik chiqindilardan tayyorlangan beton mahsulotlari ekologik xavfsiz, iqtisodiy jihatdan tejimli hamda texnik ko'rsatkichlari bilan raqobatbardosh hisoblanadi. Tadqiqotlarga ko'ra, bunday betonlarning ishlab chiqarish tannarxi an'anaviy betonlarga nisbatan 20–30 foizga past bo'ladi. Shu bilan birga, chiqindilarni qurilishda qayta ishlatish orqali atrof-muhitga chiqarilayotgan zararli moddalar hajmini kamaytirish, tabiiy resurslar sarfini optimallashtirish va sanoat chiqindilarini utilizatsiya qilish kabi muhim ekologik masalalarga ham yechim topiladi.

2. Tadqiqot metodologiyasi

Bugungi kunda, qattiq chiqindilarning yillik yig'ilishi tez sur'atlarda ortmoqda. Masalan, AQShda har yili 4,5 million tonna, Yevropa davlatlarida 7,2 milliard tonna, Yaponiyada 1,3 milliard tonna va MDH mamlakatlarida

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2000-yilda 140–150 million tonnaga yetgan [1]. Mutaxassislarning fikriga ko'ra, har yili atmosferaga 4 million tonna zararli modda chiqariladi, ulardan 50% karbonat angidrid, 15% karbonat oksidi, 14% sulfat oksidi, 9% azot oksidi, 8% qattiq moddalardir. Iqlim o'zgarishining natijasi sifatida dengiz sathining ko'tarilishi yuzlab million kishilar uchun xavf tug'diradi.

Shu omillarni hisobga olgan holda, Respublikamizning barcha hududlarida qurilish materiallari sanoatini rivojlantirish maqsadida samarali tashabbuslar amalga oshirilmoqda. Ikkilamchi resurslardan xomashyo sifatida foydalanish iqtisodiy va ekologik jihatdan foydalidir. Ko'pchilik hollarda tabiiy materiallarni qayta ishlash orqali hosil bo'lgan ikkilamchi materiallar beton tayyorlashda to'ldiruvchi sifatida ishlatiladi.



1-rasm. Metallurgik korxona faoliyatidan

2022-yil 21-fevraldagi PQ-139-sonli qarorda uy-joy qurilishini va qurilish materiallari sanoatini qo'llab-quvvatlash bo'yicha qo'shimcha chora-tadbirlar belgilanib, 8 ta tuman (shu jumladan Forish tumani)da qurilish materiallari klasterlari tashkil etilishi nazarda tutilgan [2].

Atrof-muhitga tushayotgan qattiq chiqindilar quyidagi toifalarga bo'linadi:

1. Sanoat, qishloq xo'jaligi va shahar xo'jaligi chiqindilari.
2. Qora va rangli metallurgiya chiqindilari (shlaklar, loylar, changlar).
3. Yog'ochsozlik va o'rmon sanoati chiqindilari.
4. Issiqlik elektr stansiyalari (ISS) chiqindilari.
5. Energetika boshqarmasi chiqindilari (kul, shlak).
6. Kimyo sanoati chiqindilari (fosfogips, shisha chiqindilari, tsement changi).
7. Organik chiqindilar (rezina, plastmassa).
8. Oziq-ovqat sanoati chiqindilari (suyak, jun).
9. Yengil sanoat (paxta tozalashdan chiqqan chang, aralashmalar).

3. Natija va muhokamalar

Metallurgik chiqindilar asosida tayyorlangan betonlarning zichligi va mustahkamligi chiqindi turiga bog'liq. Masalan, og'ir betonlar (zichligi $>2500 \text{ kg/m}^3$) rangli va qora metallurgiyada hosil bo'lgan shlaklardan olinadi. Yengil betonlar (zichligi $<1800 \text{ kg/m}^3$) shlak pemza yoki granulyatsiyalangan shlakdan tayyorlanadi.

Slakli beton quyidagi turlarga bo'linadi:

- Konstruktiv;
- Issiqlik izolyatsiyalovchi;
- Hidrotexnik;
- Yo'l qurilishida;
- Kislota va haroratga chidamli.

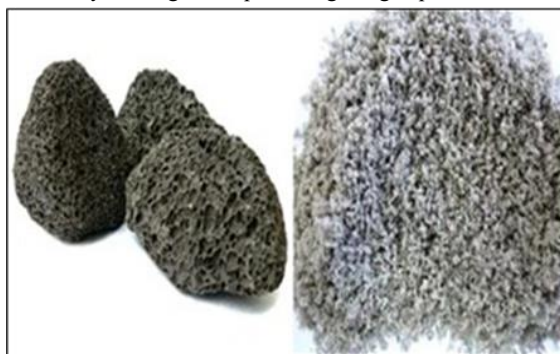
Issiqlik ta'sirida shlak betonlari mustahkamligini bir necha bor oshiradi. Ayniqsa, avtoklavda qizdirib ishlav berish orqali ularning sifati sezilarli darajada oshadi. Shlakbetonlarning sovuqqa chidamliligi ham yuqori – 600 ta muzlatib-eritish sikliga bardosh bera oladi. Shlakli issiqlikbardosh betonlar 1200°C gacha bo'lgan haroratda qo'llanilishi mumkin. Portlantsementga shlak qo'shib, $700\text{--}800^\circ\text{C}$ haroratgacha bardosh bera oladigan issiqlikbardosh beton olish mumkin.

№	Beton turi	Zichlik (kg/m^3)	Siqilishdagi mustahkamlik (MPa)
1	Og'ir shlakli beton (qora metallurgiya)	2600	35
2	Og'ir shlakli beton (rangli metallurgiya)	2500	32
3	Yengil shlakbeton (shlak pemza asosida)	1200	8
4	Yengil shlakbeton (granulyatsiyalangan shlak)	1400	10

Muhokama. Shlak pemza betoni boshqa yengil betonlarga qaraganda yorig'lanishga chidamli. Betonning zichligi $410\text{--}1600 \text{ kg/m}^3$ oralig'ida, maksimal haroratga chidamliligi esa 1000°F ($\sim 538^\circ\text{C}$) ga yetadi. Yengil issiqlikbardosh betonlar metallurgik chiqindilar (masalan, domna shlaki, shlak pemza) asosida tayyorlanadi.

Shlakli betonlarning deformatsiyalanish xususiyatlari armatura bilan yaxshi bitishuvga ega bo'lib, temir-beton konstruksiyalar tayyorlashda keng qo'llaniladi.

Shlak asosidagi betonlarning issiqlik va sovuqqa chidamlilik ko'rsatkichlari ularning tarkibiga, zichligiga hamda foydalanilgan chiqindi turiga bog'liq.



3-rasm. Shlak pemza

• Shlak pemza betoni yengil bo'lishiga qaramay, 538°C gacha issiqlikka bardosh beradi va 600 ta sikl sovuqqa chidamlilik bilan ajralib turadi. Bu uni fasadlar, issiqlik izolyatsiyasi va sovuq iqlim uchun moslashtirilgan qurilishlarda qo'llashga asos yaratadi.

• Yengil shlakli beton (granulyatsiyalangan shlak asosida) 700°C gacha bardoshli, 300 sikl sovuqqa chidamli bo'lib, o'rtacha iqlimli hududlar uchun konstruktiv va issiqlik izolyatsiyalovchi material sifatida ishlatiladi.

• Og'ir shlakli beton esa yuqori zichlik (2500 kg/m^3) va yuqori haroratga (800°C) chidamli bo'lsa-da, sovuqqa chidamliligi nisbatan past (100 sikl), bu esa uni asosan ichki konstruksiyalar yoki iliq hududlar uchun mos qiladi.

4. Xulosa

Qurilishda tabiiy materiallarning o'rni bosuvchi sanoat chiqindilari muhim ahamiyat kasb etmoqda. Og'ir va yengil shlakli betonlar sanoat chiqindilaridan – kul, shlak, yoqilg'i qoldiqlari, yonuvchi jinslar – foydalanish orqali iqtisodiy, ekologik va texnik jihatdan foydali tarzda tayyorlanadi. Xususan, og'ir va yengil shlakli betonlarni ishlab chiqarishda sanoat chiqindilari asosida aralashma tarkibini shakllantirish bir qator ustunliklarni beradi:

- Iqtisodiy jihatdan - tabiiy qum yoki shag'alga nisbatan ancha arzon yoki tekin bo'lgan chiqindi resurslardan foydalanish umumiy tannarxni sezilarli darajada kamaytiradi;
- Texnik nuqtai nazardan - kul va shlaklar betonning yengilligini, issiqlik izolyatsiyasini, va hatto bosimga chidamliligini oshiruvchi tabiiy plomba vazifasini bajaradi;
- Ekologik tomondan - chiqindilarni ikkilamchi resurs sifatida qayta ishlash orqali atrof-muhitga chiqarilayotgan zararli moddalar miqdori kamayadi, chiqindi poligonlar bosimi pasayadi, va chiqindisiz texnologiya yo'lga qo'yiladi.

Shu sababli, sanoat chiqindilaridan foydalanilgan betonlar, ayniqsa, energiya tejankor, yengil konstruksiyalar, devorbop bloklar, issiqlik izolyatsiyasi talab qilinadigan qurilmalar uchun nihoyatda maqsadga muvofiq hisoblanadi. Ular nafaqat mahalliy qurilish sanoatining texnologik darajasini oshiradi, balki barqaror rivojlanish tamoyillarini qo'llab-quvvatlaydi.

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